

UNIVERSITY OF MINNESOTA

BULLETIN

1994 - 1996



Graduate School
Bulletin

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Graduate School

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Introduction

Location

The Graduate School's main administrative offices are on the East Bank of the University of Minnesota's Twin Cities campus in Johnston Hall, 101 Pleasant Street S.E., Minneapolis, MN 55455.

Publications

Graduate School Bulletin—Prospective and current graduate students are responsible for all information contained in this bulletin that is pertinent to graduate study and their specific field.

The first section, *General Information*, is the official source of information about Graduate School policies and procedures.

The largest section, *Graduate Programs*, presents faculty, requirements, and course descriptions for the various programs offering graduate degrees. The short section that follows, *Related Courses*, features faculty and course descriptions for units offering graduate credits but not graduate degrees. The next section is called *Graduate Offerings, Duluth Campus*.

At the back are a complete set of *Campus Maps*, an extensive *Index*, and an alphabetical list of *Course Designators* with the programs under which they are found. The inside back cover, *Course Numbers and Symbols*, explains the numbering system, punctuation, department designators, and symbols used throughout the course descriptions.

The bulletin is available in the Graduate School (309 Johnston Hall) or in the Office of Admissions (240 Williamson Hall), both on the East Bank; in the Department of History (633 Social Sciences Building), West Bank; and in 130 Coffey Hall, St. Paul campus.

Updates to Bulletin Information—Changes in Graduate School policies and procedures relating to admission, registration, financial assistance, and commencement are accessible at no cost on Internet via Gopher.

Other Publications—The quarterly *Class Schedule* lists basic costs and regulations. Separate bulletins are printed for Continuing

Education and Extension, the Duluth campus, and other University units. Most may be obtained by visiting the Office of Admissions, 240 Williamson Hall.

Policies

Bulletin Use—The information in this bulletin and other University bulletins, publications, or announcements is subject to change without notice. University offices can provide current information about possible changes.

This publication is available in alternative formats upon request. Please contact the Office of Admissions, University of Minnesota, 240 Williamson Hall, 231 Pillsbury Drive S.E., Minneapolis, MN 55455 (612/625-2008).

This bulletin also is available in electronic format on Internet and may be accessed via Gopher.

Equal Opportunity—The University of Minnesota is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, color, creed, religion, national origin, sex, age, marital status, disability, public assistance status, veteran status, or sexual orientation. In adhering to this policy, the University abides by the Minnesota Human Rights Act, Minnesota Statute Ch. 363; by the Federal Civil Rights Act, 42 U.S.C. 2000e; by the requirements of Title IX of the Education Amendments of 1972; by Sections 503 and 504 of the Rehabilitation Act of 1973; by the Americans with Disabilities Act of 1990; by Executive Order 11246, as amended; by 38 U.S.C. 2012, the Vietnam Era Veterans Readjustment Assistance Act of 1972, as amended; and by other applicable statutes and regulations relating to equality of opportunity.

Inquiries regarding compliance may be directed to Patricia A. Mullen, Director, Office of Equal Opportunity and Affirmative Action, University of Minnesota, 419 Morrill Hall, 100 Church Street S.E., Minneapolis, MN 55455 (612/624-9547).

The establishment in 1988 of the Office of the Associate Provost and Associate Vice President for Academic Affairs with special responsibility for minority affairs has confirmed the University's long-standing commitment to the belief that all students, regardless of their social, racial, or economic backgrounds, have a right to equity and excellence in education. In conjunction with the faculty and other units of the University administration, this office acts as a catalyst and provides appropriate incentives, programs, and policies to facilitate access and retention among traditionally underrepresented groups. By placing this responsibility within Academic Affairs, the University has uniquely positioned itself in its ability to make excellence and diversity intrinsic components of its institutional makeup.

Disability Services—The University's mission is to provide optimal educational opportunities for all students, including those with disabilities. In general, accommodations are made on an individualized and flexible basis.

It is the responsibility of students to seek assistance at the University and to make their needs known. Disability Services provides direct assistance such as information, referral, advocacy, support, and academic accommodations (e.g., interpreters, readers) for enrolled and prospective students. For more information, contact Disability Services, University of Minnesota, 30 Nicholson Hall, 216 Pleasant Street S.E., Minneapolis, MN 55455 (612/626-1333 voice or TTY).

Access to Student Educational Records—In accordance with regents' policy on access to student records, information about a student generally may not be released to a third party without the student's permission. (Exceptions under the law include state and federal educational and financial aid institutions.) The policy also permits students to review their educational records and to challenge the contents of those records.

Some student information—name, address, electronic (e-mail) address,

telephone number, dates of enrollment and enrollment status (full time, part time, not enrolled, withdrawn and date of withdrawal), college and class, major, adviser, academic awards and honors received, and degrees earned—is considered public or directory information. Students may prevent the release of public information only during their terms of enrollment. To do so, they must notify the records office on their campus.

Students have the right to review their educational records. The regents' policy, including a directory of student records, is available for review at 150 Williamson Hall, Minneapolis, and at records offices on other campuses of the University. Questions may be directed to the Office of the Registrar, 150 Williamson Hall (612/625-5333).

Immunization—Students born after 1956 who take more than one University course are required under Minnesota law to submit a Student Immunization Record form.

The form, which is sent along with the official University admission letter, should be filled out and returned to Boynton Health Service as soon as possible, but absolutely no later than 45 days after the beginning of the first term of enrollment, in order for students to continue registering for courses at the University. Complete instructions accompany the form.

Extracurricular Events—No extracurricular events requiring student participation may be scheduled from the beginning of study day to the end of finals week. Exceptions to this policy may be granted by the Senate Committee on Educational Policy. The Senate advises all faculty that any exemption granted pursuant to this policy shall be honored and that students who are unable to complete course requirements during finals week shall be provided an alternative and timely opportunity to do so.

Smoke-Free Campus Policy—Smoking is prohibited in all facilities of the University of Minnesota, Twin Cities campus except for designated private residence hall rooms.

The Campus and Community

On the Twin Cities campus, Graduate School students enjoy the vast academic and cultural opportunities of a major university and a unique metropolitan area.

Two Campuses in One—The Twin Cities campus, the largest and oldest in the University system, is technically two separate campuses: one just east of downtown Minneapolis on the Mississippi River, the other just west of the State Fairgrounds a couple of miles from downtown St. Paul.

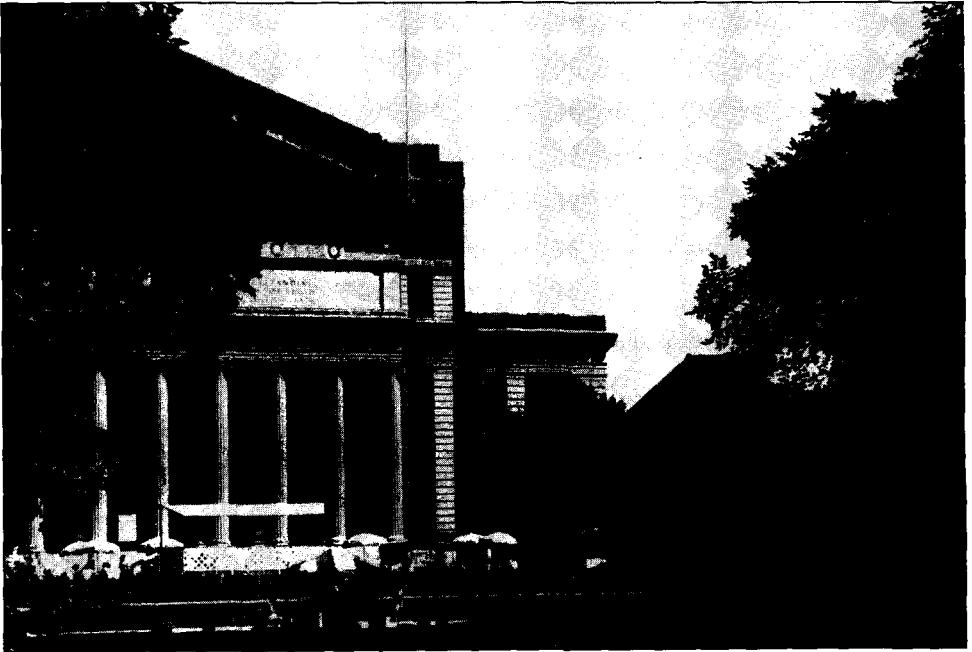
The Mississippi River divides the Minneapolis campus into two banks connected by the double-decker Washington Avenue Bridge. The picturesque mall of the main East Bank is bordered by stately traditional buildings—including Johnston Hall, home of the Graduate School. Next door is Northrop Auditorium and its plaza. On the other end of the mall, Coffman Memorial Union offers a good place to relax between classes. Nearby are unique underground facilities and the health sciences complexes.

Just across the river is the West Bank. Newer and smaller, it boasts sleek brick buildings like the main library, the Humphrey Institute of Public Affairs, the Law Center, and the new Ted Mann Concert Hall.

Three miles away is the St. Paul campus, whose animal barns, croplands, flowers, and wooded areas evoke a small college atmosphere.

Urban Diversity—The Dinkytown, Stadium Village, Seven Corners, and Cedar-Riverside areas near the Minneapolis campus, and the St. Anthony Park neighborhood alongside the St. Paul campus, all feature shops and restaurants tailored to students' interests and budgets.

Minneapolis (the largest city in Minnesota) and St. Paul (the state capital) are both flourishing centers of commerce and industry, where grandiose historic buildings complement bold new skyscrapers. Focal points of a progressive metropolitan area of 2.3 million people, the two downtowns offer many opportunities for entertainment, research, volunteer or part-time work, internships, and careers.



Arts and Entertainment—The Twin Cities are renowned for their innovative and varied cultural attractions, such as the Guthrie Theater, Ordway Music Theater, Orchestra Hall, Science Museum and Omnitheater, and Dudley Riggs' Brave New Workshop. Northrop Auditorium, the campus centerpiece, hosts performances by popular musical and dance artists and outstanding University bands and ensembles. Students can see or star in plays at the Rarig Center and summertime Showboat. Or they can enjoy the Walker Art Center and the Minneapolis Institute of Arts, the Minnesota and Como Zoos, the Mall of America, the Renaissance Festival and Valleyfair, and the Minneapolis Aquatennial and St. Paul Winter Carnival. In 1993, the University Art Museum moved into its new building overlooking the Mississippi River, the Frederick R. Weisman Art Museum, with award-winning design by Frank Gehry.

Recreation and Sports—The Rec Sports program, one of the largest of its kind on any campus in the country, offers curling, cycling, racquetball, crew, ballroom dance, juggling, and 100 other teams, clubs, and fitness activities. Big-league sports fans can view Golden Gophers or Vikings football and Twins baseball at the Metrodome. Many women's and men's intercollegiate athletic events also take place right on campus.

Outdoor enthusiasts can explore the Twin Cities' 150 parks and 200 lakes, ideal for picnicking, hiking, biking, swimming, canoeing, sailing, fishing, rollerblading or ice skating, cross-country or downhill skiing, or simply sitting and thinking. The Boundary Waters Canoe Area Wilderness, one of the most unsullied wilderness treasures in the entire nation, is only a few hours drive north.

The warmth of spring, greenery of summer, and bright colors of autumn are followed by at least three months of winter snow, but even then, daytime temperatures generally average an invigorating 10 to 30 degrees above.

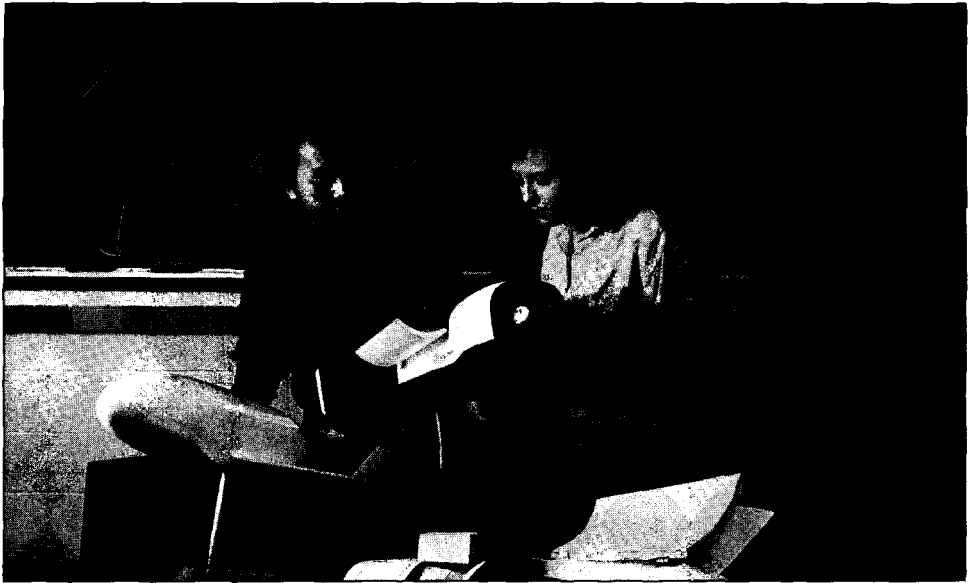
University Counseling and Consulting Services

University Counseling and Consulting Services (UCCS) offers counseling for academic, career, personal, or relationship concerns. Besides counseling, UCCS features a variety of services. The Career Development Center and the Learning and Academic Skills Center offer workshops, courses, and materials for career development or academic skills improvement. The Organizational Development Program offers consultation, assessment, team building, conflict mediation, training, and workshops. UCCS's Measurement Services office administers tests; scores exams, surveys, and research instruments for University faculty; and operates the Minnesota Statewide Testing Program for Minnesota elementary and secondary schools. The Testing Center administers admissions, placement, and national tests.

Libraries and Research Opportunities

The University of Minnesota, Twin Cities Libraries, with a collection of more than 5 million catalogued volumes and 41,000 serials, ranks 16th in size among American universities. Included in the system are the *Bio-Medical Library* (health sciences); *St. Paul Central Library* (agriculture, biological sciences, human ecology); *Walter Library* (engineering, mathematics, physics, geology); and *Wilson Library* (social sciences, humanities, special collections). Other campus libraries include those for architecture, biochemistry, entomology, forestry, horticulture, journalism, law, mathematics, music, plant pathology, and veterinary medicine. The library system also includes many specialized libraries and archives, such as the Children's Literature Research Collections and the Immigration History Research Center Archives. In addition to strong comprehensive research collections, the system offers a full range of

Introduction



reference and information services, including specialized reference assistance, interlibrary loan service, database literature searching, and library user instruction. LUMINA, the library system's online catalog, may be accessed from residence halls, offices, and other locations.

Among the University's many research centers are:

Addiction Studies, Center for
Advanced Manufacturing, Design, & Control, Center for
Agricultural Experiment Station
Alternative Plant and Animal Products, Center for
Applied Research and Educational Improvement, Center for
Archaeology Laboratory
Archaeometry Laboratory
Army High Performance Computing Research Center
Austrian Studies, Center for
Avian Research Center
Biological Process Technology,
Institute for Advanced Studies in
Biomaterials and Biomechanics, Dental Research Center for
Biomedical Engineering Center
Biomedical Ethics Center
Biometric Research, Coordinating Centers for
Building Research Center, Minnesota
Cedar Creek Natural History Area
Cereal Rust Laboratory
Chemical Toxicology Research Center
Child Welfare, Center for Advanced Studies in
Clinical Research Center
Cloquet Forestry Center
Cold Climate Housing Center
Community and Regional Research, Center for

Community Integration, Institute on
Community Studies, Center for
Conflict and Change Center
Control Science and Dynamical Systems Center
Cooperative Learning Center
COPD (Chronic Obstructive Pulmonary Disease)
Coordinating Center
Corrections Education Research, Center on
Corrosion Center
CPCRA (Community Program for Clinical Research on AIDS)
Statistical Center
CPRU (Cancer Prevention Research Unit) Statistical Center
Criminal Justice Studies, Center for
Dairy Foods Research Center
Daylighting Center, Regional
Death Education and Research, Center for
Dental Research Institute
Design Center for the American Urban Landscape
Dutch Studies, Center for
Early Childhood Research Institute
Early Education and Development, Center for
Early Modern History, Center for
Economic Development Center
Economic Education (Twin Cities), Center for
Economic Education (Duluth), Center for
Economic Research, Center for
Education in Agriculture and Extension, Center for
Educational Outcomes, National Center on
Electron Microscopy, Laboratory of
Engineering and Science Research Development Center
Entrepreneurial Studies, Carlson Center for
Epilepsy Clinical Research Program
European Studies, Center for
Experiential Education and Service Learning, Center for
Feminist Studies, Center for Advanced
Finnish Studies, Center for
Geological Survey, Minnesota

Geometry Center, The
 Gray Freshwater Biological Institute
 Herbarium
 High Resolution Microscopy Center
 History of Information Processing,
 (Charles) Babbage Institute for the
 Hormel Institute
 Horticultural Research Center
 Human Genetics, Institute of
 Hydraulic Laboratory, St. Anthony Falls
 Immigration History Research Center
 Industrial Relations Center
 Interdisciplinary Archaeological Studies
 Interdisciplinary Studies of Writing, Center for
 Interest Measurement Research, Center for
 Interfacial Engineering, Center for
 International Food and Agricultural Policy, Center for
 International Studies, Royal D. Atworth Jr. Institute for
 International Studies and Programs, Institute of
 Jewish Studies Center
 Lake Itasca Forestry and Biological Station
 Lake Superior Research, Institute of
 Landscape Arboretum, Minnesota
 Learning, Perception, and Cognition, Center for Research in
 Life Course Center
 Limnological Research Center
 Long-Term Care Administration, Center for
 Low-Vision Research, Minnesota Laboratory for
 Management Information Systems Research Center
 Mathematics and Its Applications, Institute for
 Medieval Studies, Center for
 Microelectronics Laboratory for Research and Education
 Micromagnetics and Information Technologies Center (MINT)
 MnCrash (Minnesota Center of Research in Agricultural
 Safety and Health)
 Natural Resource Policy and Management, Center for
 Natural Resources Research Institute
 Neurocommunication Research, Edwin Eddy Center for
 Nordic Studies, Center for
 North Central Soil Conservation Research Laboratory
 Nuclear Physics, Williams Laboratory for
 Occupational Health and Safety, Midwest Center for
 Philosophy of Science, Minnesota Center for
 Plant Molecular Genetics Institute
 Polymerization and Polymer Process Engineering Center
 Population Analysis and Policy, Center for
 Productivity Center
 Psychiatry Research
 Raptor Center, Gabbert
 Reflective Leadership Center
 Residential Services and Community Living, Center for
 Rock Magnetism, Institute for
 Rural Health Research Center
 Sand Plain Research Farm
 Sea Grant College Program, Minnesota
 Strategic Management Research Center
 Superconductivity, Center for Science and Application of
 Survey Research, Minnesota Center for
 Sustainable Agriculture, Minnesota Institute for (MISA)
 Technological Leadership, Center for Development of
 Theoretical Physics Institute
 TOMHS (Treatment of Mild Hypertension) Statistical Center
 Training and Development Research Center
 Transportation Studies, Center for
 Twin and Adoption Research, Minnesota Center for

Underground Research Site, Soudan
 Underground Space Center
 Urban and Regional Affairs, Center for
 Vocational Education, Minnesota Research and Development
 Center for
 Vocational Education, National Center for Research in
 Water Resources Research Center
 Women and Public Policy, Center on
 Women in International Development Research and
 Information Center
 Youth Development and Research, Center for

Research support is provided by the Graduate School as well as by the public and private sectors. The Graduate School fellowship and research support programs distribute nearly \$7 million annually to students and faculty. The University also ranks among the top research universities receiving federal research money.

Administration

University Regents

Jean B. Keffeler, Minneapolis, Chair
 Thomas R. Reagan, Gilbert, Vice Chair
 Wendell R. Anderson, Wayzata
 Julie A. Bleyhl, Madison
 William E. Hogan II, Minnetonka
 Hyon T. Kim, St. Anthony
 H. Bryan Neel III, Rochester
 Mary J. Page, Olivia
 Lawrence J. Perlman, Minneapolis
 William R. Peterson, Eagan
 Darrin M. Rosha, Owatonna
 Stanley D. Sahlstrom, St. Cloud

University Administrators

Nils Hasselmo, President
 Robert O. Erickson, Senior Vice President for Finance
 and Operations
 Ettore F. Infante, Senior Vice President for Academic
 Affairs and Provost
 C. Eugene Allen, Vice President for Agriculture,
 Forestry, and Home Economics
 William R. Brody, Provost for the Academic Health
 Center
 Melvin George, Vice President for Institutional Relations
 Anne H. Hopkins, Vice President for Arts, Sciences, and
 Engineering
 John Q. Imholte, Acting Vice President for Student
 Affairs
 Mark L. Brenner, Acting Vice President for Research and
 Acting Dean of the Graduate School
 Mark B. Rotenberg, General Counsel

Introduction

Graduate School Administrators

- Mark L. Brenner, Ph.D., Acting Vice President for
Research and Acting Dean of the Graduate School
To be announced, Acting Associate Vice President for
Research and Acting Associate Dean of the Graduate
School
- Charles F. Louis, Ph.D., Assistant Vice President for
Research and Associate Dean of the Graduate School
- Stephen C. Hedman, Ph.D., Associate Dean of the
Graduate School, Duluth
- Theodore P. Labuza, Ph.D., Associate Dean of the
Graduate School
- Kenneth C. Zimmerman, Ph.D., Associate Dean of the
Graduate School

Graduate School Executive Committee

- Mark L. Brenner, Ph.D., Acting Vice President for
Research and Acting Dean of the Graduate School
To be announced, Acting Associate Vice President for
Research and Acting Associate Dean of the Graduate
School
- Charles F. Louis, Ph.D., Assistant Vice President for
Research and Associate Dean of the Graduate
School; Chair, Graduate School Fellowship
Committee
- Theodore P. Labuza, Ph.D., Associate Dean of the
Graduate School
- Kenneth C. Zimmerman, Ph.D., Associate Dean of the
Graduate School
- James C. Klueg, M.F.A., Associate Professor, Art; Chair,
Duluth Graduate Faculty Committee
- Kent R. Bales, Ph.D., Professor, English; Chair,
Language, Literature, and the Arts Policy and Review
Council
- Edward J. Cushing, Ph.D., Professor, Ecology, Evolution,
and Behavior; Chair, Biological Sciences Policy and
Review Council
- Michael F. Graves, Ph.D., Professor, Curriculum and
Instruction; Chair, Education and Psychology Policy
and Review Council
- Kevin A. Janni, Ph.D., Professor, Agricultural
Engineering; Chair, Physical Sciences Policy and
Review Council
- Nancy J. Johnston, M.S.W., Instructor, Social Work;
Chair, Social Sciences Policy and Review Council
- To be announced; Chair, Health Sciences Policy and
Review Council
- G. David Tilman, Ph.D., Professor, Ecology, Evolution,
and Behavior; Chair, Graduate School Research
Advisory Committee
- Four student representatives
One civil service representative

General Information



History of Medicine and Biological Sciences	M.A., Ph.D.	Public Affairs	M.A.
History of Science and Technology	M.A., Ph.D.	Recreation, Park, and Leisure Studies	M.A.
Horticulture	M.S., Ph.D.	Rhetoric and Scientific and Technical Communication	M.A., Ph.D.
Hospital Pharmacy	M.S.	Russian Area Studies	M.A.
Industrial Education	M.A.	Scandinavian Studies	M.A., Ph.D.
Industrial Engineering	M.S.I.E., M.I.E., Ph.D.	Scientific and Technical Communication	M.S.
Industrial Relations	M.A., Ph.D.	Scientific Computation	M.S., Ph.D.
Interdisciplinary Archaeological Studies	M.A., M.S., Ph.D.	Social and Administrative Pharmacy	M.S., Ph.D.
Italian	M.A.	Social Work	M.S.W., Ph.D.
Japanese	M.A., Ph.D.	Sociology	M.A., Ph.D.
Kinesiology	M.A., Ph.D.	Soil Science	M.S., Ph.D.
Landscape Architecture	M.S., M.L.A.	South Asian Languages	M.A., Ph.D.
Latin	M.A., Ph.D.	Speech-Communication	M.A., Ph.D.
Liberal Studies	M.L.S.	Statistics	M.S., Ph.D.
Linguistics	M.A., Ph.D.	Surgery	M.S.Surg., Ph.D.Surg.
Luso-Brazilian Literature	M.A.	Theatre Arts	M.A., M.F.A., Ph.D.
Management of Technology	M.S.MOT.	Therigenology	M.S., Ph.D.
Mass Communication	M.A., Ph.D.	Toxicology	M.S., Ph.D.
Materials Science and Engineering	M.S., M.S.Mat.S.E., M.Mat.S.E., Ph.D.	Veterinary Biology	M.S., Ph.D.
Mathematics	M.A., M.S., Ph.D.	Veterinary Medicine	M.S., Ph.D.
Mathematics Education ¹	M.A.	Veterinary Pathobiology	M.S., Ph.D.
Mechanical Engineering	M.S.M.E., M.M.E., Ph.D.	Veterinary Surgery, Radiology, and Anesthesiology	M.S., Ph.D.
Mechanics	M.S., Ph.D.	Vocational Education	Ed.D.
Medicinal Chemistry	M.S., Ph.D.	Wildlife Conservation	M.S., Ph.D.
Microbial Engineering	M.S.	Zoology	M.S., Ph.D.
Microbiology	M.S., Ph.D.	<i>Certificate of specialist in education</i>	
Mineral Engineering	M.S., M.Min.E., Ph.D.	Counseling	
Molecular, Cellular, Developmental Biology and Genetics	M.S., Ph.D.	Elementary School Administration	
Music	M.A., M.M., D.M.A., Ph.D.	General Curriculum Supervision	
Music Education	M.A.	General Educational Administration	
Neuroscience	Ph.D.	Mathematics Education	
Neurosurgery	M.S., M.S.Nsurg., Ph.D.Nsurg.	School Psychological Services	
Nursing	M.S., Ph.D.	Secondary School Administration	
Nutrition	M.S., Ph.D.	Special Education	
Obstetrics and Gynecology	M.S., M.S.Obs. & Gyn.	Special Education Administration	
Oral Biology	M.S., Ph.D.	<i>Freestanding Minors</i>	
Otolaryngology	M.S., M.S.Otol., Ph.D.Otol.	Bioethics	
Pathobiology	Ph.D.	Building Science	
Pharmaceutics	M.S., Ph.D.	Cognitive Science	
Pharmacology	M.S., Ph.D.	Conflict Management	
Philosophy	M.A., Ph.D.	Development Studies and Social Change	
Physical Medicine and Rehabilitation	M.S., M.S.P.M. & Rehab., Ph.D.P.M. & Rehab.	Feminist Studies	
Physical Therapy	M.S.	Gerontology	
Physics	M.S., Ph.D.	Interfacial Engineering	
Planning	M.Plan.	Interpersonal Relationships Research	
Plant Biological Sciences	M.S., Ph.D.	Law	
Plant Breeding	M.S., Ph.D.	Medieval Studies	
Plant Pathology	M.S., Ph.D.	Microbial Ecology	
Political Science	M.A., Ph.D.	Museum Studies	
Psychology	M.A., Ph.D.	Political Psychology	
		Psychoneuroimmunology	
		Public Health	
		Quaternary Paleoecology	
		Religious Studies	
		Social and Philosophic Studies of Education	
		Studies in Africa and the African Diaspora	
		Studies of Science and Technology	
		Water Resources	

¹ Also see specialist certificate in education offerings at end of this listing.

General Information

Duluth Campus

<i>Major</i>	<i>Degree</i>
Applied and Computational Mathematics	M.S.
Art	M.A.
Biology	M.S.
Business Administration	M.B.A.
Chemistry	M.S.
Communication Disorders	M.A.
Computer Science	M.S.
Education	M.A.
Educational Psychology	M.A.
English	M.A.
Geology	M.S.
Liberal Studies	M.L.S.
Physics	M.S.
Social Work	M.S.W.
<i>Freestanding Minor</i>	
Linguistics	

Tuition and Fees

Current tuition for the various categories of Graduate School registration and current fees are listed in the quarterly *Class Schedule*. Summer Session tuition and fees are listed in the current *Summer Session Bulletin*.

For residents of Kansas, Michigan, Missouri, Nebraska, North Dakota, South Dakota, Wisconsin, or Manitoba who qualify for reciprocity privileges, tuition is dependent upon the state or province of residence and the program to which they are admitted. For information and forms, applicants should contact their state board of higher education or any public college or university in their state or province.

Basic Admission Requirements

Any student with a U.S. bachelor's degree or a comparable foreign degree from a recognized college or university may apply to the dean of the Graduate School for admission. Applicants with the necessary background for their chosen major field, an excellent scholastic record from an approved college or university, and appropriate professional qualifications may be admitted for graduate work on recommendation of the graduate faculty in the proposed major field and approval of the Graduate School dean. The Graduate School standard for admission

is an undergraduate grade point average (GPA) of 3.00. Many programs require a higher GPA. Applicants should consult the program to which they are applying for more specific information about admission standards.

University of Minnesota undergraduates who have no more than nine quarter credits or two courses to complete for their bachelor's degree (including both distribution and total credit requirements), if they are admitted, may register in the Graduate School to begin a graduate program while simultaneously completing their baccalaureate work.

The faculty and staff of the Graduate School encourage applications from persons of color or other groups that have been underrepresented in the student body. The Graduate School is committed to providing equal opportunity to all who seek access to its programs, facilities, and services; establishing fair educational standards and applying them equitably in making decisions about admission and academic standing; and helping to compensate for inequities in society.

For more information on admission requirements and application procedures, contact the proposed major field at the address or phone number listed for each program under Graduate Programs.

Application Procedure

Requests for application materials should be sent to the director of graduate studies in the individual program (see Graduate Programs for program addresses). Requests should specify the applicant's proposed major field and emphasis, degree objective, and date of entry.

Applicants are encouraged to apply for admission well in advance of the term in which they wish to enter the Graduate School (but no more than one year in advance of the proposed entry date). The Graduate School application, complete with all required materials, must be submitted by the following deadlines:

Fall quarter—July 15

Winter quarter—October 25

Spring quarter—December 15

Summer session, first term—April 15

Summer session, second term—May 15

Deadlines that fall on a holiday or weekend will be extended through the next regular workday.

Many major fields have established deadlines earlier than those listed above and also require additional application and supporting materials. It is the applicant's responsibility to obtain information about those deadlines and requirements from the program description in this bulletin and from the director of graduate studies for the proposed major.

Note—More detailed and up-to-date information regarding the application fee, transcripts, and test data is included in the instructions accompanying the Graduate School Application for Admission form.

Transcripts—Official transcripts of previous academic study must be submitted.

Experience at the University of Minnesota has been that often during the course of the program of study a student has need of a complete set of official credentials covering previous college and university training. Applicants are urged to request two sets of official credentials when preparing their application for admission—one to be submitted for permanent filing in the Graduate School and the other for personal use.

International Applicants—All international applicants are required to submit complete credentials. Details on the types of transcripts required are given in the Graduate School Application for Admission instructions.

Test Data—One or more of the following tests may be required as part of the application process (in addition, consult the individual program requirements under Graduate Programs):

Miller Analogies Test—A graduate-level form of the Miller Analogies Test is an alternative requirement to the Graduate

Record Examination for a few major fields and programs. Those on or near a college or university campus should contact the student counseling center, testing service, or similar office on that campus to arrange for testing. Those not near a college or university campus should write to the Psychological Corporation, 555 Academic Court, San Antonio, TX 78204, for a list of testing centers.

Graduate Management Admission Test (GMAT)—Please see the Business Administration program description under Graduate Programs. For information on registering for the GMAT, write to the Educational Testing Service, CN 6108, Princeton, NJ 08541.

Graduate Record Examination (GRE)—Most major fields request the GRE. It would be wise, therefore, for applicants to complete this test either in the senior year of undergraduate work or before filing an application for admission.

The Graduate School requires GRE General Test results from all applicants who submit undergraduate narrative transcripts or transcripts containing “pass-no credit (P-N),” “credit,” or other ungraded notations for a substantial number of courses taken during the junior and senior years or whose transcripts do not show a substantial number of letter grades during those years.

For information about the test, contact the Educational Testing Service, CN 6000, Princeton, NJ 08541. Official scores must be sent to the Graduate School office from the testing service.

Test of English as a Foreign Language (TOEFL)—The operational standard for admission to the Graduate School is a TOEFL score of 550; individual programs may require a higher TOEFL score. This test is required of all international applicants whose native language is not English, except those who will have completed 24 quarter credits (16 semester credits) in residence as a full-time student at a recognized institution of higher learning in the United States before entering the University of Minnesota. These

General Information

transfer students, however, may be asked to take locally administered English tests after arrival on campus.

Foreign Medical Graduate Examination in the Medical Sciences (FMGEMS)—

Applicants seeking admission to graduate study in clinical medical fields whose medical degrees or qualifications were conferred by medical schools outside the United States, Puerto Rico, or Canada must submit certification by the Educational Commission for Foreign Medical Graduates or evidence of a full and unrestricted license to practice medicine issued by a state or other territory under United States jurisdiction that is authorized to license physicians. For more information on certification and the FMGEMS, write directly to the Educational Commission for Foreign Medical Graduates, 3624 Market Street, Philadelphia, PA 19104, U.S.A. or phone 215/386-5900.

Additional Information—The Graduate School and individual programs within it reserve the right to request additional information for any case in which it is believed necessary.

Special Applicant Categories

Professional Development—Applicants who wish to enroll in a field in the Graduate School but are not interested in a graduate degree may apply for admission for “professional development coursework.” Applicants for professional development courses must complete the usual application materials and meet existing deadlines and admission standards. Because some major fields restrict admission to those planning on pursuing an advanced degree, applicants are advised to consult with the director of graduate studies in their proposed major field before completing application materials.

Visiting Graduate Students—Students who have registered within the previous 24 months in a graduate degree program at another recognized U.S. graduate school and wish to enroll for a summer session or single

quarter in the University of Minnesota Graduate School to earn credits to apply toward their degree program may be admitted as visiting graduate students. Applicants must meet the current University of Minnesota entrance standards. They are required to ask the dean of their graduate school to complete the Visiting Student Application (G.S. Form 57) and return it to the Graduate School, University of Minnesota, 309 Johnston Hall, 101 Pleasant Street S.E., Minneapolis, MN 55455. Submission of the application fee and a photocopy of the bachelor’s degree transcript is required.

Under no circumstances will students be permitted to register for more than one quarter or summer session as visiting students. Persons originally registering under this status who wish to apply for regular admission must follow the application procedures outlined above.

Academic Staff—Members of the University of Minnesota staff holding academic appointments above the rank of instructor or research fellow are normally not permitted to complete a graduate degree at the University. Those who wish to register for courses and transfer them elsewhere may apply for admission for “professional development coursework.”

Committee on Institutional Cooperation Traveling Scholar Program—The University of Minnesota is a participant in the Traveling Scholar Program for graduate students enrolled in CIC (Committee on Institutional Cooperation) institutions. The 14 participating universities are the members of the “Big Ten,” the University of Chicago, the University of Illinois at Chicago, and the University of Wisconsin (Milwaukee).

The program enables doctoral students at any CIC university to take advantage of educational opportunities—specialized courses, unique library collections, unusual laboratories—at any other CIC university without change in registration or increase in fees. Students may take advantage of these educational opportunities for three quarters or two semesters.

Graduate students interested in graduate course offerings not available at the University of Minnesota should confer first with their major department and major adviser concerning which of the cooperating institutions to select for program enrichment and diversification. Information on procedures for participation in the Traveling Scholar Program is available in the Graduate School Admissions Office, third floor Johnston Hall, or by calling 625-9364.

University of Minnesota Undergraduates—University of Minnesota students who have no more than 9 quarter credits or two courses to complete for their bachelor's degree (including both distribution and total credit requirements), if they are admitted, may register in the Graduate School to begin a graduate program while simultaneously completing their baccalaureate work.

Assistantships and Fellowships

Resolution of the Council of Graduate Schools in the United States—Acceptance of an offer of financial aid (such as a graduate scholarship, fellowship, traineeship, or assistantship) for the next academic year by an enrolled or prospective graduate student completes an agreement that both student and graduate school expect to honor. When a student accepts an offer before April 15 and subsequently desires to withdraw, the student may submit a written resignation for the appointment at any time through April 15. However, an acceptance given or left in force after April 15 commits the student not to accept another offer without first obtaining a written release from the institution to which a commitment was made. Similarly, an offer made by an institution after April 15 is conditional on presentation by the student of a written release from any previously accepted offer. It is further agreed by the institutions and organizations subscribing to this resolution that a copy of the resolution should accompany every scholarship, fellowship, traineeship, and assistantship offer.

Graduate Assistantships—Graduate assistantships are academic appointments that are reserved for graduate students. Appointments to teaching assistant, research assistant, or administrative fellow positions are offered through various departments. A teaching assistant helps in teaching students in a specified course or courses under the general supervision of the academic staff. A research assistant carries out activities connected with research studies that are assigned by the supporting department or principal research investigator. An administrative fellow performs 1) duties of a specialized nature connected with administration or 2) general advising functions not related specifically to a course.

To be eligible to hold one of these appointments, a student must have been admitted to the Graduate School and be registered in the Graduate School each quarter of the appointment; this applies to appointments of any percentage or any number of hours. Appointments normally do not exceed a combined total of 50 percent or 20 hours per week. Only under rare circumstances do students hold appointments of more than 50 percent time. For more specific information, refer to the Handbook for Graduate Assistants.

All students registered in the Graduate School and holding appointments as teaching assistants, research assistants, and administrative fellows at 25 percent time or more pay resident tuition rates. This same privilege applies to members of their immediate families (spouses and children). Extensions of the privilege beyond the term of qualifying appointment are subject to the following rules:

1. The qualifying appointee must have held one of the above appointments for a minimum of three academic quarters at 25 percent time or more. Two summer terms will count as one academic-year quarter.

2. After completion of the qualifying three quarters (minimum) of appointment, the use of the privilege is extended for the number of quarters the appointment was held, up to a maximum of six quarters of use.

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3. The entitlement of the qualifying appointee and members of her or his immediate family to this privilege will not extend beyond three years from the termination of the last or most recent qualifying appointment.

Graduate assistants with an appointment of 25 percent time or more during the entire quarter or semester receive a tuition benefit equal to twice the percentage of their appointment. Students with an appointment of 50 percent or more receive a 100 percent tuition benefit, not including fees. (Many fellowships that are University administered also include tuition awards.)

Each department sets its own financial aid application deadline. Unless otherwise noted, application should be made by January 15 for appointments for the ensuing academic year; applications made at other times will be considered for any available vacancies.

Graduate assistants are compensated according to a pay range established each year by the University's central administration and approved by the Board of Regents. The current pay range for graduate assistants is available from the department or the Graduate Assistant Office. Graduate students may not hold appointments for which there is no monetary compensation, nor are they allowed to hold appointments for which they receive only course credit or resident tuition rates.

Further information may be obtained from either the head of the department offering the appointment or from the Graduate Assistant Office, which distributes *The Handbook for Graduate Assistants* and the *Grapevine*, a quarterly newsletter for graduate assistants. Copies of the handbook and more information about the assistantship program at the University may be obtained from the Graduate Assistant Office, University of Minnesota, 1313 5th Street S.E., Suite 317, Minneapolis, MN 55414 (612/627-1075).

Graduate Assistant Health Care Plan—University-subsidized health insurance through Group Health, Inc., is available to most Graduate School or professional school students who hold an appointment as a

teaching assistant, research assistant, or administrative fellow (some other fellows and trainees enrolled in the Graduate School are also eligible). For these students, the University pays 50 to 100 percent of the insurance premium during the academic year (fall, winter, and spring quarters), the percentage depending on the level of appointment. *To receive this coverage, eligible students must apply for it by the enrollment deadline.* An eligible student's spouse and children may also be enrolled (at the student's expense) in a separate plan with similar benefits and clinic locations. To apply, and for further information, contact the Graduate Assistant Insurance Office, W-328 Boynton Health Service, 410 Church Street S.E., Minneapolis, MN 55455 (612/626-9536).

General College Assistantships—Graduate students are eligible to apply for teaching assistantships in the General College in mathematics, natural sciences, social sciences, writing, oral communication, and the humanities. The General College program consists of developmental and general education courses that enable underprepared students to later transfer to degree-granting colleges. Approximately 25 percent of the students in the college are from Asian/Pacific-American, African-American, Native American, and Hispanic ethnic groups.

All graduate teaching assistantships for General College are posted for at least five days in the Graduate Assistant Office, University of Minnesota, 1313 5th Street, S.E., Suite 317, Minneapolis, MN 55414 (612/627-1075). Notices of vacancies in General College may also be sent to related academic departments in other University colleges.

Graduate Fellowships—Graduate fellowships, awards based on academic merit, are available to new and currently enrolled graduate students. The Graduate School Fellowship Office, third floor Johnston Hall, administers several fellowship programs, described in detail below; a number of individual academic departments

also administer field-specific fellowships. Entering students should contact their prospective graduate program. Currently enrolled students should consult the Fellowship Office and their graduate program office for current information on fellowship opportunities. The Fellowship Office also processes applications for several international competitions, such as Fulbright Grants for graduate study abroad.

Resident Benefit for Graduate Fellows and Trainees—Graduate students who hold fellowships or traineeships are eligible for resident tuition rates, provided the award is administered by the University and the stipend is at least equal to a 25-percent-time graduate assistantship. This eligibility also extends to members of the immediate family (i.e., parent, spouse, child, or ward).

Fellowships Awarded and Administered Through the Graduate School Fellowship Office—Awards listed below are subject to change in amounts or cancellation, depending on availability of funds. The following policies govern all awards administered by the Graduate School Fellowship Office:

Supplementation—Recipients of any full-support Graduate School awards may concurrently hold an assistantship or other position at 25 percent time or less without reduction in the fellowship stipend. Recipients of full-support awards may not hold other fellowships, scholarships, grants, or similar awards that duplicate the benefits of the fellowship; they may, however, receive additional partial stipends (not administered by the Graduate School) not to exceed the value of a 25-percent-time assistantship. No part of any full Graduate School fellowship may be used to supplement other full support awards.

Terms of Award—Graduate School awards may not be renewed, used for summer study (unless specifically designated), or deferred for use in another academic year.

For New Graduate Students

GRADUATE SCHOOL FELLOWSHIPS—Those planning to enter the Graduate School for the first time in the fall quarter are eligible for these one-year fellowships, which provide for the academic year a stipend of approximately \$11,000 plus tuition at regular Graduate School rates (fees not included) and health insurance. Students must be nominated by the graduate program they plan to enter. Application must be made directly to the prospective graduate program by the program's specified deadline, but no later than mid-January.

NORWEGIAN NATIONAL TORSKE KLUBBEN FELLOWSHIP—See Endowed Fellowships below.

FELLOWSHIPS AVAILABLE FOR STUDENTS OF COLOR AND DISADVANTAGED STUDENTS

Because eligibility varies depending on the fellowship, students should contact the appropriate program office to see if they are eligible. Information can also be obtained from the Office of Equal Opportunity in Graduate Study, third floor Johnston Hall (612/625-6858; e-mail gsoe@maroon.tc.umn.edu).

Minority and Disadvantaged Student Fellowship—Students planning to enter the Graduate School for the first time in the fall quarter are eligible for these one-year fellowships, which provide a stipend of approximately \$11,000 plus tuition (fees not included) for the academic year. Departmental support following the fellowship year is included. All applicants must be nominated by the graduate program they plan to enter. About 10 fellowships are awarded by the Graduate School each year.

The CIC Predoctoral Fellowship Program

Sponsored by the 14 CIC universities, this program awards approximately 35 fellowships to members of underrepresented minority groups seeking Ph.D. degrees in a wide variety of fields. The fellowship can be used at the University of Minnesota. The CIC fellowship is a four-year award, with two years of the award provided by the CIC central office and a third and fourth year of support from the admitting department. The stipend for the first two years is approximately \$11,000 per year plus tuition. The application deadline is in early December. For complete information, write to CIC Predoctoral Fellowship Program, 803 East 8th Street, Bloomington, IN 47405.

Other Available Fellowships—The availability of other fellowships for graduate students of color changes yearly. They include the Ford Foundation Predoctoral and Dissertation Fellowships for Minorities, the National Science Foundation Minority Graduate Fellowship, the GEM Master's Fellowship, the GEM Ph.D. Engineering and Natural Science Fellowship, the MacArthur Scholars Fellowship, the National Physical Science Consortium Fellowships for Minorities and Women in the Physical Sciences, and others. Contact the Office of Equal Opportunity in Graduate Study, third floor Johnston Hall, for information. In addition, students of color should check all regular sources of support described in this bulletin.

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For Currently Enrolled Graduate Students

GRADUATE SCHOOL DOCTORAL DISSERTATION FELLOWSHIPS

—Available to Ph.D. candidates who have on file a degree program approved by the Graduate School, have passed the written and oral preliminary examinations by the nomination deadline, and have completed all program coursework by the end of spring quarter. Late April/early May deadline; program nomination required. About \$12,000 for 12 months.

GRADUATE SCHOOL DOCTORAL DISSERTATION SPECIAL GRANTS

—For dissertation research expenses for students who have passed preliminary written and oral examinations by the end of the quarter in which they apply. Deadlines: May and December. Up to \$1,500.

TUITION SCHOLARSHIPS—*Category 1:* For master's and doctoral students in the middle year(s) of their program. Partial and full waivers of tuition are available to U.S. citizens or permanent residents who have been registered for at least three quarters in the Graduate School. Preference is given to those who have completed 24 graded credits in the Graduate School (i.e., not transfer work) and who are making steady progress toward completing the degree. *Category 2:* For advanced doctoral students. Partial and full waivers of tuition are available to students who have completed all degree requirements except the thesis—written and oral examinations, program coursework, 36 thesis credits, and the residency requirement.

ENDOWED FELLOWSHIPS—Not all fellowships listed below are offered every year. Stipends are approximate and may vary from year to year. Deadlines for application are generally in mid-March unless otherwise indicated. Contact the Graduate School Fellowship Office for current information and application procedures.

Alexander P. Anderson and Lydia Anderson

Fellowship—For students who have completed either a bachelor's or master's degree at the University of Minnesota. Must be graduate students in the plant and animal sciences, e.g., agronomy, animal science, ecology, forestry, and horticulture, with preference to students involved in basic scientific research. Up to \$2,500.

Charles J. Brand Fellowship—Offered to graduate students in the plant biological sciences program. About \$9,000 plus tuition.

Class of 1890 Fellowship—Available to graduate students in the arts, sciences, or engineering. Relevant programs may nominate one candidate each. About \$4,500.

Walter B. Cline Memorial Fellowship—For students pursuing graduate study in the language or cultural history of Asia or the Moslem world. About \$4,500.

Carolyn M. Crosby Fellowship—Available to graduate students or, in rare instances, advanced undergraduates of high promise engaged in field-based botanical investigation. May be used for independent field research or for research or study at a field facility, such as the Lake Itasca Biological Station or other similar facilities. Up to \$3,000.

Norman Johnston DeWitt Fellowship—Intended to support an advanced graduate student in the humanities. About \$9,000 plus tuition.

Louise T. Dossdall Fellowship in Science—For women graduate students in any field of the natural and physical sciences who show exceptional promise for a successful career in research. About \$9,000 plus tuition.

Grants for Research Abroad—Available to graduate students who are U.S. citizens or permanent residents for research abroad. Preference to doctoral students for dissertation research. Supported in part by private foundations. Up to \$4,000.

Albert Howard Fellowship—For students who have completed either a bachelor's or a master's degree at the University of Minnesota. Each graduate program may nominate one candidate. About \$4,500.

Stanwood Johnston Memorial Fellowship—For promising graduate students in geology, geophysics, physics, chemistry, biochemistry, or microbiology. About \$9,000 plus tuition.

Harold Leonard Memorial Fellowship in Film

Study—Open to graduate students proposing a year of well-defined research or study in film history, criticism, theory, or aesthetics. About \$9,000 plus tuition.

Harold Leonard Memorial Film Study Grants—For graduate or undergraduate students in good standing at the University of Minnesota for specific research expenses in film history, criticism, or aesthetics. Up to \$3,000.

Eva O. Miller Fellowship—For graduate students beyond their first year in the areas of educational psychology, statistics and measurement, counseling psychology, and child development who are engaged in research or scholarly work. Projects may include, but are not limited to, the study of individual differences and cognitive aspects of measurement. About \$9,000 plus tuition.

Norwegian National Torske Klubben Fellowship

—Available to Norwegian nationals, both new and continuing students, for one year of study at the University of Minnesota. \$4,500 for nine months, or \$5,500 for twelve months, plus tuition for the academic year.

Shevlin Fellowship—For graduate students in the biological and agricultural sciences, basic physical and medical sciences, and liberal arts. Graduate programs in appropriate fields may nominate one candidate each. About \$9,000 plus tuition.

William W. Stout Fellowship—Open to graduate students in the humanities and social sciences who are in the intermediate years of the Ph.D. Relevant graduate programs in which the Ph.D. is offered as a major may nominate one candidate each. About \$9,000 plus tuition.

Torske Klubben Fellowship to Norway—For University of Minnesota graduate students to engage in research or study in Norway for three to ten months. Preference to advanced graduate students. \$500 per month.

Thomas F. Wallace Fellowship—Open to graduate students in the humanities and social sciences who are in the intermediate years of the Ph.D. Relevant graduate programs in which the Ph.D. is offered as a major may nominate one candidate each. About \$9,000 plus tuition.

Woman's Club of Minneapolis Fellowship—Available to a graduate student with high scholarship and leadership qualifications. Must be U.S. citizen. Special consideration given to candidates who are planning to remain in the metropolitan area. \$2,200.

Fellowships and Scholarships Awarded and Administered Through Academic Departments—*See the end of this General Information section for a listing by department.*

Office of Equal Opportunity in Graduate Study

This office on the third floor of Johnston Hall (612/625-6858; e-mail gsoeo@maroon.tc.umn.edu) provides prospective students of color and disadvantaged students with information on graduate education. It assists students with the admissions process and identifies financial aid sources. The office also administers a number of fellowships available to underrepresented students and maintains statistics on students of color.

Orientation to the Twin Cities Campus

Designed to ease graduate students' transition to the University, Graduate Student Orientation (GSO) provides information about University policies and services in an atmosphere in which graduate students can meet each other. GSO also conducts writing and library research workshops in the fall. All incoming graduate students (except those with foreign addresses) are mailed a brochure outlining GSO's schedule. For more information and additional copies of the brochure, contact the program coordinator, Graduate Student Orientation, University of Minnesota, 324 Coffman Memorial Union, 300 Washington Avenue S.E., Minneapolis, MN 55455 (612/624-0666).

In addition to this University-wide orientation service, many graduate programs offer orientation information specifically aimed at graduate students in their fields. For more information, students should contact the director of graduate studies in their major program.

Council of Graduate Students

The Council of Graduate Students (COGS) is the official governing body representing graduate students at the University. COGS provides opportunities for graduate students to participate actively in University administrative and policy decisions. Graduate students in each degree-granting program are entitled to elect one representative to serve on COGS, which also recruits student representatives for the Graduate School Policy and Review Councils, the University Senate, and many College of Liberal Arts and University-wide committees. In addition, COGS assists in providing ombudsman services for graduate students and disseminates information, primarily through the *Gradletter* and through general meetings held twice per quarter. Information on housing, University governance, and grievance procedures is available from the COGS office.

Students may contact COGS at University of Minnesota, Johnston Hall, Third Floor, 101 Pleasant Street S.E., Minneapolis, MN 55455 (612/626-1612; e-mail cogs@gold.tc.umn.edu).

Teaching Opportunity Program for Doctoral Students (TOPDS)—Funded by the Bush Foundation, TOPDS is a year-long program offered to doctoral students in a participating department or graduate program. Doctoral students who enroll in TOPDS are expected to complete the following four components: take a teaching course, practice teach, develop a teaching portfolio, and attend a minimum of one teaching workshop.

For their course on teaching, most participants select *Grad 8100—Teaching in Higher Education*, a three-credit introductory

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course on teaching methods and techniques; individual departments and the College of Education also offer courses that fulfill this requirement. For teaching practice, students prepare for and teach a minimum of three class sessions of an existing course with the assistance and feedback of a faculty mentor and a TOPDS teaching consultant. Another component of the program that helps students prepare for entering the job market is the creation of a teaching portfolio in which students document and reflect upon their teaching experience.

Interested students should consult with their program about whether it currently participates in TOPDS or will in the future.

Registration

The Graduate School operates on a quarter system, and registration ordinarily begins about six weeks before the opening of the term. Courses are also offered in a variety of fields during two summer terms of five weeks each (two terms per summer session).

New graduate students must receive notification of admission from the Graduate School before attempting to register and must obtain first-quarter registration materials from the Graduate School. New graduate students may register any time during the registration period (see below). Previously registered graduate students must follow the registration queue published in the quarterly *Class Schedule*.

Registration Deadlines—All graduate students must register before the start of classes to avoid a late registration fee. Friday of the second week of the quarter is the last day to register during fall, winter, and spring quarters. Exceptions to these deadlines will be considered only by written request to the Graduate School; such requests are not routinely granted. For University calendar and registration information and the University-wide policy governing cancel/adds, refer to the quarterly *Class Schedule*. For information about summer terms, refer to the *Summer Session Bulletin*.

Registration Requirements—Registration requirements for the various graduate degrees are specified in the subsections on degree requirements in this bulletin. Most graduate students are enrolled full time every quarter. In addition, the following requirements apply as appropriate.

1. To maintain their active status, *graduate students must at minimum register once every two years*. Those who do not register in the Graduate School during a consecutive two-year period are considered to have withdrawn; their Graduate School records are deactivated. Deactivated students may not register for courses, take examinations, submit degree program or thesis proposal forms, file for graduation, or otherwise participate in the University community as Graduate School students. Those who wish to resume graduate work must request readmission to the Graduate School (see *Readmission and Other Changes* below) *and, if readmitted, must register in the Graduate School for the quarter of readmission* to regain their active status. See *Registration Deadlines* above.

Graduate students who *have* been registered within the past two consecutive years need not register for the sole purpose of taking final written or oral examinations for the master's degree or specialist certificate, or preliminary written, preliminary oral, or final oral examinations for the doctorate.

2. Graduate students holding appointments as teaching assistants, research assistants, or administrative fellows must be registered each quarter of their appointment; this applies to appointments of any percentage or any number of hours. See *Graduate Assistantships under Assistantships and Fellowships* above for more information.

3. Each individual enrolled in a clinical residency or post-M.D. graduate training program sponsored by the University of Minnesota and directed by a clinical department of the Medical School is required to register either as a medical fellow in the Graduate School or as a medical fellow specialist in the Medical School.

4. Students receiving other types of financial aid from the University or from other agencies, international students with certain types of visas, and students who wish to use various University services and facilities may have specific registration requirements; these students are responsible for obtaining information about such requirements from the appropriate offices.

Varieties of Registration—There are two kinds of registration.

1. *Registration for Coursework*—Graduate students may register for no more than 18 credits during any single fall, winter, or spring quarter. The maximum registration permitted during a single summer term is 11 credits.

2. *Thesis Credit Registration*—Students completing a Plan A master's thesis or a professional master's degree in engineering, design project track, are required to enroll for a minimum of 16 master's thesis credits (8777) before receiving the degree. Students completing a doctoral degree are required to enroll for a minimum of 36 doctoral thesis credits (8888) before receiving the degree.

Some students who were first registered in the Graduate School before fall quarter 1983 may have their thesis credit requirement reduced or eliminated. Contact the Graduate School, 316 Johnston Hall, for more information.

Changes in Registration—During fall, winter, and spring quarters, Friday of the second week of the quarter is the last day to add a course or change sections of a course, change grading option (including to or from auditor status), or cancel a course without a "W" (indicating withdrawal) appearing on the student's transcript.

Students may *cancel* courses through Friday of the sixth week of the quarter; canceling courses after the sixth week requires the signature of both the adviser and the instructor, as well as Graduate School approval. For University calendar and registration information and the University-wide policy governing cancel/adds, refer to the quarterly *Class Schedule*. For

information about summer terms, refer to the *Summer Session Bulletin*.

Students are not permitted to change their registration after the last day of instruction of a quarter and are not permitted to register for previous quarters.

Registration Holds—Students who maintain active registration are reminded by the Graduate School to file official degree program and thesis proposal forms at times defined by the faculty of their major field (e.g., after a certain number of credits or quarters of registration). Those who fail to do so may have holds placed on their registration by the director of graduate studies. Registration holds may also be placed on students who fail to meet the standards for academic achievement and degree progress defined by their major field.

Registration holds can also be placed by other University units, such as the University Libraries and Student Accounts Receivable. Students must contact the specific unit for instructions on how to clear such holds.

In order to register for a particular quarter, students must clear any outstanding registration holds before the end of the regular registration period for that quarter. After this period, even when holds are cleared, requests to register are not routinely granted.

Readmission and Other Changes

Requests for readmission, change of major or degree objective, or change of campus within the Graduate School should be made on the Change of Status/Readmission Request form (G.S. Form 72), available from the Graduate School Admissions Office, third floor Johnston Hall.

Readmission—To maintain their active status, *graduate students must at minimum register once every two years*. Previously registered students who do not register in the Graduate School of the University of Minnesota during a consecutive two-year period will be considered to have withdrawn and must apply for readmission in order to resume graduate work.

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Change of Major or Degree Objective—

Students currently enrolled in the Graduate School who intend to change either their major or their degree objective from that originally approved by the Graduate School should request a change of status. Students who have already been awarded a degree in the Graduate School must request a change of status if they wish to pursue another degree.

Change of Campus—Students currently enrolled in the Graduate School on one campus who wish to complete their studies on another campus should request a change of status. Graduate study is currently available on the Twin Cities campus and on the Duluth campus.

Grading System

The Graduate School uses two grading systems: A-B-C-D-F and S-N. Students have the option of choosing the system under which they will be graded, except in courses in which grading has been restricted to one system with approval of the Graduate School. Only 5xxx and 8xxx courses with grades of A, B, C, and S may be applied to a Graduate School degree program. Students pursuing a Plan A master's degree or a doctoral degree are required to register for thesis credits (8777 and 8888 respectively); these registrations are not graded and therefore cannot be used to meet course credit requirements. At least two-thirds of the credits included on any degree program must be taken under the A-F system. Individual major fields have the option of specifying more stringent requirements regarding the application of S-N courses to a degree program.

Students must declare their choice of grading system as part of their initial registration. Any changes in grading option must be made as an official registration change no later than Friday of the second week of the quarter during the academic year (refer to the *Summer Session Bulletin* for summer term deadlines for changing the grading option).

For information about courses in which grading is restricted, students should consult the department offering the course (see also Minimum Grade Requirements under Master's Degree or under Doctor of Philosophy Degree below).

Incomplete Grades—The symbol "I" may be assigned by an instructor to indicate "incomplete," in accordance with provisions announced in class at the beginning of the quarter, when in the instructor's opinion there is a reasonable expectation that the student can successfully complete the work of the course. An "I" remains on the transcript until the instructor replaces it with a final A-F or S-N grade. Course instructors may, at their discretion, establish a time limit for the removal of incomplete grades. The maximum number of credits of incompletes allowable at any given time is established by each major field for its graduate students.

Retaking Courses—The Graduate School discourages the retaking of courses to improve grades. If a course is retaken, all registrations for the course remain on the student's transcript.

Grade Changes—To preserve the integrity of the graduate transcript as an accurate record of a student's academic progress, the Graduate School does not approve requests to change final grades assigned to students in prior quarters.

Credit Hour Definition

The credit hour, as defined by the University of Minnesota Senate, is equivalent to three hours of work by the student per week. "Work" includes time spent in class, in the laboratory, and in outside preparation. Independent study courses, workshops, clinics, and practicums are also assigned credit on this basis. One quarter credit, then, involves three hours of student work per week for ten weeks, or thirty hours total.

Student Transcripts and Other Records

The Office of the Registrar of the University maintains and releases the *official* University of Minnesota student transcript. Requests must be submitted in person or in writing, accompanied by the appropriate fee, to the Transcript and Certification Service, University of Minnesota, 150 Williamson Hall, 231 Pillsbury Drive S.E., Minneapolis, MN 55455 (call 612/625-5333 for current fee).

An *unofficial* copy of the transcript may be obtained at no charge by presenting a picture ID at 150 Williamson Hall or at 130 Coffey Hall (St. Paul campus), with a limit of one per day.

The Graduate School also maintains records of students who have been admitted and enrolled. In accordance with regents' policy on access to student records, students are permitted to review their educational records and to challenge the contents of those records. For information, students should contact the Graduate School, 316 Johnston Hall.

Termination of Graduate Student Status

When performance is unsatisfactory in terms of grades or normal progress toward the student's degree objective, graduate student status may be terminated. All guidelines stated in this bulletin are minimal requirements, and each program is free to set more specific terms by which progress is measured for purposes of continuation. Students are encouraged to check with the director of graduate studies in their major field for complete information about academic performance and degree progress standards and the procedures used to monitor these standards.

Students who do not register in the Graduate School during a consecutive two-year period are considered to have withdrawn; their Graduate School records are deactivated (see Registration Requirements above).

Master's Degree

The master's degree is awarded in recognition of academic accomplishment as demonstrated by a coherent program of coursework, passing of the required examinations, and the preparation of a thesis or projects.

Two Plans for the Master's Degree—The Graduate School offers the master's degree under two plans: Plan A, requiring a thesis, and Plan B, which substitutes additional coursework and special projects for the thesis. For plans offered in each major, consult the Graduate Programs section of this bulletin.

Registration Requirement for the Master's Degree—Master's degree students are required by the Graduate School to complete at least 60 percent of the coursework for their official degree programs (excluding thesis credits) as registered University of Minnesota Graduate School students; individual major fields may require a higher percentage. With the approval of the adviser, the director of graduate studies in the major, and the Graduate School, transfer coursework may make up the remaining 40 percent (maximum) of the degree coursework (see Transfer of Credits below).

Master's Plan A students are required to enroll for a minimum of 16 thesis credits (8777) before receiving the degree.

Double Counting—Students may have a maximum of 9 credits in common between two Plan A master's degrees or a maximum of 12 credits between two Plan B master's degrees or between a Plan A and Plan B master's degree.

Transfer of Credits for the Master's Degree—Unless otherwise specified under a student's major in Graduate Programs, the following rules apply to transfer of credits.

Master's degree students are required by the Graduate School to complete at least 60 percent of the coursework for their official degree programs (excluding thesis credits) as registered University of Minnesota Graduate School students. With the approval of the

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adviser, the director of graduate studies in the major (and the director of graduate studies in the minor, if the courses are for a designated minor), and the Graduate School, the transfer of up to 40 percent of the degree program coursework from any combination of the following is permitted:

1. Other recognized graduate schools;
2. Adult Special, Summer Session, and Continuing Education and Extension (CEE) registrations at the University of Minnesota.

Individual graduate programs have the option of specifying a lower percentage of coursework for transfer.

The work to be transferred must be graduate level (postbaccalaureate), must have been taken for graduate credit, and must have been taught by faculty members authorized to teach graduate courses. Credits transferred from other institutions must in addition have been taken as an enrolled, graduate-degree-seeking student and must appear on official graduate school transcripts of the institutions. University of Minnesota CEE courses must bear the special CEE transcript entry verifying that they were completed for graduate credit.

In the case of a transfer from a non-U.S. institution, the credits must have been earned in a program judged by the Graduate School to be comparable to a graduate degree program in a graduate school of a regionally accredited institution in the United States.

Regarding the transfer of coursework from either a U.S. or non-U.S. institution, if conditions are placed on a student's admission to exclude certain coursework from transfer to a Graduate School degree program, that coursework may not be transferred regardless of the level of the coursework or the status of the school or college in which it was earned.

The transfer of credits is accomplished by the inclusion of the courses on the proposed degree program. Credits that are not accepted as part of a student's degree program cannot be transferred to the Graduate School transcript.

Courses completed through independent (correspondence) study, completed through

extension or special categories at other institutions, or taken before the awarding of a baccalaureate degree cannot be transferred.

CEE Tuition Differential—For all Continuing Education and Extension (CEE) coursework taken fall 1980 or later and then transferred to a graduate degree program, students must pay the difference between the CEE rate and the Graduate School rate in effect at the time the credits were taken.

Time Limit for Earning the Master's Degree—All requirements for the master's degree must be completed and the degree awarded within seven years. The seven-year period begins with the earliest work included on the official degree program, including any transfer work. The graduate faculty in a specific program may set more stringent time requirements.

Students who are unable to complete the degree within the seven-year limit may petition the Graduate School for an extension of up to one additional year. *Extensions beyond one year are considered only in the most extraordinary circumstances.* Contact the Graduate School, 316 Johnston Hall, concerning information to be included in such a petition. To ensure timely consideration, petitions should be filed early in the quarter in which the time limit expires.

If a petition is approved, the student is notified of the expectations for progress and completion of the degree. If the petition is denied, the student is terminated from the graduate program.

Students who have been terminated under such circumstances may apply for readmission to the Graduate School; *readmission under these circumstances is not assured, however.* The faculty in the major field and the Graduate School would set any readmission conditions on the student's resumption of work toward the degree, such as registering for additional coursework, retaking written examinations, completing the degree within a specified time period, or other appropriate terms.

Official Program for the Degree—After completing 15 credits, and ordinarily not later than the third quarter of registration (the second year for the longer programs), students must file with the Graduate School an official program for the degree. The degree program form is available from the Graduate School, 316 Johnston Hall. Students list all coursework, completed and proposed, that will be offered in fulfillment of degree requirements, including transfer work (see Transfer of Credits above). If a foreign language is required for the degree, it also is specified on the degree program form. If the degree is being completed under Plan A, students include the proposed thesis title. *The members of a student's final examining committee (who are the thesis reviewers for Plan A) are appointed by the dean of the Graduate School on recommendation of the faculty in the major field at the time the student's official degree program is approved.*

The minimum credit requirements for the program are specified under the Plan A and Plan B sections below.

A degree program approved by the Graduate School must be on file before reviewers report, examination, or graduation forms can be released to the student.

Official Program for the Degree in the Clinical Medical Fields—Students are expected to file an official program for the degree, including the proposed thesis title, before the end of the second year of registration. Approval by the faculty in the major field and by the Graduate School indicates a student's admission to candidacy for the degree. Students should include on the official program forms only the minimum number of credits actually required for the award of the degree, rather than the full complement of credits taken during the course of the residency program.

Changes in the Approved Program—Once approved, the degree program must be fulfilled in every detail to meet graduation requirements. Changes in the program that are found necessary or desirable should be requested by completing a Graduate School petition form.

Minimum Grade Requirements—*The Graduate School requires a minimum GPA of 2.80 (on a 4.00 scale) for courses included on any official master's degree program.* Courses with grades of A, B, C, and S may be included in the official degree program, but grades of S are not calculated in the GPA. Students pursuing a Plan A master's degree are required to register for thesis credits (8777); these registrations are not graded and therefore cannot be used to meet course credit requirements. *At least two-thirds of the course credits included on any degree program must be taken A-F.*

Individual major fields have the option of setting higher grade requirements and specifying more stringent requirements regarding the application of S-N courses to a degree program; students should be familiar with any special requirements in their major field.

Language Requirement—See Graduate Programs to determine the language requirement, if any, for a specific major field. The Graduate School monitors the fulfillment of language study when a major field requires a language. Information on how to demonstrate proficiency, and on the conditions under which proficiency will be recorded on the official transcript, is available from the Graduate School, 316 Johnston Hall.

Use of Human Subjects in Research—All research on the Twin Cities, Duluth, Morris, and Crookston campuses that involves the use of human subjects must be reviewed and approved by the Institutional Review Board: Human Subjects Committee before initiation. This policy, approved by the University Senate and Board of Regents, applies to funded and nonfunded faculty, staff, and student research. All research projects, including Plan B projects, theses, and dissertations, that involve human subjects must be approved by this committee to ensure that the rights and welfare of the subjects are protected. For additional information, contact the committee office at 1300 South 2nd Street, Suite 10, Minneapolis, MN 55454 (612/624-9829; fax 612/626-9755).

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Clearance for Graduation—Degrees are awarded at the end of each month. To qualify for graduation for a particular month, students must submit the Application for Degree form on or before the first workday of that month and must complete the final examination and all other requirements (including submission of all necessary forms) by the last workday of that month.

Commencement Ceremony—Two Graduate School commencement ceremonies are held each year—in *late spring* (for January through June graduates) and in *late fall* (for July through December graduates). Graduates are encouraged, but not required, to attend. To make sure their names appear in the program distributed at the commencement ceremony, graduates must submit the Application for Degree form by the deadline specified in the Graduate School section of the *Class Schedule*.

Further Information—Students who have questions about the master's degree after reading this entire section (including the following on Plan A and Plan B) may contact the Graduate School by e-mail (gsmast@maroon.tc.umn.edu).

Plan A: Master's Degree with Thesis

Minimum Credit Requirements—Students must complete an approved program of coursework consisting of a minimum of 20 quarter credits in the major field and a minimum of 8 quarter credits in one or more related fields outside the major. All credits included in the official degree program must be in graduate-level courses. A minimum GPA of 2.80 must be maintained for all courses included on the program. Students are also required to register for a minimum of 16 master's thesis credits (8777); these registrations are not graded and therefore cannot be used to meet course credit requirements.

Students who wish to complete a designated minor (which is certified on the transcript—unlike the related fields option, which is not) must complete 9 or more quarter credits in a single field. A designated

minor must be approved by the director of graduate studies in the minor field.

For majors in clinical branches, the minor or related fields must be in nonclinical fields that will serve as a basis for the proposed clinical specialization. This fundamental work should be taken early in the program. Familiarity with those phases of the nonclinical disciplines essential to proficiency in the major specialty is required.

Thesis Credits—Students must enroll for a minimum of 16 master's thesis credits (8777) before receiving the degree. Students cannot include thesis credits in the total program credits when determining maximum transfer allowed (see Transfer of Credits above). They also cannot transfer thesis credits from other graduate institutions, double-count thesis credits between two master's degrees, or use thesis credits to meet the minimum major and related field coursework requirements for the degree.

Some students who were first registered in the Graduate School before fall quarter 1983 may have their thesis credit requirement reduced or eliminated. Contact the Graduate School, 316 Johnston Hall, for more information.

Master's Thesis

Students must demonstrate familiarity with the tools of research or scholarship in their major field, the ability to work independently, and the ability to present the results of their investigation effectively, by completing a master's thesis.

Thesis Title—The thesis title is submitted for approval as part of the information provided on the student's official degree program form. Subsequent changes in the *wording of the thesis title* only may be made without special approval. However, once the student *registers* the thesis title with the Graduate School (see Registration of the Thesis Title below), changes to the title should not be made.

Language of the Thesis—Theses must normally be written in English or in the language of instruction. *If a thesis is to be*

written in a foreign language, including a language of instruction other than English, a letter should be attached to the degree program form when it is submitted to the Graduate School. This letter should confirm that the recommended thesis reviewers (including the outside reviewer) are qualified to read, comprehend, and criticize a thesis in the foreign language.

Published Work Included in or in Lieu of the Thesis—The thesis may include materials that students have published while University of Minnesota graduate students, provided the research was carried out under the direction of the graduate faculty and approved by the adviser for incorporation into the thesis. Such publication is welcomed as the best demonstration of quality in a student's research, and the Graduate School encourages the practice. The adviser should notify the Graduate School in writing of the intention to publish part of the thesis material, but the Graduate School's approval is not required.

In cases where the thesis research is to be presented to the examining committee in the form of one or more articles that have been published, or are in a form suitable for publication, the student should contact the Graduate School, 316 Johnston Hall, for information on accommodating such a presentation to the required thesis format.

Registration of the Thesis Title—When the draft of the thesis is ready to be distributed to the thesis reviewers, the student must register the title with the Graduate School, 316 Johnston Hall, by submitting a copy of the thesis title page as it will appear in the final document. Upon submission of the thesis title page, the Graduate School confirms that the degree program has been approved by the Graduate School and that the student has maintained active status (see Registration Requirements under Registration above). If so, the student is provided with the thesis reviewers report form and the other forms and information necessary to graduate.

Thesis Reviewers—The thesis is read by the entire examining committee, which is appointed by the dean of the Graduate School on recommendation of the faculty in the major field at the time the student's official degree program is approved. This examining committee consists of at least three members: two representatives from the major field and one from the minor or a related field.

To permit faculty to allocate sufficient time to read the thesis and decide whether it is ready for defense, students must notify their adviser and other members of the final oral committee at least two weeks in advance that the thesis will be delivered on a particular date. All members of the examining committee must then have at least two weeks to read the thesis after it has been delivered. These are minimum standards; individual programs may establish other standards for their students.

The entire committee must be unanimous in certifying that the thesis is ready for defense, as indicated by their signatures on the thesis reviewers report form. When the signed form is returned to the Graduate School, 316 Johnston Hall, the student is provided with the final examination report form.

Final Examinations—Candidates for the master's degree, Plan A, must pass a final oral examination; a final written examination may also be required at the discretion of the graduate faculty in the major field. If both a written and an oral examination are specified, the written examination must precede the oral examination. The final examinations cover the major field and the minor or related fields, and may include any work fundamental to these fields. The final oral for the master's degree is conducted as a closed examination, attended by only the student and the examining committee.

Final examinations are coordinated by the chair of the student's examining committee. All committee members must be present at the examination; *the absence of any member results in an invalid examination.* The results of the examinations are reported to the Graduate School on the final examination

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report form. *A majority vote of the committee, all members present and voting, is required to pass the examination. A student who fails the examination may be terminated from the graduate program or may be allowed, on unanimous recommendation of the examining committee, to retake the examination, providing the reexamination is conducted by the original examining committee.*

Changes in the Examining Committee—Substitutions on the examining committee may be necessitated by such circumstances as a faculty member's temporary absence on leave from the University. The adviser or the director of graduate studies must request the Graduate School's approval of such substitutions well in advance of the examination. *Substitutions for an oral examination that are necessitated by emergency situations must also be approved in advance. In such cases, the adviser should consult with the Graduate School staff by telephone before the start of the examination.*

Preparation and Submission of the Bound Copies of the Thesis—Two bound copies of the thesis must be submitted to the Graduate School. *The student's adviser(s) must sign both bound copies of the thesis to confirm that they are complete and satisfactory in all respects and that all revisions required by the final examining committee have been made.* Instructions for the preparation of the thesis, including format and binding specifications and adviser's signature requirements, should be obtained from the Graduate School, 316 Johnston Hall.

Plan B: Master's Degree Without Thesis

Minimum Credit Requirements—Students must complete an approved program of coursework consisting of a minimum of 20 quarter credits in the major field and a minimum of 8 quarter credits in one or more related fields outside the major. The balance of the credits to be completed to meet the 44-credit minimum requirement for the degree is chosen by agreement between the adviser and the student, subject to whatever

restrictions the graduate faculty in the major field may place on that choice. All credits included in the official degree program must be in graduate-level courses. A minimum GPA of 2.80 must be maintained for all courses included on the program.

Students who wish to complete a designated minor (which is certified on the transcript—unlike the related fields option, which is not) must complete 9 or more quarter credits in a single field. A designated minor must be approved by the director of graduate studies in the minor field.

Plan B Project(s)—Students must demonstrate familiarity with the tools of research or scholarship in their major field, the ability to work independently, and the ability to present the results of their investigation effectively, by completing at least one Plan B project. The graduate faculty in each major field may require as many as three such projects.

The Plan B project(s) should involve a combined total of approximately 120 hours (the equivalent of three full-time weeks) of work. The graduate faculty in each major field specifies both the nature and extent of the options available to satisfy this requirement, and whether the requirement is to be satisfied in conjunction with or independent of the courses in the student's program.

Final Examinations—The Graduate School requires a final examination for Plan B candidates; this may be written, oral, or both, at the discretion of the graduate faculty in the major field. The final examinations cover the major field and the minor or related fields, and may include any work fundamental to these fields. Students should make the Plan B project(s) available to the examining committee for its review well in advance of the final examination. If a final oral is held, it is conducted as a closed examination, attended by only the student and the examining committee. All committee members must be present at the oral examination; *the absence of any member results in an invalid examination.*

A committee of at least three examiners is appointed by the dean of the Graduate School upon recommendation of the faculty in the major field at the time the official degree program is approved. This committee consists of two representatives from the major field and one from the minor or a related field. The examination is coordinated by the chair of the student's examining committee. The results of the examination are reported on a form the student must obtain from the Graduate School, 316 Johnston Hall, before the examination is held. To obtain this form, the student must have on file a degree program approved by the Graduate School and must have maintained active status (see Registration Requirements under Registration above). A *majority vote of the committee*, all members present and voting, is required to pass the examination. A student who fails the examination may be terminated from the graduate program or may be allowed, on unanimous recommendation of the examining committee, to retake the examination, *providing the reexamination is conducted by the original examining committee.*

Changes in the Examining Committee—Substitutions on the examining committee may be necessitated by such circumstances as a faculty member's temporary absence on leave from the University. The adviser or the director of graduate studies must request the Graduate School's approval of such substitutions well in advance of the examination. *Substitutions for an oral examination that are necessitated by emergency situations must also be approved in advance. In such cases, the adviser should consult with the Graduate School staff by telephone before the start of the examination.*

Master of Architecture

See Architecture under Graduate Programs for requirements.

Master of Business Administration

See Business Administration under Graduate Programs for requirements.

Master of Business Taxation

See Business Administration under Graduate Programs for requirements.

Professional Master's Degree in Engineering

A number of engineering departments offer programs, with emphasis on design methods, leading to a designated professional master of engineering degree. The design emphasis of the program is on engineering applications rather than on engineering methods or material behavior, and on application of knowledge and methods of the physical and social sciences as well as of engineering. The programs are designed primarily for students who have already earned a bachelor's degree in a related engineering field. Students normally are expected to be recent graduates of bachelor of science in engineering programs accredited by the Engineers' Council for Professional Development (ECPD). Full-time students should be able to complete a program in one calendar year. The professional master's degree in engineering is considered a terminal degree. Students should also note that only under exceptional circumstances will the Graduate School and the participating programs permit students to transfer from this program to an M.S. program.

Fields in Which the Program is Offered—Refer to the appropriate engineering department sections under Graduate Programs for information about the fields in which the professional master of engineering program is offered.

Regular Graduate School application procedures should be followed. Applicants should designate the master of engineering as their degree objective, to distinguish it from the master of science degree also available in the engineering fields.

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Two Tracks for the Professional Master's Degree in Engineering—The Graduate School offers the professional master's degree in engineering under two tracks, depending on the major field: a design project track and a coursework only track.

Design Project Track—This track requires 20 quarter credits in the major field, a minimum of 8 credits in one or more related fields outside the major, and a design project measured as a minimum of 16 project credits. The design project stresses problem solving based on engineering design criteria extant in industry. Performance of professional caliber is expected which can be subjected to the scrutiny and critique of senior design engineers in industry as well as engineering faculty members.

Coursework Only Track—This track requires a minimum of 44 quarter credits distributed to include 20 credits in the major field, a minimum of 8 credits in one or more related fields outside the major, and the remaining credits to be determined by the student and adviser subject to whatever guidelines the graduate faculty in the major field may place on such elective choices. No projects or papers specific to this track are required.

Final Examinations for the Two Tracks—The design project track requires a final oral examination focused on the design project itself and involving a three-person faculty committee. For the coursework-only track, students should confer with their director of graduate studies about the final examination.

Master of Fine Arts

Prerequisites—Admission to master of fine arts programs is limited to students with the bachelor's degree or its equivalent from an accredited university or college who demonstrate exceptional promise as creative artists in one or more of the subfields in their major area. For a list of the subfields, see Art and Theatre Arts under Graduate Programs.

Course Requirements—For specific program requirements, see Art and Theatre Arts under Graduate Programs.

A degree program approved by the Graduate School must be on file before exhibit report, examination, or graduation forms can be released to the student.

Creative Project—Students must complete a creative project (production or exhibition) accompanied by a supporting paper that deals with the project's planning or execution. Those pursuing a master of fine arts in art must obtain an Exhibit Report form and an Examination Report form from the Graduate School, 316 Johnston Hall. After securing the appropriate signatures on these forms, return them immediately to 316 Johnston Hall.

Final Examinations—The Graduate School requires a final examination for the master of fine arts degree; this may be written, oral, or both, at the discretion of the graduate faculty in the major field. The final examinations cover the major field and the minor or related fields, and may include any work fundamental to these fields. If a final oral is held, it is conducted as a closed examination, attended by only the student and the examining committee. All committee members must be present at the oral examination; *the absence of any member results in an invalid examination.*

Except as noted in this section, requirements for the master of fine arts degree are comparable to those described under Plan B: Master's Degree Without Thesis above.

Master of Forestry

See Forestry under Graduate Programs for requirements.

Master of Landscape Architecture

See Landscape Architecture under Graduate Programs for requirements.

Master of Music

See Music under Graduate Programs for requirements.

Master of Planning

See Public Affairs under Graduate Programs for requirements.

Master of Science (Designated) in Clinical Medicine

See Master's Degree above for requirements.

Master of Social Work

See Social Work under Graduate Programs for requirements.

Specialist Certificate in Education

The Graduate School offers two-year specialist programs in several education fields (see Education, Educational Administration under Educational Policy and Administration, and Educational Psychology under Graduate Programs for specific fields and program descriptions). The specialist certificate requires completion of a minimum of 90 credits.

Transfer of Credits—With the approval of the adviser, the director of graduate studies in the major, and the Graduate School, the transfer of up to 50 percent of the degree program coursework from any combination of the following is permitted:

1. Other recognized graduate schools;
2. Adult Special, Summer Session, and Continuing Education and Extension (CEE) registrations at the University of Minnesota.

Individual graduate programs have the option of specifying a lower percentage of coursework for transfer.

The work to be transferred must be graduate level (postbaccalaureate), must have been taken for graduate credit, and must have been taught by faculty members authorized to teach graduate courses. Credits transferred from other institutions must in addition have been taken as an enrolled, graduate-degree-seeking student and must appear on official graduate school transcripts of the institutions. University of Minnesota CEE courses must bear the special CEE transcript entry

verifying that they were completed for graduate credit.

In the case of a transfer from a non-U.S. institution, the credits must have been earned in a program judged by the Graduate School to be comparable to a graduate degree program in a graduate school of a regionally accredited institution in the United States.

Regarding the transfer of coursework from either a U.S. or non-U.S. institution, if conditions are placed on a student's admission to exclude certain coursework from transfer to a Graduate School degree program, that coursework may not be transferred regardless of the level of the coursework or the status of the school or college in which it was earned.

The transfer of credits is accomplished by the inclusion of the courses on the proposed degree program. Credits that are not accepted as part of a student's degree program cannot be transferred to the Graduate School transcript.

Courses completed through independent (correspondence) study, completed through extension or special categories at other institutions, or taken before the awarding of a baccalaureate degree cannot be transferred.

Degree Requirements—Students pursuing the specialist certificate ordinarily complete the requirements for the master's degree with a major in the field of the specialty as the first year of the program. All first-year students must meet regular admission, candidacy, and examination requirements for the master of arts degree and should specify as their degree objective the master's degree on the application form. A decision regarding continuation beyond the master's degree in a specialist program will depend on an evaluation of performance in meeting the master's requirements.

Time Limit for Earning the Specialist Certificate—The specialist certificate can be completed in 2 years but must be completed in 12 years. Graduate credits earned before the 12-year span are evaluated by the graduate faculty in the area of specialization and may be recommended to the Graduate School for acceptance on a full or partial basis.

Doctor of Philosophy Degree

The doctor of philosophy degree is awarded chiefly in recognition of high attainment and ability in a special subject field as demonstrated by passing the required examinations covering both a candidate's general and special subject fields, and by preparing and successfully defending a thesis that is based on original research and that makes a significant contribution to knowledge in the student's field.

Registration Requirement for the Doctoral Degree—Doctoral students are generally required to register for major field and minor or supporting program coursework. Students should consult their graduate program to determine whether coursework completed while pursuing a University of Minnesota master's degree may be used to meet their doctoral coursework requirement.

In addition to a residency requirement (see Residency Requirement for the Doctoral Degree below), doctoral students are required to enroll for a minimum of 36 thesis credits (8888) while writing the doctoral thesis. Students may not register for thesis credits until the quarter *after* they have passed their preliminary oral examination.

Some students who were first registered in the Graduate School before fall quarter 1983, or who filed a doctoral degree program with the Graduate School before fall quarter 1991, may have their thesis credit requirement reduced or eliminated. Contact the Graduate School, 316 Johnston Hall, for more information.

Doctoral Pre-Thesis Credits (8666)—

Effective fall quarter 1994, doctoral pre-thesis credits (8666) will be available for doctoral students who have not yet passed their preliminary oral examination but who need to be registered in the Graduate School to meet requirements of agencies or departments outside the Graduate School (e.g., loan agencies). Doctoral pre-thesis credits are not graded. *Note: Registration for doctoral pre-thesis credits cannot be used to meet any Graduate School degree requirements.*

Transfer of Credits for the Doctoral Degree

—Students may request from the Graduate School the transfer of the following types of course credits by including the courses on the proposed degree program. In all cases, official transcripts of the work must be attached to the degree program form, unless they have already been included in the student's Graduate School file. Transfer of graduate credit is not allowed for courses completed through independent (correspondence) study, completed through extension or special categories at other institutions, or taken before the awarding of a baccalaureate degree.

From Adult Special or Summer Session—Students admitted to and registered in the Graduate School may transfer to their doctoral programs the graduate-level credits earned in their *first academic quarter as adult special students* (or in their first summer session, including both summer terms if registered in the same calendar year) at the University of Minnesota. Such work must be graduate level and must be offered by members of the faculty approved to teach graduate courses, and students must complete the work required of graduate students in the courses.

From Continuing Education and Extension—A maximum of 12 credits of graduate-level work completed in Continuing Education and Extension (CEE) may be transferred to the doctoral program. This applies only to credits earned in CEE at the University of Minnesota; extension credits earned at other institutions may not be transferred. University extension courses must bear the special CEE transcript entry showing they were completed for graduate credit.

CEE Tuition Differential—For all Continuing Education and Extension (CEE) coursework taken fall 1980 or later and then transferred to a graduate degree program, students must pay the difference between the CEE rate and the Graduate School rate in effect at the time the credits were taken.

From Other Graduate Institutions—Graduate credits earned at other recognized graduate institutions may be applied to doctoral

degrees if the coursework was taken as an enrolled, graduate-degree-seeking student and the credits appear on official graduate school transcripts.

In the case of a transfer from a non-U.S. institution, the credits must have been earned in a program judged by the Graduate School to be comparable to a graduate degree program of a regionally accredited institution in the United States.

In the case of a transfer from either a U.S. or non-U.S. institution, if conditions are placed on a student's admission to exclude certain coursework from transfer to a Graduate School degree program, that coursework may not be transferred regardless of the level of the coursework or the status of the school or college in which it was earned.

Transfer of graduate credit is not allowed for courses completed through independent (correspondence) study, completed through extension or special categories at other institutions, or taken before the awarding of a baccalaureate degree.

Residency Requirement for the Doctoral Degree

A residency requirement of seven quarters of full-time registration is required for the doctoral degree. Students registered for one to six credits in a quarter (or one to six credits total for both summer session terms *in the same academic year*) accumulate one-tenth of a quarter's residency for each credit taken. Students registered for seven or more credits in a quarter (or seven or more credits total for both summer session terms *in the same academic year*) accumulate one quarter of residency.

Doctoral thesis credits (8888) may be used to fulfill the residency requirement, as may registration for 1xxx and 3xxx courses.

No residency is granted for transferred coursework or prior degrees.

Note: Some students who were first registered in the Graduate School before fall quarter 1984 or who filed a doctoral degree program with the Graduate School before fall quarter 1991 may have their residency requirement reduced or eliminated. Contact the Graduate School, 316 Johnston Hall, for information.

Time Limit for Earning the Doctoral Degree

All requirements for the doctoral degree must be completed and the degree awarded within five calendar years after passing the preliminary oral examination (see Preliminary Written and Oral Examinations below).

Students who are unable to complete the degree within the five-year limit may petition the Graduate School for an extension of up to one additional year. *Extensions beyond one year are considered only in the most extraordinary circumstances.* Contact the Graduate School, 316 Johnston Hall, concerning information to be included in such a petition. To ensure timely consideration, petitions should be filed no later than early in the quarter in which the time limit expires.

If a petition is approved, the student is notified of the expectations for progress and completion of the degree. If the petition is denied, the student is terminated from doctoral candidacy and from the graduate program.

Students who have been terminated under such circumstances may apply for readmission to the Graduate School; *readmission under these circumstances is not assured, however.* The faculty in the major field and the Graduate School would set any readmission conditions on the student's resumption of work toward the degree, such as registering for additional coursework, retaking written examinations, filing a revised thesis proposal, completing the degree within a specified time period, or other appropriate terms.

Official Program for the Degree

Students are expected to file an official program for the degree during their second year of study; the specific quarter depends upon individual major field requirements. *Students should submit their completed degree program forms to the Graduate School at least two quarters before the term in which they plan to take the preliminary oral examination.* The degree program form is available from the Graduate School, 316 Johnston Hall. The form should list all coursework, completed and proposed, that will be offered in

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fulfillment of degree requirements in the major field and in the minor field or supporting program, including any transfer work (see Transfer of Credits above). If the student's major field requires proficiency in one or more foreign languages, these should be specified as well. *The members of a student's preliminary oral examining committee are appointed by the dean of the Graduate School on recommendation of the faculty in the major field at the time the student's official degree program is approved.*

A degree program approved by the Graduate School must be on file before the student is permitted to schedule the preliminary oral examination.

Changes in the Approved Program—Once approved, the program must be fulfilled in every detail to meet graduation requirements. Changes in the program that are found necessary or desirable should be requested by completing a Graduate School petition form.

Minimum Grade Requirements—The Graduate School does not define a minimum GPA for courses included on an official doctoral degree program, although individual programs are free to do so as part of their effort to monitor their students' academic achievement and degree progress. Courses with grades of A, B, C, and S may be included in the official degree program, but grades of S are not calculated in the GPA. Students pursuing a doctoral degree are required to register for doctoral thesis credits (8888); these registrations are not graded and therefore cannot be used to meet course credit requirements. *At least two-thirds of the course credits completed in the Graduate School and included on any degree program must be taken A-F.* Individual major fields have the option of specifying more stringent requirements concerning the application of S-N courses to a degree program.

Major Field Credits—The Graduate School does not specify a minimum number of credits in the major field for the doctoral degree. Depending on previous preparation and the nature of the research undertaken, the

number of credits required for individual students, even within the same major field, may vary considerably.

Minor Field or Supporting Program

Work—For the doctoral degree, at least 18 quarter credits must be offered in the minor field or supporting program. With a traditional minor, this work is in a single field related to the major; *the minor field must be declared before the student passes the preliminary oral examination.* If the student is offering a supporting program, it must be composed of a coherent pattern of courses, possibly embracing several disciplines. Both the minor and supporting program options may require students to take written preliminary examinations in the fields included, but students electing the supporting program option are not expected to have competency in each of the fields comparable to that of a person with a traditional minor.

For majors in clinical branches, the minor field or supporting program must be in nonclinical fields that will serve as a basis for the proposed clinical specialization. This fundamental work should be concentrated in the first part of the program. Familiarity with those phases of the nonclinical disciplines essential to proficiency in the major specialty is required.

Language Requirement—See Graduate Programs to determine the language requirement, if any, for a specific major field. The Graduate School monitors the fulfillment of language study when a major field requires a language. Information on how to demonstrate proficiency, and on the conditions under which proficiency will be recorded on the official transcript, is available from the Graduate School, 316 Johnston Hall.

Official Doctoral Candidacy—Doctoral candidacy is established when a student passes the preliminary oral examination (including "pass with reservations").

Further Information—Students who have questions about the doctoral degree after reading this entire section (including the

following on examinations and the thesis) may contact the Graduate School by e-mail (gsdoc@maroon.tc.umn.edu).

Preliminary Written and Oral Examinations

Preliminary Written Examination—All doctoral students are required to pass a written examination in the major field. This examination covers all work completed in the major field and may include any work fundamental to this field. The results of the examination are reported on the preliminary written examination report form, signed by the student's adviser and the director of graduate studies in the major field. It is the student's responsibility to ensure that this form is received by the Graduate School, 316 Johnston Hall, before scheduling the preliminary oral examination.

Preliminary Oral Examination—Students take the preliminary oral examination after completing a substantial part of the coursework and passing the preliminary written examination, but before writing the dissertation.

Preliminary Oral Examining Committee—The examination is administered by the committee appointed by the dean of the Graduate School on recommendation of the faculty in the major field at the time the student's official doctoral degree program is approved. The examining committee includes a minimum of five members: three from the major field and two from the minor field or supporting program.

All assigned members must be present at the preliminary oral examination; *the absence of any member results in an invalid examination.*

Changes in the Preliminary Oral Examining Committee—Substitutions on the examining committee may be necessitated by such circumstances as a faculty member's temporary absence on leave from the University. The adviser or the director of graduate studies must request the Graduate School's approval of such substitutions well in advance of the examination. *Substitutions necessitated by*

emergency situations must also be approved in advance. In such cases, the adviser should consult with the Graduate School staff by telephone before the start of the examination.

Scheduling the Preliminary Oral Examination—It is the responsibility of the student to schedule the preliminary oral with the examiners and with the Graduate School, 316 Johnston Hall, *at least one week in advance.* In certain of the health science fields, however, the faculty requires 30 days' notice of the date of the preliminary oral.

Preliminary oral examinations should not be scheduled from the beginning of the second term of summer session to the opening of the fall quarter, unless the members of the assigned committee can be assembled without substitution.

Before the oral examination can be scheduled, a degree program form approved by the Graduate School must be on file, along with a written examination report form indicating that the student has passed the preliminary written examination. The Graduate School must also confirm that the student has maintained active status (see Registration Requirements under Registration above).

If these documents are on file and the student has active status, the Graduate School issues the preliminary oral examination report form and instructions for conducting the preliminary oral examination to the chair of the examining committee. A copy of the student's degree program form is also sent to both the chair of the examining committee and the student; this may be useful to the committee in reviewing the student's preparation and in confirming the completion of degree requirements, including coursework and any language requirements. The preliminary oral examination may be authorized in spite of deficiencies in these requirements, unless more stringent standards have been established by the major field. All requirements must be completed before the final oral examination may be scheduled.

Preliminary Oral Examination Content and Outcome—All doctoral students are required to pass an oral examination in the

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major field. The preliminary oral examination covers the major field, the minor field or supporting program, and any work fundamental to these areas, including possible plans for thesis research. Unlike the final oral examination, *the preliminary oral is conducted as a closed examination, attended by only the student and the examining committee.*

Immediately before the preliminary oral examination, the committee chair stipulates the objectives of the examination and, in consultation with other members of the examining committee, determines how the examination is to be conducted. Immediately after the examination, the candidate is excused from the room and a written secret ballot is taken before discussing the examination. Following the discussion, a second and final vote is taken, and the participants sign in the appropriate place on the report form, which is to be returned to the Graduate School, 316 Johnston Hall, *no later than the first workday after the examination.*

The outcome of the examination, with all committee members present and voting, is recorded in one of three ways: pass, pass with reservations, or fail. The voting proportions necessary for these decisions are as follows: if the committee consists of five members, a favorable verdict for passing consists of either a unanimous vote or a vote of 4-1; if the committee consists of six members, a unanimous vote or a vote of 5-1 or 4-2 is needed; and if there are seven members, a unanimous vote or a vote of 6-1 or 5-2 is needed. Candidates who do not earn committee votes in these proportions *fail* the examination. If, to achieve the *minimum* number of votes to reach a verdict of pass, any vote of pass with reservations is included, then the outcome will be recorded as a *pass with reservations*. A vote to pass the student with reservations still constitutes a passing vote.

Pass with Reservations—If the student passes the examination with reservations, the student is informed immediately, but the committee is permitted one week in which to convey its reservations to the student *in writing*, informing the student of the steps

that must be taken to remove them. *A copy of this letter must be sent to the Graduate School.* When the student has satisfied the committee's reservations, a second letter informing the student and the Graduate School that the reservations have been removed and that the student may proceed toward the degree is also required. Both letters should be written by the committee chair. The final oral examination may not be scheduled until the Graduate School has received a copy of the letter indicating that the reservations have been removed.

If the committee members disagree as to whether the reservations have been satisfactorily removed, the committee chair asks for another vote, the results of which are subject to the same voting proportions as the initial vote. If the student is unable to satisfy the committee's reservations, his or her doctoral candidacy and graduate student status may be terminated.

Failure of the Preliminary Oral Examination—Students who fail the examination may be excluded from candidacy for the degree or may be allowed, on unanimous recommendation of the examining committee, to retake the examination, *providing the reexamination is conducted by the original preliminary oral examining committee.*

In no case may the reexamination take place before at least one full academic quarter (10 weeks) has passed. No more than one reexamination is allowed.

Recess of a Preliminary Oral Examination—If the preliminary oral examining committee recesses without having determined whether a student has passed the examination, the chair of the committee must send a letter to the dean of the Graduate School explaining the reasons for the recess and noting the date on which the examining committee will reconvene. If the recess will be longer than one week, the examination report form must be returned to the Graduate School, 316 Johnston Hall. A new examination report form will be mailed to the chair of the committee one week before the date on which the committee will reconvene.

The reconvened committee must be composed of the same members as the original preliminary oral examining committee.

Ph.D. Thesis

The thesis must demonstrate the student's originality and ability for independent investigation, and the results of the research must constitute a contribution to knowledge. The thesis must exhibit the student's mastery of the literature of the subject and familiarity with the sources. The subject matter must be presented with a satisfactory degree of literary skill.

Thesis Proposal—At the time of submission of the doctoral program, or not later than the first quarter after passing the preliminary oral examination, students must file the thesis proposal form with the Graduate School, 316 Johnston Hall. The form must include the proposed thesis title and a thesis proposal, about 250 words in length, describing the research to be undertaken and the methods to be employed in carrying it out.

The thesis reviewers and other members of the final oral examining committee are appointed by the dean of the Graduate School upon recommendation of the faculty in the major field at the time the student's thesis proposal is approved.

A thesis proposal approved by the Graduate School must be on file before the reviewers report form can be issued to the student.

Changes in the Thesis Title or the Thesis Proposal—Changes in the *wording* of the thesis title may be made without special approval, but changes should not be made after the thesis title is registered (see Registration of the Thesis Title and Delivery of the Thesis to Thesis Reviewers below). If substantive changes are made in the nature of the thesis research itself, the student must submit a revised thesis proposal immediately.

Language of the Thesis—Theses must normally be written in English or in the language of instruction. *If a thesis is to be written in a foreign language, including a language of instruction other than English, a*

letter should be attached to the thesis proposal form when it is submitted to the Graduate School. This letter should confirm that the recommended thesis reviewers (including the outside reviewer) are qualified to read, comprehend, and criticize a thesis in the foreign language.

Use of Human Subjects in Research—All research on the Twin Cities, Duluth, Morris, and Crookston campuses that involves the use of human subjects must be reviewed and approved by the Institutional Review Board: Human Subjects Committee before initiation. This policy, approved by the University Senate and Board of Regents, applies to funded and nonfunded faculty, staff, and student research. All research projects, including Plan B projects, theses, and dissertations, that involve human subjects must be approved by this committee to ensure that the rights and welfare of the subjects are protected. For more information, contact the committee office at 1300 So. 2nd Street, Suite 10, Minneapolis, MN 55454 (612/624-9829; fax 612/626-9755).

Published Work Included in or in Lieu of the Thesis—The thesis may include materials that students have published while University of Minnesota graduate students, provided the research was carried out under the direction of the graduate faculty and approved by the adviser for incorporation into the thesis. Such publication is welcomed as the best demonstration of quality in a student's research, and the Graduate School encourages the practice. The adviser should notify the Graduate School in writing of the intention to publish part of the thesis material, but the Graduate School's approval is not required.

In cases where the thesis research is to be presented to the examining committee in the form of one or more articles that have been published, or are in a form suitable for publication, the student should contact the Graduate School, 316 Johnston Hall, for information on accommodating such a presentation to the required thesis format.

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Registration of the Thesis Title—Students must register the thesis title with the Graduate School, 316 Johnston Hall, by submitting a copy of the *thesis title page* as it will appear in the final document. Upon submission of the thesis title, the Graduate School provides the student with the thesis reviewers report form and the other forms necessary to graduate, on condition that the student has on file a thesis proposal approved by the Graduate School and has maintained active status (see Registration Requirements under Registration above).

Thesis Reviewers—*All members of the final oral examining committee read the thesis, although only those designated as thesis reviewers sign the report form certifying that the thesis is ready for defense.*

The designated thesis reviewers consist of the adviser, representing the major field, and at least two other members of the final oral examining committee, including at least one representative from the major field and one representative from the minor or supporting program. Part of this group of reviewers should come from outside of the graduate program's thesis advisory committee, if the program uses such a committee.

Certification of the thesis as ready for defense is a necessary step toward the final oral examination, but in no way diminishes the significance of that examination.

Delivery of the Thesis to Thesis

Reviewers—At the time the candidate submits a draft of the thesis to the thesis reviewers, copies must also be provided to all other members of the final oral examining committee. The thesis abstract must be included with the thesis when it is distributed to the committee. The abstract must be signed by the adviser before it is submitted to the Graduate School, which forwards it to University Microfilms.

To permit faculty to allocate sufficient time to read the thesis and decide whether it is ready for defense, students must notify their adviser and other members of the final oral committee at least two weeks in advance that the thesis will be delivered on a particular

date. All members of the examining committee must then have at least two weeks to read the thesis after it has been delivered.

When signing the thesis reviewers report form, the reviewers have three options: the thesis is acceptable for defense as presented; the thesis is acceptable for defense with minor revisions; or the thesis requires major revisions and is not acceptable for defense as presented.

The reviewers must be unanimous in certifying that the thesis is ready for defense, whether as presented or with minor revisions. If this is the case, and all other requirements have been met (see Final Oral Examination below), the Graduate School authorizes the final oral examination. In any instance where revisions are required, the committee must inform the student in writing of the revisions required, and all questions concerning such revisions must be resolved before the final copies of the thesis are submitted and the degree is conferred. *It is the adviser's responsibility to ensure that revisions required by the reviewers are satisfactorily made* (see Preparation of the Bound Copies of the Thesis below).

Final Oral Examination

All doctoral students are required to successfully defend their theses in a final oral examination. To be eligible for the final oral examination, a student must have completed all work on the official doctoral degree program form, including the language requirement, if any; must have passed both the written and oral preliminary examinations; must have maintained active status; and must have satisfied both the thesis credit and residency requirements. In addition, the thesis must have been certified by the readers as ready for defense.

Scheduling the Final Oral with the

Graduate School—*The student must schedule the examination at least one week in advance with both the committee and the Graduate School (see Clearance for Graduation below). In certain of the health science fields, however, the faculty requires 30 days' notice of the date of the final oral.*

When the examination is scheduled, the student's Graduate School file is checked to determine if the student can be cleared to take the examination as stipulated above. If so, the report form for the final oral examination will be forwarded to the chair of the examining committee. If difficulties are apparent, the Graduate School staff will contact the adviser and the student immediately.

A minimum of ten weeks must intervene between the preliminary oral and the final oral examinations. Also, the final oral should not be scheduled from the beginning of the second summer term to the opening of the fall quarter unless the committee members can be assembled without substitution.

Final Oral Examining Committee—The committee must consist minimally of five members: three from the major field and two from the minor field or supporting program. At least two of the faculty from the minor field or supporting program should represent a graduate program and budgetary unit other than that of the student's major.

Although the student's adviser serves as a member of the final oral examining committee, another member of the committee is designated as the chair and functions in this capacity at the final oral examination. The chair must be a full member of the graduate faculty and may be from either the major field or the minor field or supporting program. *The chair and other members of the final oral examining committee are appointed by the dean of the Graduate School upon recommendation of the faculty in the major field at the time the student's thesis proposal is approved.*

All committee members must be present at the examination; *the absence of any member results in an invalid examination.*

Changes in the Final Oral Examining Committee—Substitutions on the examining committee may be necessitated by such circumstances as a faculty member's temporary absence on leave from the University. The adviser or the director of graduate studies must request the Graduate School's approval of such substitutions well

in advance of the examination. *Substitutions necessitated by emergency situations must also be approved in advance. In such cases, the committee chair should consult with the Graduate School staff by telephone before the start of the examination.*

Form of the Final Oral Examination—The final oral examination consists of a seminar in which the candidate presents the thesis and to which the scholarly community is invited. The seminar may take place only after the thesis has been judged ready for defense. The examination is limited to the candidate's thesis subject and relevant areas. It will not exceed three hours. A closed meeting between the candidate and the appointed examining committee immediately follows the thesis presentation. The candidate is then excused and the vote taken on whether the candidate passed the examination.

Reporting the Results of the Final Oral Examination—Upon completion of the examination, a formal vote of the committee is taken. To be recommended for the award of the doctoral degree, candidates must receive a vote with no more than one dissenting member of the total examining committee. If the student has clearly *passed* or clearly *failed* the examination and all members have signed the final examination report form, the report form must be returned to the Graduate School *no later than the first workday following the examination.*

The adviser should be responsible for ensuring the inclusion of appropriate modifications and required revisions, if any, in the final thesis. The final oral examination report form should not be signed and submitted to the Graduate School until all reservations have been satisfied. *If the form will be held for more than one week, a letter must be sent to the Graduate School stating that the form is being held pending required revisions.*

Once the final report form has been returned to the Graduate School indicating that the student has either passed or failed the final oral examination, a hold is placed on the student's records to prevent further registration in the Graduate School. If the

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adviser indicates that the student needs additional time to make minor revisions to the thesis before it is submitted to the Graduate School, the student is permitted to register for one additional quarter. Once the thesis has been submitted, no further registration in the Graduate School is permitted unless the student has been admitted to professional development status or to another major field.

Recess of a Final Oral Examination—On rare occasions, the examining committee may conclude that the final oral examination should be recessed, to be reconvened at a later date. Guidelines for such circumstances are sent to the chair of each examining committee along with the final oral examination report form.

The Graduate School need not be notified until after the fact of informal recesses of up to a week. In the case of a longer recess, the committee must inform the student *in writing* of the reasons for recessing the examination, including any deficiencies noted in the student's thesis or defense, and must indicate when they expect to reconvene and resume the examination. A copy of this letter must be sent to the Graduate School, along with the unsigned final examination report form. When the student and the committee are ready to reconvene the examination, it should be scheduled in the normal way with the Graduate School. A new examination report form will be mailed to the chair of the committee one week before the date on which the committee will reconvene. *The reconvened committee must be composed of the same members as the original final oral examining committee.*

Preparation and Submission of the Bound Copies of the Thesis—Two bound copies of the thesis must be submitted to the Graduate School. *The student's adviser(s) must sign both bound copies of the thesis to confirm that they are complete and satisfactory in all respects and that all revisions required by the final examining committee have been made.* Instructions for the preparation of the thesis, including format and binding

specifications and adviser's signature requirements, should be obtained from the Graduate School, 316 Johnston Hall.

Clearance for Graduation—Degrees are awarded at the end of each month. To qualify for graduation for a particular month, a student must submit the Application for Degree form on or before the first workday of that month and must complete the examination and all other requirements (including necessary forms and fees) by the last workday of that month.

Commencement Ceremony—Two Graduate School commencement ceremonies are held each year—in *late spring* (for January through June graduates) and in *late fall* (for July through December graduates). Graduates are encouraged, but not required, to attend. To make sure their names appear in the program distributed at the commencement ceremony, graduates must submit the Application for Degree form by the deadline specified in the Graduate School section of the *Class Schedule*.

Doctor of Education

The University of Minnesota awards the doctor of education (Ed.D.), its highest professional degree in the fields of educational administration and vocational education, in recognition of satisfactory academic preparation and demonstrated competence for professional activity in those fields.

Standards and procedures for admission, and expectations for scholastic performance, are comparable to those for the Ph.D. A major part of the program must be conducted in full-time residence, including at least one continuous academic year at advanced stages of the program. Rules and procedures governing examinations, candidacy, time limits, appointment of committees, and the thesis for the Ph.D. apply in general to the Ed.D.

Program for the Degree—The Ed.D. program requires the completion of a major, a minor or a supporting program, and a collateral field of study. A foreign language

is not required. A significant proportion of the graduate coursework, usually at least one-fifth of the total program, should be completed in fields other than education.

A supervised internship or clinical experience is an integral part of the program and must be completed by each candidate.

Project—Candidates for the Ed.D. must complete an extended essay that demonstrates the ability to carry out an independent and meaningful study of a problem relevant to the field.

Examinations—Satisfactory performance on both a written comprehensive examination conducted by the major field and a preliminary oral examination conducted by a committee of graduate faculty members is required to establish candidacy for the degree. These examinations assess students' scholarly mastery of the subject matter of their major field and their general readiness and qualifications to pursue the Ed.D.

The final examination committee is appointed by the dean of the Graduate School upon recommendation of the faculty in the major field. It consists of three project reviewers and two others who are qualified to assess the student's professional competency. In the final examination, students are expected to defend the essay and their general qualifications for the degree.

For detailed requirements, see Doctor of Philosophy Degree above.

Doctor of Musical Arts

The program for the professional doctor of musical arts (D.M.A.) degree has a performance-teaching orientation. Emphases are offered in piano, organ, voice, violin, viola, cello, clarinet, woodwinds, trumpet, trombone, guitar, accompanying and coaching, and orchestral conducting. Standards and procedures for admission, and expectations for scholastic performance, are comparable to those for the Ph.D. Details concerning major and minor requirements, recitals, and supporting papers for the D.M.A. are included in the Music section under Graduate Programs. Rules and

procedures governing examinations, candidacy, time limits, appointment of committees, and the thesis for the Ph.D. apply in general to the D.M.A.

Doctor of Philosophy (Designated) in Clinical Medicine

In the clinical fields, the Ph.D. is always a degree with designation. See Doctor of Philosophy Degree above and individual clinical medicine fields under Graduate Programs for requirements.

Other Financial Assistance

Student Employment—The University's Student Employment Center (part of the Office of Student Financial Aid) offers graduate students a wide range of non-academic employment opportunities both on campus and throughout the Twin Cities area. All jobs are posted outside the Student Employment Center, 120 Fraser Hall, 106 Pleasant Street S.E., Minneapolis, MN 55455 (612/624-8070). Contact the Student Employment Center for further information, including registration requirements for graduate student eligibility.

In addition to University (on-campus) employment, the Center offers programs for off-campus employment: the Job Location and Development (JLD) Program helps locate career-related opportunities with private and public employers in the Twin Cities; Community Service Programs helps arrange employment on and off campus with nonprofit organizations and agencies.

Students who prefer more flexibility may apply for short-term, on-campus temporary positions through the Student Temporary Service (STS). STS also offers free microcomputer training and temporary job placement.

Office of Student Financial Aid—To apply for financial aid, graduate students must complete the Free Application for Federal Student Aid (FAFSA), available from the financial aid office each year. Graduate students will be considered for funding from

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the University Trust Fund Loan (UTFL), Perkins Loan, College Work-Study (CWS), Stafford Student Loan, and Student Educational Loan Fund (SELF) programs.

Most awards are based on financial need and full-time enrollment status. Aid from the UTFL, Perkins, and CWS programs is awarded as applications become complete and until all funds have been spent.

Application as soon after January 1 as possible is encouraged for aid for the next academic year. Prospective students may apply before admission to the University.

United States Steel Foundation loans for graduate students are approved on the basis of a recommendation from the dean of the Graduate School.

For more information and applications, write to the Office of Student Financial Aid at either University of Minnesota, 210 Fraser Hall, 106 Pleasant Street S.E., Minneapolis, MN 55455, or University of Minnesota, 197 Coffey Hall, 1420 Eckles Avenue, St. Paul, MN 55108, or call (612) 624-1665 or 1-800-400-UofM(8636).

International Students and Scholars—

Counseling, advising, and educational services are provided for students and scholars from other countries by International Student and Scholar Services (ISSS). Staff members offer counseling and advising services regarding visa requirements and other immigration issues; social, personal, and financial matters; international and intercultural educational opportunities; academic issues; and English language requirements.

International students new to the University of Minnesota are required to participate in ISSS's Pre-Registration Program, which introduces students to academic, social, and practical matters relevant to their study in the United States. In addition, ISSS coordinates many cross-cultural programs for students, faculty, staff, and the community. All admitted international students and scholars are mailed materials pertaining to pre-arrival, arrival, and transition to the University system. Prospective student inquiries may be addressed to International

Student and Scholar Services, University of Minnesota, 149 Nicholson Hall, 216 Pillsbury Drive S.E., Minneapolis, MN 55455 (612/626-7100).

Army and Air Force ROTC—Students in the Graduate School may pursue a two-year Army or Air Force ROTC program. To be eligible, applicants must have six quarters of academic work remaining after successful completion of a required six-week paid ROTC basic summer camp. Transportation, meals, lodging, and a salary are furnished during the summer encampment. All ROTC textbooks and uniforms are loaned to the student without cost, and all cadets receive a tax-free stipend of \$100 per month during the school year. Students successfully completing the program are commissioned as second lieutenants in the Army or Air Force. For more information, see the University's *Army-Navy-Air Force ROTC Bulletin* or call the Army ROTC (612/624-7300) or the Air Force ROTC (612/624-2884).

Fellowships and Scholarships Awarded and Administered Through Academic Departments—Further information on eligibility and application procedures for the following fellowships and scholarships is available from academic departments unless otherwise indicated. Awards are subject to change or cancellation depending on availability of funds.

AGRICULTURAL AND APPLIED ECONOMICS

The Center for International Food and Agricultural Policy Graduate Study Fellowships—To attract high-quality Ph.D. students to the program and to strengthen opportunities for international experience within the graduate curricula. Up to \$2,000 plus a regular 12-month, half-time research assistantship each year for up to 45 months of study; up to \$2,000 travel grant in the final year of the student's program.

AGRICULTURAL ENGINEERING

Alton Levorson Award—For an agricultural engineering graduate student who demonstrates excellence in academics and research. Variable amount.

AGRONOMY AND PLANT GENETICS

H. K. Hayes Memorial Scholarship—For a current graduate student in the Department of Agronomy and Plant Genetics who is outstanding in scholarship, research, and leadership in department and student activities. \$1,000.

J.W. Lambert Memorial Fellowship—For graduate students entering the Department of Agronomy and Plant Genetics with exceptional academic records and/or experience. \$3,000 plus a half-time assistantship first year; \$1,000 plus a half-time assistantship subsequent years.

AMERICAN STUDIES

American Studies Fellowship—To support three first-year graduate students. About \$5,000 plus a quarter-time assistantship.

ARCHITECTURE

All scholarships/fellowships are for graduate and undergraduate students already in the architecture program and are given at the discretion of the department, unless otherwise noted.

AIA (American Institute of Architects) Foundation Scholarships—Stipends awarded to architecture students on the basis of financial need and academic achievement. Nominations are made by CALA to the AIA Foundation.

AIA Henry Adams Medal and Certificate—Awarded to the two graduating architecture students highest in academic rank.

AIA Minneapolis Chapter—Two stipends for third-year architecture students who do not qualify for other awards.

AIA Minority-Disadvantaged Scholarship Program—Awarded to architecture students based upon need and background. Nominations are made by CALA to the AIA.

Alpha Rho Chi Medal—Given to a graduating architecture student for leadership and service by the national architecture fraternity.

Thomas Ellerbe Fellowship—Stipend awarded to architecture students in their final year by the Minnesota Architectural Foundation based on academic record, portfolio, and recommendations.

Stanley and Doris Moe Scholarship—Offered to outstanding architecture applicants at the time of their admission.

SPQR Travel Award—Stipend awarded to architecture students for participating in the Study Abroad Program based on need and academic rank.

Stretch/Morrill Memorial Award—Thesis award for graduating architecture students nominated by faculty.

In addition, several corporations and firms sponsor other annual scholarships and architectural design competitions (with financial awards) as part of design studios. Recent sponsors have included Pella Products, and the Minnesota Prestress Association. For graduate students, there are many teaching and research assistantships available as well as a limited number of tuition scholarships.

ART (Duluth Campus)

Alice Tweed Tuohy Foundation Scholarship—For graduate or undergraduate art students to help defray tuition expenses. Variable amount.

ART HISTORY

Elizabeth Roe Fellowship—For art history graduate students. \$500 to \$3,000.

Pioneer Fellowship—For Art History Graduate Students \$500 to \$3,000.

BIOCHEMISTRY

Chemical Bases of Cell and Molecular Biology Training Grant—To train doctoral students in biochemistry, chemistry, genetics and cell biology, and microbiology, in a chemically based approach to cellular and molecular biology. U.S. citizenship required. \$8,800 plus tuition, health insurance, and certain fees. This amount is supplemented to bring the stipend to that received by other graduate students in the program.

Arnold H. Johnson Doctoral Fellowship—To train pre-doctoral students in biochemistry with faculty in the College of Biological Sciences. U.S. citizenship required. Apply through the Biochemistry Department, College of Biological Sciences. \$8,250.

BIOLOGICAL SCIENCES

Bell Delta Waterfowl Fellowship—For graduate students in ecology, evolution, behavior, and biology who are studying North American waterfowl at the Delta Waterfowl Research Station in Manitoba. Apply through Bell Museum of Natural History. Variable amounts.

Belwin Fellowship—For students conducting research on the natural environment, with a portion of their research at the Belwin Nature Center. Primarily for students specializing in the biological sciences, natural resources, agriculture, education, or liberal arts. At least \$500.

Dayton Natural History Fund—To encourage field research in field biology by graduate students without geographic restrictions. Apply through Bell Museum of Natural History. Variable amounts, usually \$100 to \$2,000.

Itasca Research Stipends—To encourage research at Lake Itasca Forestry and Biological Station by qualified graduate students from any area relating to field biology. Apply through the Itasca Biology Program. Variable amounts.

Sigerfoos Fellowship—For short-term zoological study by graduate students at another institution or research area. Preference for study of marine or tropical zoology. Apply through the director of graduate studies in zoology.

James W. Wilkie Fund for Natural History—For field studies in natural history by graduate students in any aspect of field biology. Apply through Bell Museum of Natural History. Variable amounts, usually \$100 to \$2,000.

BIOSTATISTICS

U.S. Public Health Service Traineeships in Public Health—For graduate students in biostatistics. U.S. citizenship or permanent residency required. Variable amounts.

BUSINESS ADMINISTRATION

Accounting Department Scholarships—Awarded to MBA and Ph.D. accounting students on the basis of merit. Variable amount. Further information is available from the Carlson School Accounting Department.

American Production and Inventory Control Society—For Carlson School of Management graduate and undergraduate students interested in a career in operations and materials management. Variable amount.

Carlson Companies Scholarship—For Carlson Companies employees or children or grandchildren of employees enrolled as graduates or undergraduates in the Carlson School. Variable amount.

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Carlson Minority/Disadvantaged Fellowship—

Awarded to two graduate M.B.A. minority/disadvantaged students annually. Variable up to \$5,000.

Carlson School Dissertation Fellowships—Awarded to dissertation-stage Ph.D. students on the basis of merit. Variable amount.

Carlson School Ph.D. Fellowships—Awarded to first-year Ph.D. students on the basis of merit. Variable amount.

Carlson Student Aid Fund—For graduate and undergraduate students enrolled in the Carlson School. Variable amount.

DeRoy Foundation International MBA Exchange Program—For five Carlson School M.B.A. students attending European schools. \$1,000.

Richard Ellis Dupuy, Jr. Fellowship in Strategic Management—Awarded to Ph.D. students in the department of Strategic Management and Organization on the basis of merit. Variable Amount.

Elwell Foundation—Awarded to several Ph.D. students in finance. Variable amount.

Richard K. Gaumnitz Scholarship—In honor of Professor Gaumnitz for Carlson School students in the department of strategic management. Variable amount.

Frederick Grose Scholarship—Awarded to a Carlson School undergraduate or graduate student in accounting.

Ernest Heilman Award—An Outstanding Teacher Award for a Ph.D. student in accounting.

Herrick Scholarship—For Carlson School Ph.D. students in finance; based on financial need and merit. Variable amount.

Honeywell Scholarship—Awarded to an outstanding graduate student in accounting. Variable amount.

Robert Lieberman Memorial Award—For one or two Carlson School Ph.D. student(s) in marketing; based on excellence in teaching. Variable amount.

Carl Nelson Doctoral Award—Awarded to a Ph.D. student in accounting.

Jay Phillips Endowed Scholarship—For Carlson School graduate students based on need and merit. Variable amount.

Charles R. Purdy Scholarship—Awarded to a Carlson School Ph.D. student in accounting.

George Russell International Fund—For students and faculty of the Carlson School to defray costs of international research and study. Variable amount.

C. E. Tranter Scholarship—Awarded to outstanding graduate and undergraduate students in accounting.

Roland S. Vaile Fellowship in Business—Awarded to a graduate student interested primarily in marketing. Variable amount.

CELLULAR AND INTEGRATIVE PHYSIOLOGY

Bacaner Research Awards—For doctoral students in cell biology and neuroanatomy, biochemistry, laboratory medicine and pathology, microbiology, pharmacology, and physiology. Students are selected by their

departmental faculty on the basis of research conducted for the Ph.D. degree. Limited to students in their final year who will complete all requirements for the Ph.D. degree no later than December of the year awarded. \$500.

Irwin J. Fox Scholarship—For a doctoral student in physiology. \$1,000.

Allan Hemingway Endowed Scholarship—For a doctoral student in physiology who has demonstrated outstanding merit, academic potential, and financial need. \$2,000.

Lifson-Johnson Award—For a doctoral student in the Department of Physiology, to recognize outstanding teaching or research in the area of physiological transport systems. \$1,000.

CHEMICAL ENGINEERING AND MATERIALS SCIENCE

All chemical engineering and materials science graduate students who submit applications for graduate assistantships or Graduate School Fellowships are considered for departmental fellowships. The criterion for selection is academic excellence. In recent years, departmental fellowship funds have come from the following sources:

AMOCO Corporation

Atlantic Richfield Company

Chevron

DuPont

Eastman Kodak

Exxon Education Foundation

Fridley Foundation

IBM

Minnesota Mining and Manufacturing Company (3M)

Mobil

Shell Companies Foundation

Union Carbide

Upjohn Company

Xerox Corporation

CHEMISTRY

The Department of Chemistry awards seven to ten industrial fellowships for outstanding doctoral candidates in chemistry each year. Several fellowships for partial summer support are sponsored by a number of corporations.

CHEMISTRY/CHEMICAL PHYSICS

Same as Chemistry.

CHILD PSYCHOLOGY

Center for Research in Learning, Perception, and Cognition—To prepare doctoral students in learning, perception, cognition, and related areas for research careers in cognitive science. Must be U.S. citizen, national, or permanent resident. \$8,800 (12 months) plus tuition and fees.

Institute for Disabilities Studies—To prepare doctoral students in interdisciplinary approaches to research in developmental disabilities. Must be U.S. citizen, national, or permanent resident. \$8,800 (12 months) plus tuition and fees.

Institute of Child Development—To prepare continuing doctoral students in child psychology for research careers. Must be U.S. citizen, national, or permanent resident. \$6,600 (9 months) plus tuition and fees.

CIVIL ENGINEERING

Sommerfeld Fellowships—For outstanding graduate students in any branch of civil engineering. \$9,750 plus tuition and health coverage.

CLASSICAL AND NEAR EASTERN STUDIES

John C. Hutchinson Fellowship—To support promising classics students in the study of Greek and Latin language and literature at an advanced level. \$1,000 to \$4,000.

COMMUNICATION DISORDERS (Twin Cities Campus)

Center for Research in Learning, Perception, and Cognition—To prepare doctoral students with interests in perception, learning, and cognition for research careers in cognitive science. U.S. citizenship required. \$8,800 plus tuition and fees.

Veteran's Administration Traineeships in Speech-Language Pathology and Audiology—For master's and doctoral students in speech-language pathology and audiology. U.S. citizenship required. \$4,000 to \$13,200.

COMMUNICATION DISORDERS (Duluth Campus)

Eddy Foundation Scholarships—For students in communication disorders at University of Minnesota-Duluth. Preference to Duluth area residents. \$1,000 to \$2,800.

COUNSELING

Counseling Internship and Associate Staff Positions—For doctoral students in psychology and education to provide experience and training in college student counseling. Apply through University Counseling and Consulting Services.

CREATIVE WRITING

See *ENGLISH* below.

CURRICULUM AND INSTRUCTION

(Reading/Language Arts Education)

Guy Bond Research Assistantship—To support a first year doctoral student in reading education. \$12,000 plus tuition.

Reading/Language Arts Education Dissertation Fellowship—To support preparation of a publishable paper. \$1,000.

Robert Schreiner Reading Fellowship—To support preparation of a publishable paper. \$1,000.

Frances Triggs Reading/Language Arts Memorial Fellowship—To assist a doctoral candidate in the completion of the dissertation. \$2,500.

DENTISTRY

Individuals interested in assistantships or fellowships associated with clinical sciences and specialty or advanced education programs should contact program directors of specific disciplines or the director of graduate studies for the School of Dentistry.

ECONOMICS

Harold Hardy Fellowship—Thesis support for doctoral students.

Heller Fellowship in Public Policy—For thesis research support in public policy economics.

EDUCATION

See also *CURRICULUM AND INSTRUCTION* above.

Ruth Eckert Scholarship—For women doctoral students who have completed the preliminary examination for the Ph.D. Recommendations from the student's major adviser and one other faculty member are required. Variable amount not to exceed \$1,000.

Education Alumni Society Advanced Study Scholarship—For graduate students with outstanding academic performance and whose faculty recommendations show the students' potential to make significant contributions to the field. \$500, subject to availability of funds.

Education Alumni Society Larry Wilson Scholarship—For degree-seeking students who have career objectives related to non-school-based education. Recipients will be selected based on leadership potential and a strong academic record. \$500, subject to availability of funds.

Education Student Community Service Award—For students who have performed outstanding volunteer service for nonprofit organizations and groups external to the University. \$500.

Epsilon Chapter of Pi Lambda Theta Dissertation Research Grant—For graduate students who have completed the preliminary exam for the doctorate in education. \$500, subject to availability of funds.

Home Economists in Business—For graduate student majoring in home economics education with career goals oriented toward working in a business setting. Applicants must be members of the Minnesota Home Economics Association. \$800.

Minnesota Home Economics Association—For students in home economics, preferably members of the Minnesota Home Economics Association. \$500.

Minnesota Recreation and Park Foundation Scholarship—For students in recreation, park, and leisure studies. Awards are based on scholarship, volunteer work, and extracurricular activities.

J. Anna Norris Award—For graduate or postbaccalaureate women students in a program likely to lead to a career in college teaching or adult education in physical education and/or sport. Variable from \$100 to \$500 per quarter.

Omicron Nu Research Fellowship—Awarded to graduate students at the doctoral level in the Division of Home Economics Education, Department of Vocational and Technical Education. \$2,250.

Jason David Schleien Memorial Scholarship Fund—For students in therapeutic recreation, adapted physical education, special education, or areas related to serving students with disabilities. \$100 to \$1,000.

General Information

Twin City Home Economists in Homemaking—Awarded to a graduate student in home economics education or other home economics field. \$1,200.

ENGLISH

Edelstein-Keller Teaching/Writing Fellowships—For outstanding writers entering or enrolled in the M.A. program in English with an emphasis in writing. Up to three appointments combining fellowship support with some work for a total stipend of about \$9,000.

Frederick Klaeber Fellowship in Medieval Studies—For doctoral students in medieval English language and literature, especially those concentrating in Anglo-Saxon. \$8,500 plus tuition for the year of tenure; a teaching assistantship plus tuition for another year.

Martin Ruud Memorial Fellowship—For doctoral students in English during their first two years of coursework. \$8,500 plus tuition for the first year; a teaching assistantship plus tuition for the second year.

ENTOMOLOGY

Dr. Alexander A. Granovsky Pest Management Scholarship—To recognize an entomology student for outstanding professional interests and studies related to pest management, with particular focus on urban pest management. Must be a student member of the Entomological Society of America and have at least one popular or scientific publication related to arthropods published or in press. \$1,000.

ENVIRONMENTAL HEALTH

National Institute for Occupational Safety and Health—For graduate students specializing in industrial hygiene, occupational health nursing, and injury prevention. U.S. citizenship or permanent residency required. Up to \$8,500 plus tuition and fees; partial awards also offered.

U.S. Public Health Service Traineeships in Public Health—For graduate students in environmental health. U.S. citizenship or permanent residency required. Stipend plus tuition and fees; partial awards also offered.

Richard G. Bond Memorial Scholarship—For full-time environmental health student with preference to student with experience in environmental health or related field. Full tuition for up to four quarters.

EPIDEMIOLOGY

Behavioral Aspects of Cardiovascular Diseases Fellowship—For pre- and postdoctoral scholars preparing for research careers. \$8,800 to \$32,300, plus tuition, fees, and travel (according to level of training and experience).

Cancer Epidemiology Fellowship—Pre- and postdoctoral cancer research training program in the epidemiology of cancer with a focus on nutrition. Stipends according to level of training and experience.

Preventive Cardiology Fellowship—Three-year postdoctoral training in the epidemiology and prevention of cardiovascular disease. Stipends according to level of training and experience.

INTERNATIONAL STUDIES

(Foreign Language and Area Studies Fellowships)

International Studies—Applications welcome from graduate students pursuing the master's or doctoral

degree in fields other than foreign languages and literatures who are seeking support to study an eligible world language. A successful applicant must have research interests with an international focus and be a U.S. citizen or resident alien. Please contact the Institute of International Studies, 214 Social Sciences, for more information. Fellowship is for summer or academic year and includes stipend and tuition.

Western European Studies—Applications welcome from graduate students pursuing the master's or doctoral degree in fields other than foreign languages and literatures who are seeking support to study an eligible Western European language. A successful applicant must have research interests in Western Europe and be a U.S. citizen or resident alien. Please contact the Center for European Studies, 309 Social Sciences, for more information. Fellowship is for summer or academic year and includes stipend and tuition.

FISHERIES AND WILDLIFE

John Dobie Fellowship in Fisheries—To encourage graduate students in fisheries who are interested in careers in fisheries research and management, particularly in Minnesota; must have ranked in upper third of college graduating class. Variable amount.

Gordon Guillion Scholarship—Awarded to a student in Wildlife Conservation who demonstrates an interest in subject areas that reflect Gordon Guillion's dedication to the study of the beneficial relationship between forest management and the proliferation of diverse wildlife species. \$1,000.

Robert Lick Waterfowl Management Award—To encourage graduate students with a strong interest in waterfowl management. About \$1,000.

FORESTRY

Leiton E. Nelson Scholarship—For a graduate student in forest resources or forest products. Offered alternate years. \$1,200.

Potlatch Fellowship in Forestry—For a graduate student in forest resources. \$10,000.

FRENCH

Marguerite Guinotte Memorial Scholarship—For needy and promising graduate students or advanced undergraduates in French language and literature to study in or travel to a French-speaking country. \$350 to \$500.

Elizabeth Folsom Rathert Graduate Fellowship in French—For graduate students in French literature to become more proficient in foreign languages. Recipient teaches in fall quarter and receives fellowship in winter and spring. Must be U.S. citizen with limited experience living in French-speaking cultures. Offered every year. \$9,000 plus tuition.

Travel or Special Project Grant—For current graduate students in French and Italian seeking support for a trip (e.g., to present a conference paper or to conduct research) or for a special project related to the student's academic work. \$300 to \$400.

MOLECULAR, CELLULAR, DEVELOPMENTAL BIOLOGY AND GENETICS

Genetics and Cell Biology Departmental

Fellowships—For outstanding new doctoral students in

Molecular, Cellular, Developmental Biology and Genetics. \$1,100 per month plus tuition and health insurance.

GEOGRAPHY

John R. Borchert/CURA Fellowship—For geography graduate students in their second or later year of graduate study who propose to carry out a research project consistent with the mission of CURA (Center for Urban and Regional Affairs). Equivalent to 50%-time assistantship for 9 months plus tuition.

Darrell Haug Davis Memorial Fellowship—For doctoral students in geography who are in their third, fourth, or fifth year of study. \$9,500 plus tuition.

GEOLOGY AND GEOPHYSICS

Thomas F. Andrews Fund—In part for graduate students in geology or geophysics who have strong academic records and financial need. Up to \$1,000.

Richard Clarence Dennis Fellowship—For graduate students in geology and geophysics with strong academic records. Up to \$10,000/year.

Department of Geology and Geophysics Travel Awards—For graduate students in geology and geophysics to present research papers and posters at scientific meetings. Variable amount.

William Harvey Emmons Fund—In part for graduate students in geology and geophysics who have strong academic records and financial need. Up to \$5,000.

Francis A. Gibson Fellowship—For graduate students in geology and geophysics with preference for those studying hydrogeology or energy. Up to \$6,000.

Samuel S. Goldich Award—To support graduate students in geology and geophysics conducting research in geochemistry of the Precambrian. Variable amount.

John W. Gruner Fellowship—For outstanding graduate students in geology and geophysics. Up to \$6,000.

David Keith Jensen Scholarship—In part for graduate students in geology or geophysics who have strong academic records and financial need. Variable amount.

Maximilian N. Lando Scholarship—For graduate students in geology and geophysics who have strong academic records and financial need. Variable amount.

Harold M. Mooney Fellowship—In part for meritorious graduate students in geophysics. Variable amount.

GERMAN

Bochum Fellowship—For graduate student in German literature to study for a year at the University of Bochum in West Germany. About DM 830 per month.

Humboldt University Exchange—For graduate students in German with teaching experience who are native speakers of English to spend one quarter teaching English at Humboldt University in East Berlin.

Elizabeth Folsom Rathert Graduate Fellowship in German—For graduate students in German. Must have been U.S. citizen at least ten years before fellowship term. For students with limited experience in German-speaking culture. Offered every year. At least \$5,000.

GERONTOLOGY

All-University Council on Aging/CURA—One or more awards for graduate research on aging related to Minnesota populations. Contact All-University Council on Aging. \$500.

HEALTH INFORMATICS

NLM Traineeships in Medical Informatics—For doctoral students or postdoctorates in health informatics or related computer-oriented fields. Must demonstrate computer expertise and knowledge of health sciences. U.S. citizenship or permanent residency required. NIH stipends.

HISTORY

Class of 1889 Memorial Prize Fund—Annual awards for the best essay in history with both undergraduates and first-year graduate students eligible. Variable amount.

Dissertation Research Fellowships—For students who have passed their preliminary examinations. One-quarter fellowships to further dissertation research and writing. Three awarded annually. Each fellowship is named for one of the donors whose gifts support the awards (William Stearns Davis, Samuel Deinard, the Lothrop Memorial Fund, Harriet Rislove Schoonover, Albert Beebe White, and John B. and Theta Wolf).

History Department Summer Grants for Language or Special Training—For graduate students in history. Variable amount.

INDUSTRIAL RELATIONS

ARCO Scholarship—For an outstanding master's degree candidate. \$1,000.

Randy A. Bray Scholarship—For a promising new master's degree candidate. Variable amount.

Cargill Scholarship—For an outstanding master's degree candidate. \$1,000.

Chrysler Corporation Fund Scholarship—For an outstanding master's degree candidate. \$3,500.

Dow Chemical Company—For an industrial relations graduate student. \$2,000.

Exxon Scholarship—For an outstanding master's degree candidate. \$1,000.

Herbert G. Heneman, Jr. Scholarship—For a promising new graduate student. \$4,000.

I.R. Council on Graduate Opportunities for Advanced Level Studies (G.O.A.L.S.) Graduate Fellowships—For a minority student. \$7,800 per academic year plus tuition and fees. Renewable for second year if progress is satisfactory.

Pfizer Scholarship—For a master's degree candidate. \$4,000.

Twin City Personnel Association Scholarship—For a second-year master's degree candidate who is a Minnesota resident and intends to pursue a personnel career in the Twin Cities. Variable amount.

Union Carbide Scholarship—For an outstanding master's degree candidate with at least one full academic year of study remaining. \$3,000.

Weyerhaeuser Company—For an outstanding master's degree candidate. \$4,000.

General Information

INTEREST MEASUREMENT

E. K. Strong, Jr., Memorial Fellowship—For doctoral candidates in psychology, child development, or educational psychology for interest measurement research. Contact Center for Interest Measurement Research. Up to \$1,000.

ITALIAN

See *FRENCH* above.

LANDSCAPE ARCHITECTURE

Edmund J. Phelps Memorial Fellowship—To recruit outstanding students from allied disciplines. \$5,000.

MASS COMMUNICATION

Ralph D. Casey Dissertation Award—For doctoral candidates embarking on dissertation research who have proposed outstanding, meritorious dissertation research projects. \$2,000.

Herbert Berridge Elliston Fellowship—For worthy and needy seniors or graduate students in mass communication. \$500 to \$3,000.

Arle and Billy Haeberle Memorial Scholarship—A merit scholarship for graduate students based on academic excellence. Variable amount.

Hubbard/KSTP Broadcast Scholarship—For currently enrolled graduate students in broadcast journalism who show professional promise and academic achievement. Variable amount.

Reader's Digest Excellence in Journalism Scholarship—For graduate students in mass communication who show promise of contribution to excellence in journalistic performance, either as professionals in writing or as teachers of journalistic writing. Amount varies.

Siha Center Fellowship in Ethics and Law—For graduate students in mass communication who have demonstrated interest and ability in mass communication ethics or law. Up to \$5,000.

MATHEMATICS

Lando Fund—For doctoral students in mathematics for summer support. \$2,200.

NSF Research Funds—For doctoral students in mathematics for summer support. \$2,200.

Ella Thorpe Fund—For doctoral students in mathematics for summer support. \$2,200.

MECHANICAL ENGINEERING

McDonnell Douglas Fellowship—For outstanding graduate students in mechanical engineering.

Murphy/Robertson Fellowship—To support outstanding graduate students in study of power and propulsion.

Chester E. Dekko Fellowship—To recognize outstanding graduate students in mechanical engineering.

MEDICAL SCHOOL, CLINICAL SCIENCES

A medical student or physician seeking information on post-M.D. graduate training programs (residencies), fellowships, or advanced degree programs in any of the clinical fields should contact the director of graduate studies or the department office in the clinical science of interest.

MICROBIOLOGY

National Institutes of Health National Research Service Awards—For doctoral students in microbiology involved in cancer research. Limited to U.S. citizens, nationals, or permanent residents. Requires payback or service in biomedical or behavioral research and/or teaching within two years of termination of award. \$8,500 plus tuition and fees, supplemented by the department to a total stipend of about \$12,500.

Dennis W. Watson Fellowship—For outstanding graduate student in honor of Regents' Professor Emeritus and former department head Dennis W. Watson. \$13,000.

MUSIC

School of Music Scholarship—For graduate students in all areas of music. Performance awards require audition. \$600 to 4,000.

NURSING

Marion Borgenson Nursing Scholarship—For a qualified enrolled undergraduate or graduate nursing student.

Ruth Thomas Brisker Nursing Scholarship—Provides a minimum of one quarter tuition for a qualified enrolled undergraduate or graduate nursing student.

Clifton J. Brisco Nursing Scholarship—For qualified enrolled undergraduate or graduate nursing student.

Margaret Caldwell Memorial Scholarship Nursing—For qualified enrolled undergraduate or graduate nursing student. Criteria: scholastic record, ability, personal attributes, professional promise. Financial Need.

Grace B. Dayton Nursing Scholarship—For enrolled undergraduate or graduate nursing student with demonstrated ability.

Beatrice Lofgren Delue Scholarship in Nursing—For a Minnesota resident. Must have a minimum GPA of 3.00 and demonstrated financial need.

Agnes Dempster Nursing Scholarship—Completed a minimum of 12 graduate credits; a minimum 3.50 GPA; minimum award of \$1,000. Random drawing by Foundations Board Member.

Katherine Densford Drees Nursing Scholarship—Minimum \$100 awards for students with superior scholastic achievement/promise/apptitude. Financial Need.

Suzanne J. Doehring Memorial Scholarship in Nursing—For qualified enrolled undergraduate or graduate nursing student with demonstrated ability.

Eisenmenger Scholarship in Nursing—For qualified enrolled undergraduate or graduate nursing student. Financial Need.

Ardus Kluth Hopkins Nursing Scholarship—Annual award of up to one-half the cost of tuition/fees. Career goal of public school nurse.

Florence Julian Memorial Nursing Scholarship—Enrolled graduate student with demonstrated interest or aptitude in area of management.

James Lillehei Scholarship in Cardiac Nursing Research—Enrolled graduate student with demonstrated interest in conducting research relating to care of patients and families with cardiac conditions. Financial need.

Minority Nursing Scholarship Fund—Financial assistance for minority and/or non-traditional enrolled nursing student.

Alice & Gale W. Perry Nursing Scholarship Fund—For qualified enrolled undergraduate or graduate nursing student.

Jennie Siebold Memorial—For qualified enrolled undergraduate or graduate nursing student.

Mary Hensler Spurzem Nursing Scholarship—For qualified enrolled undergraduate or graduate nursing student. Financial need.

Marion Vannier Nursing Scholarship—For students who show academic promise and are in financial need.

PHARMACOLOGY

National Research Service Award—For doctoral students in pharmacology and toxicology. \$13,000 plus tuition, fees and health insurance.

PHARMACY

American Foundation for Pharmaceutical Education Graduate Fellowships—For U.S. citizens. \$6,000 to \$10,000.

S. W. Melendy Fellowships—For graduate students engaged in programs offered through the College of Pharmacy. *Summer Fellowships: Average \$600-\$800; Academic Year Fellowships: \$10,000/Departments determine number and amount of individual student awards.*

Ted Rowell Fellowship—For graduate students engaged in basic science programs offered through the College of Pharmacy. \$3,000-\$6,000. Preference to Minnesota residents who are US citizens.

PHYSICS AND ASTRONOMY

In addition to the awards listed below, other fellowships from the University and the Institute of Technology are available to physics and astronomy students.

Phyllis St. Cyr Freier-Centennial Fellowships—In honor of Professor Freier and the centennial of physics at the University of Minnesota. \$9,600.

PLANT BIOLOGY

USDA National Needs Fellowship in Plant

Biotechnology—To support doctoral students in plant biotechnology, which has been identified as an area of national need for trained scientists. Students in plant molecular biology, biochemistry, physiology, cell biology, and genetics are eligible to apply. \$17,000 plus tuition and travel funds.

PLANT PATHOLOGY

Fred I. Frosheiser Scholarship—For graduate students in plant pathology who have demonstrated outstanding abilities in scholarship, research, and all aspects of graduate study, based on at least one year of a proven performance record in graduate school. Variable amounts.

M. F. Kernkamp Fellowship—For graduate students in plant pathology who are outstanding in scholarship, research, and all aspects of graduate study including participation in department activities. Variable amounts.

POLITICAL SCIENCE

Harold W. Chase Memorial Award—For doctoral students with distinguished records in public law. Up to \$1,000.

Asher N. Christensen Memorial Award—For doctoral students in political science for study abroad or research in American government and politics.

Hubert H. Humphrey Fellowship—For doctoral students with distinguished records in political science. Up to \$8,500.

Clara H. Ueland Memorial Fellowship—For female doctoral students with distinguished record in political science. Up to \$8,500.

Vernie Wolfsberg Fellowship—For female doctoral students with distinguished record in political science. Up to \$8,500.

PSYCHOLOGY

Center for Research in Learning, Perception, and Cognition—To prepare doctoral students in related areas for research careers in cognitive science. Apply through Center for Research in Learning, Perception, and Cognition. \$8,800 plus tuition and fees.

University Counseling and Consulting Services—To provide APA-approved predoctoral internships for clinical and counseling psychology students. Internship is a 12 month full-time position for \$13,500 plus health insurance. Apply through Training Program Director, University Counseling and Consulting Services. Typical deadline is November 30th for the following year.

Veteran's Administration—For doctoral students in counseling and clinical psychology to pursue APA-approved internship experience. U.S. citizenship required. Apply through Training Director, Psychology Service, Veteran's Administration Medical Center, Minneapolis. \$17,000 for 1900 hours.

PUBLIC AFFAIRS

Cram-Dalton International Women's Rights Scholarship—For an entering graduate student who has shown an interest in international women's rights. International students are encouraged to apply. Variable amount.

Gerald W. Heaney Fellowship or Scholarship—Award made on basis of academic merit. Applicants should be from Duluth, the Duluth area, or northeast Minnesota. Variable amounts.

Hubert H. Humphrey Fellowships and Scholarships in Public Affairs—For outstanding graduate students preparing for careers in public service. Up to \$10,000 plus tuition first year; with satisfactory performance, up to \$4,200 plus tuition second year.

Minority and Disadvantaged Student Awards—For graduate students preparing for careers in public affairs; awards based on need. Variable amounts.

Joseph Robbie Fellowship or Scholarship in Metropolitan Government and Planning—Award made on basis of academic merit. Applicants must be planning to enter career in metropolitan or regional government or planning. Variable amounts.

General Information

Woodrow Wilson Minority Access Program

Fellowships—For minority students entering graduate school in *public affairs* or *planning*. Must have completed one of the Wilson Junior Year Summer Institutes Programs.

PUBLIC HEALTH

Federally funded traineeships are available in some major areas. Research assistant, teaching assistant, and postdoctoral fellowship positions are available dependent on student's area of interest. A limited number of high-ability minority fellowships are available to qualified applicants. See specific listings in this section for biostatistics, environmental health, epidemiology, health services research and policy and health services research, policy and administration.

RHETORIC

Rhetoric and Scientific and Technical Communication Scholarship—National awards of \$2,000 through the Society for Technical Communication. Advisory Council in RSTC to establish links with industry for research grants for MS, MA and Ph.D. students.

Scientific and Technical Communication

Fellowship—To encourage MSTC candidates to pursue qualitative and quantitative research and theory building in STC and to encourage MSTC candidates to teach STC at the postsecondary level. \$300-\$4,000.

SOCIAL WORK

A small number of training fellowships from federally funded grants, paid field placements from local agencies, and assistantships, including the Morris Hursh Graduate Assistant Endowment, are directly available from the School of Social Work. Number of awards and amounts vary from year to year.

Rose E. Snyder Memorial Scholarship—Provides annual funding for one M.S.W. student.

SOCIAL WORK (Duluth Campus)

Will Dodge Memorial Fund—For graduate students in social work to support field placements or projects that involve grass-roots community organizing. Must register for 7 credits per quarter during the next academic year. About \$500.

SOCIOLOGY

Bright Research Award—Given annually to graduate student(s) for whom the award will make possible a significant improvement in the progress of research toward the Ph.D. Up to \$3,000.

Don Martindale Award for Scholarship—Given annually to a current Ph.D. student who has shown exceptional accomplishment and progress toward the degree as well as toward contributing to the profession. \$1,000.

SPEECH COMMUNICATION

Arle and Billie Haerberle Fellowship in Electronic Media Studies—Support for the first year of graduate study for a person specializing in the use of electronic media in communication. \$10,000 plus tuition.

STATISTICS

Statistics Alumni Fellowship Fund—For second- or third-year full-time graduate student in statistics. Amount variable depending on funds, approximately commensurate with research assistantship.

STUDIO ARTS

Dayton-Hudson Internships in the Arts—To enhance graduate student involvement and visibility in the local arts community and to assist arts organizations with their missions. \$6,000 for each year of the three-year program.

Studio Arts Endowed Scholarships—To assist graduate students in their individual visual research. \$500-\$3,500.

THEATRE ARTS

Ken Bryant Directing Scholarship—For a graduate student who has expressed an interest in directing. About \$1,000.

Oscar W. Firkins Scholarship—For currently enrolled graduate students in theatre arts. Award based on service, potential in theatre, and need. About \$1,500.

Kenneth L. Graham Graduate Theatre Fellowship—For an outstanding graduate theatre major in residence. About \$1,500.

Haerberle Scholarship—For graduate students in theatre arts. Selection is made on basis of outstanding artistic and/or scholarly potential or achievement. About \$3,000.

Paul Joncas Technical Theatre Scholarship—For a currently enrolled student, junior through graduate, to benefit technical theatre students attending the annual USITT Conference. About \$500.

Elsie Kelley Lindquist Scholarship—For an outstanding undergraduate or graduate theatre major in residence. Award based on service, potential in theatre, and need. About \$1,000.

Dorothy Lambertson Fellowship—For a first-year MFA Acting student with outstanding potential. About \$1,000.

Dorothy Magnus Scholarship Fund—For deserving graduate students at the discretion of members of the Theatre Arts Department. About \$1,400.

Frank M. Rarig, Sr., Graduate Fellowship in Oral Interpretation—For a currently enrolled, worthy graduate student with a major interest in oral interpretation. About \$1,250.

Scholarship 50—Funded by alumni and patrons for outstanding theatre students with financial need. Variable amount.

Scott-Norcostco Theatre Fund—For a currently enrolled student, junior through graduate, in technical theatre. About \$750.

Frank and Josinette Whiting Scholarship—For an outstanding undergraduate or graduate major in residence. Award based on service, potential in theatre, and need. About \$1,800.

August Wilson Fellowship in Dramaturgy and Literary Criticism—For an African-American graduate student in the area of literary criticism and dramaturgy. Support is for up to three years of graduate study leading to the MA or PhD with internships in dramaturgy at the Penumbra and Guthrie Theatres. About \$10,000 per year in fellowship and/or assistantship support.

OTHER FELLOWSHIPS

Foreign Language and Area Studies Fellowships—See European Studies above.

Visiting Faculty and Scholars

Honorary Fellow—A professor or eminent scholar from another U.S. institution who is not a degree candidate at the University of Minnesota and seeks temporarily the privileges of using library or research facilities or attending seminars at the University, may be named an honorary fellow, without stipend, upon recommendation of the appropriate department head and approval of the Graduate School dean. (Note that for a professor or scholar from an international institution, the host department appoints the individual to a specific payroll appointment class, with or without salary depending upon arrangements agreed to between the department and the foreign scholar.)

Postdoctoral Associate—A postdoctoral fellow who does not hold a payroll class appointment (either with or without salary) may be named a postdoctoral associate by the Graduate School for up to one year upon recommendation of the host department.

Visiting Scholar—A regular faculty member of a Minnesota public or private college who is not studying for an advanced degree at the University of Minnesota and seeks temporary library privileges, can be named a visiting scholar, without stipend, by the Graduate School upon request of the host department. The request must include a letter from the college's academic dean or vice president verifying the visitor's faculty status and field of specialization.

Student Grievance Procedures

Academic Grievances—An all-University grievance policy exists "to provide just, efficient, and final resolution of grievances between members of the University community regarding the application of University rules and procedures." The University Grievance Officer is located in 419 Walter Library, Twin Cities campus.

Sexual Harassment—Policies and procedures pertaining to sexual harassment are contained in the University Senate's

policy statement of May 17, 1984. As the introduction to the statement notes, sexual harassment undermines the mission of the University and jeopardizes the careers of students, faculty, and staff. The statement defines sexual harassment in this manner: "Unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature constitute sexual harassment when (1) submission to such conduct is made either explicitly or implicitly a term or condition of an individual's employment or academic advancement, (2) submission to or rejection of such conduct by an individual is used as the basis for employment decisions or academic decisions affecting such individual, or (3) such conduct has the purpose or effect of unreasonably interfering with an individual's work or academic performance or creating an intimidating, hostile, or offensive working or academic environment."

Individuals seeking information and guidance in matters involving sexual harassment should contact Anne T. Truax, Sexual Harassment Officer, 419 Morrill Hall. All inquiries will be held in strictest confidence.

Housing

Students interested in living in a residence hall on campus or in off-campus housing in Minneapolis or St. Paul should contact Housing Services, Comstock Hall-East, 210 Delaware Street S.E., Minneapolis, MN 55455 (612/624-2994; fax 612/624-6987). Residence halls with floors or living areas reserved for graduate and professional school students are Bailey (St. Paul campus), Centennial, Comstock, and Middlebrook Halls. Listings of apartments, duplexes, houses, sleeping rooms, shared units, and sublets are also maintained. Information on temporary housing, living costs, transportation, and day care centers in the Twin Cities area is also available. A comprehensive booklet, *The Housing Resource Guide*, may be purchased for \$2.00.

General Information

For information on University family housing, contact Commonwealth Terrace Cooperative, 1250 Fifield Avenue, St. Paul, MN 55108 (612/646-7526) or Como Student Community, 1024 27th Avenue S.E., Minneapolis, MN 55414 (612/378-2434).

Placement

Graduate students seeking placement in college, university, or other positions may obtain aid and counsel from advisers and departments, from the deans of various colleges of the University, and through Career and Professional Services of the Education Student Affairs Office. This last office receives reports of vacancies for college teaching positions in all fields as well as for positions in counseling, administration, adult education, student personnel work, and research. Non-education graduate students seeking college teaching positions are eligible to establish credential files. The address of the Education Student Affairs Office is University of Minnesota, 110 Wullung Hall, 86 Pleasant Street S.E., Minneapolis, MN 55455 (612/625-9884).

The following offices offer placement services to graduate students seeking employment in fields other than teaching.

College of Agriculture
Career Services
University of Minnesota
272 Coffey Hall
1420 Eckles Avenue
St. Paul, MN 55108
612/624-2710; fax: 612/625-1260
e-mail: jmunder@maroon.tc.umn.edu

College of Biological Sciences
Career Information Center
Kathie Peterson, Career Information Adviser
University of Minnesota
217 Snyder Hall
1475 Gortner Avenue
St. Paul, MN 55108
612/624-9270; fax: 612/624-2785

School of Dentistry
Minnesota Dental Placement Service
University of Minnesota
15-106 Moos Health Sciences Tower
515 Delaware Street S.E.
Minneapolis, MN 55455
612/626-0171; fax: 612/626-2654

University of Minnesota, Duluth
Career Services
University of Minnesota
255 Darland Administration Building
10 University Drive
Duluth, MN 55812
218/726-7985; fax: 218/726-6394

College of Human Ecology
Career Services and Alumni Relations
Jeanne Exline, Director
University of Minnesota
68 McNeal Hall
1985 Buford Avenue
St. Paul, MN 55108
612/624-6762; fax: 612/625-5767

College of Liberal Arts
Career Development Office
University of Minnesota
345 Fraser Hall
106 Pleasant Street S.E.
Minneapolis, MN 55455
612/624-7505; fax: 612/624-2538
e-mail: klein005@maroon.tc.umn.edu

Curtis Carlson School of Management
Career Services Center
University of Minnesota
190 Hubert H. Humphrey Center
271 19th Avenue South
Minneapolis, MN 55455
612/624-0011; fax: 612/626-1822

College of Natural Resources
Career Opportunities Coordinator's Office
University of Minnesota
135 Natural Resources Administration Building
2003 Upper Buford Circle
St. Paul, MN 55108
612/624-6247; fax: 612/624-8701
e-mail: psplett@mercury.forestry.umn.edu

Hubert H. Humphrey Institute of Public Affairs
Placement Service
Lynne Schuman, Placement Coordinator
University of Minnesota
254 Hubert H. Humphrey Center
301 19th Avenue South
Minneapolis, MN 55455
612/625-2847

School of Public Health
Career Center
University of Minnesota
D-305 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, MN 55455
612/624-6915

Institute of Technology
Career Planning and Placement Office
University of Minnesota
50 Lind Hall
207 Church Street S.E.
Minneapolis, MN 55455
612/624-4090; fax: 612/626-0261

Graduate Programs



Graduate Programs

For an explanation of the numbering system, punctuation, department prefixes, and symbols used throughout the course descriptions in this section, see the last page of this bulletin.

Aerospace Engineering and Mechanics (AEM)

Regents' Professor: Daniel D. Joseph; James B. Serrin (mechanics)

Professor: William L. Garrard, *head*; Theodore A. Wilson, *director of graduate studies and associate head*; Roger E. A. Arndt (aerospace engineering); Gordon S. Beavers; Roger L. Fosdick; Chih-Chun Hsiao (*emeritus*); Richard D. James; Thomas S. Lundgren; Mitchell B. Lusk (mechanics); Tayfun E. Tezduyar; William H. Warner

Adjunct Professor: Andrew Vano

Associate Professor: Graham V. Candler; Perry H. Leo; Lev Truskinovsky

Adjunct Associate Professor: Dale F. Enns

Assistant Professor: Scott D. Abrahamson; Amy E. Alving; Gary J. Balas; Ellen K. Longmire; Anastasios S. Lyrantzis; Thomas A. Posbergh; Thomas W. Shield; Yiyuan Zhao

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—Aerospace Engineering: M.S.Aero.E. (Plan A and Plan B), M.Aero.E. (Coursework Only and Design Project), and Ph.D.; Mechanics: M.S. (Plan A and Plan B) and Ph.D.

Curriculum—The department offers graduate study in two major fields, mechanics and aerospace engineering. The graduate programs emphasize engineering sciences that are basic to these fields: fluid mechanics, dynamical systems and controls, and continuum and solid mechanics. Theoretical, analytical, experimental, and computational aspects of these fields are covered by the courses and research opportunities offered by the department.

Prerequisites for Admission—A four-year B.S. degree in an engineering, basic science, or mathematics program is required. Admission depends primarily on the applicant's undergraduate record and letters of recommendation.

Special Application Requirements—Graduate Record Examination scores are not required but are strongly recommended for students applying for graduate fellowships. In all cases, these test scores are taken into account if they are provided.

Students are admitted fall quarter only. Only under unusual circumstances are students allowed to begin their studies at another time during the academic year.

Master of Science Degree Requirements—For the M.S. degrees, see the General Information section of this bulletin. At least one sequence of 8xxx courses is required.

Master of Aerospace Engineering Degree Requirements—See Professional Master's Degree in Engineering in the General Information section of this bulletin.

Doctoral Degree Requirements—The Ph.D. program in the two major fields, mechanics and aerospace engineering, requires about two years of coursework, but the heart of the Ph.D. program is the thesis research. A Ph.D. program must contain a minimum of 64 credits of approved courses and six quarters of colloquium attendance. The first year of the Ph.D. program is similar to the master's program and most Ph.D. students receive the master's degree. By the end of the first year, the student has chosen an adviser. The second year is devoted to more advanced courses and beginning research. Subsequent years include some coursework with increased focus on research. The time required to complete a research project varies, but most students finish the Ph.D. about four years after their bachelor's degree.

Language Requirements—None, for either major. Some doctoral candidates, however, may find that reading proficiency in one or more languages is essential.

For Further Information and Applications—Contact the Department of Aerospace Engineering and Mechanics, University of Minnesota, 107 Akerman Hall, 110 Union Street S.E., Minneapolis, MN 55455 (612/625-8000; fax 612/626-1558; e-mail dept@aem.umn.edu).

Note—The courses listed below are appropriate for majors in both aerospace engineering and mechanics.

AEM 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

AEM 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

AEM 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5200. KINEMATICS AND DYNAMICS OF FLUID FLOW. (4 cr; prereq IT or grad student, 3036, ¶Math 3331 or Math 3252)

Stress and strain rate descriptions, fluid statics, use of differential and finite control volume analysis with continuity, momentum, energy equations, Bernoulli and Euler equations, introduction to Navier-Stokes equations, vorticity, potential flow.

5202. VISCOUS FLOW. (4 cr; prereq 5200, IT or grad student)

Incompressible viscous flow using Navier-Stokes equations. Dimensional analysis; one-dimensional exact solutions; pipe flow; laminar and turbulent boundary layers, wakes, and jets; momentum integral; pressure gradients and separation; introduction to turbulence; Reynolds stresses.

5204. SHOCK WAVES AND COMPRESSIBLE FLUID FLOW. (4 cr; prereq 5200, IT or grad student)

Basic concepts of thermodynamics. One-dimensional steady isentropic flow. Laval nozzle. Normal and oblique shock waves and reflections. Prandtl-Meyer flow. Supersonic thin airfoil theory.

5206. AERODYNAMICS OF LIFTING SURFACES. (4 cr; prereq 5200, CSci 3101 or CSci 3104)

Pressure distributions, forces, and moments on airfoils and wings of finite span. Analysis of potential flow by thin airfoil theory, lifting line theory, and panel methods. Viscous effects and their relation to design variables.

5240. RAREFIED GAS DYNAMICS. (4 cr; prereq IT or grad student, 5201 or Δ)

Relationship between continuum and molecular models for gas flow. Free molecule flows. Lift, drag, and energy transfer in free molecule flows. Slip flow and temperature jump.

5243. ADVANCED AERODYNAMICS. (4 cr; prereq IT or grad student, 5206)

Interaction between pressure distribution and boundary-layer growth on airfoils of arbitrary shape. Inviscid flow past non-planar wings of specified planform.

5244. HYPERSONIC AERODYNAMICS. (4 cr; prereq IT or grad student, 5204)

Importance and properties of hypersonic flow. Hypersonic shock and expansion-wave relations. Local surface inclination methods. Approximate and exact methods for hypersonic inviscid flowfields. Viscous flow: boundary layers, aerodynamic heating, hypersonic viscous interactions, computational methods. Hypersonic propulsion and vehicle design.

5250. COMPUTATIONAL FLUID MECHANICS.

(4 cr; prereq IT or grad student, FORTRAN, 5200 or Δ)
Finite element method; fundamentals of spatial discretization and numerical time-integration. Introduction to engineering and scientific computing environment and large-scale computing.

5300. FLIGHT MECHANICS. (4 cr; prereq 3005 or 5206, IT or grad student)

Standard atmosphere, analysis of power required, the classical performance data, maximum and minimum speed, maximum rate of climb, angle of climb and glide, absolute ceiling, service ceiling of propeller and jet-propelled aircraft. Static longitudinal stability, wing contribution, tail contribution, fuselage contribution and the neutral point. Power effect and longitudinal control. Formal aerospace vehicle design and wind tunnel projects.

5319. DYNAMICS AND CONTROL OF AEROSPACE VEHICLES. (4 cr; prereq 3401, 5300 or #, IT or grad student)

Reference frames, kinematics, and equations of motion. Forces and moments, trim, linearization, and dynamic response characteristics for aircraft and spacecraft. Handling qualities. Aircraft stability derivatives, phugoid, short period, spiral, roll subsidence, dutch roll modes, approximations, and transfer functions.

5321. AUTOMATIC FLIGHT CONTROL SYSTEMS. (4 cr; prereq 3401 or equiv)

Analysis and synthesis of automatic flight control systems for aerospace vehicles, longitudinal and lateral autopilots, stability augmentation systems, design by root locus, Nyquist and Bode techniques. Introduction to state-space formulation.

5322. AEROSPACE VEHICLE CONTROL. (4 cr; prereq IT or grad student, 5319 or equiv, 5321 or equiv or #)

Application of classical and multivariable methods of control system analysis and design to aerospace vehicle control. Flight control of airplanes, helicopters, and spacecraft, and trajectory control of aircraft. Design projects required.

5329. FUNDAMENTALS OF AEROSPACE VEHICLE DESIGN. (4 cr; prereq 5300 or #, AEM sr)

Design process and requirements, mission analysis, tradeoffs, vehicle component sizing, weight estimates, performance, propulsion systems, weight and balance, stability and control, cost, ground and flight testing, compliance and certification. Students prepare conceptual design of aerospace vehicle and written and oral reports.

5330, 5331. DESIGN OF AEROSPACE ELEMENTS AND SYSTEMS. (4 cr per qtr; prereq sr aerospace major or Δ)

Group and individual design projects.

5359. DECELERATION OF AEROSPACE CRAFT. (4 cr; prereq 3036, 5200, IT student)

Parachutes and other aerodynamic decelerators. Types, characteristics and applications, drag coefficients and steady descent, stability, deployment and opening forces, apparent mass effects, trajectory analysis, stress analysis, engineering properties of textile materials. Individual design projects.

Graduate Programs

5370. AERODYNAMICS OF V/STOL FLIGHT. (4 cr; prereq 5206)

Aerodynamic characteristics of the classical rotor. Combinations of rotor-wing and direct thrust-wing configurations are analyzed for high speed V/STOL aircraft. Jet flap, boundary layer control, and ground effect flight machines.

5410. INTRODUCTION TO ASTRODYNAMICS. (4 cr; prereq 3036)

Fundamental concepts of the two-body problem. Celestial coordinates, orbital elements. Orbit maneuvers and introduction to the three-body problem.

5435. INTRODUCTION TO RANDOM VIBRATIONS. (4 cr; prereq 3401 or ME 3201)

Fundamental concepts of probability theory, random variables, and statistical averages. Elements of stochastic system theory. Response of one- and two-degree-of-freedom mechanical systems to nondeterministic inputs. Fatigue failure criteria, acoustic excitation.

5438. INTERMEDIATE DYNAMICS. (4 cr; prereq 3036)

Three-dimensional Newtonian mechanics, kinematics of rigid bodies, dynamics of rigid bodies, analytical mechanics, generalized coordinates, holonomic constraints, Lagrange equations and applications, multi-degree-of-freedom dynamical systems.

5515. AEROSPACE STRUCTURES I. (4 cr; prereq 3016, IT student)

Elastic analysis of components important to aerospace structures. Finite element methods. Elastic limit and post-elastic behavior of trusses. Matrix methods for isotropic metals and composite materials in plane stress. Design and analysis of thin-walled and semi-monocoque structural members in bending and torsion. Energy and Castigliano methods for statically indeterminate structures.

5516. AEROSPACE STRUCTURES II. (4 cr; prereq IT student, 5515 or Δ)

Use of prepared computer programs for microcomputers and mainframe computers to solve moderately sized problems of analysis and design of trusses, plane frames, torsion, plane stress, and combination structures; elastic and inelastic analysis; use of symmetry and superposition to extend power of prepared programs; basis of finite element methods used.

5518. MECHANICS OF COMPOSITE MATERIALS. (4 cr; prereq 3016)

Analysis, design, and applications of laminated and chopped fiber-reinforced composites. Micro- and macro-mechanical analysis of elastic constants, failure and environmental degradation.

5580. MECHANICS OF SOLIDS. (4 cr; prereq Math 3251, IT or grad student)

Nonlinear continuum mechanics and thermodynamics in one dimension. Kinematics; mass, momentum, energy, and entropy; balance equations and jump conditions. Linear and nonlinear elastic constitutive equations. Applications drawn from wave propagation, stability, fracture mechanics, plasticity and viscoelasticity.

5581. THERMODYNAMICS OF SOLIDS. (4 cr; prereq Math 3251, IT or grad student)

Energy, power, heating, entropy, and stability; their use in formulating nonlinear constitutive equations and designing experiments. Analysis of shear-induced phase transitions and other instabilities. Topics may include shock waves, solid state engines, and other devices.

5630, 5631, 5632. AEROMECHANICS LABORATORY I, II, III. (4 cr per qtr; prereq 3016, 3036, 5200, upper div IT student)

Experiment design. Wind tunnel experiments including lift and drag measurement, flow visualization, pressure and velocity measurement techniques. Vibrations and properties of materials and structures. Systems control.

5650. AEROELASTICITY I. (4 cr; prereq 5206)
Static aeroelastic phenomena, torsional divergence of a lifting surface, control surfaces reversal and elastic efficiency. Effects of elastic deformations on stability, aeroelastic twisting of propeller blades and rotary wings, theory of lifting surface flutter, problems of gust response and buffeting, scaling of aeroelastic force models.

5687. INTRODUCTION TO ACOUSTICS AND ENVIRONMENTAL NOISE. (4 cr; prereq Math 3261, Phys 1253, IT or grad student)

Derivation of the wave equation, plane wave solution, transmission and reflection at boundaries, resonators and mufflers, three-dimensional wave propagation, properties of environmental noise sources, hearing and perception of sound, acoustical properties of rooms, lab experience in sound and noise measurements, noise control techniques.

5800, 5801, 5802. PROBLEMS IN MECHANICS AND MATERIALS. (1-4 cr per qtr; prereq Δ)

Topics of current interest. Individual projects.

5810, 5811, 5812. PROBLEMS IN FLUID MECHANICS. (1-4 cr per qtr; prereq Δ)

Topics of current interest. Individual projects.

8001, 8002, 8003. SEMINAR: AEROSPACE ENGINEERING AND MECHANICS. (1 cr per qtr; prereq consent of director of graduate studies; S-N only)
Short project based on colloquium series required for credit.

8201-8202-8203. FLUID MECHANICS I-III. (4 cr per qtr; prereq undergrad fluid mechanics and vector analysis; 8203 offered alt yrs) Abrahamson, Alving, Lundgren

Mathematical and physical principles governing the motion of fluids; kinematic, dynamic, and thermodynamic properties of fluids. Stress and deformation. Equations of motion. Analysis of rotational and irrotational inviscid incompressible flow. Two-dimensional and three-dimensional potential flow. Application to jets and lifting airfoils of infinite and finite span. Analysis of incompressible viscous flow. Creeping flows. Boundary layer flow. Analysis of compressible flow and shock waves. Method of characteristics for one-dimensional unsteady flow and for two-dimensional steady flow.

8209. ROTATING FLUIDS. (3 cr; prereq background in fluid mechanics especially boundary layer theory; offered when feasible) Abrahamson, Lundgren

8216-8217. THEORY OF TURBULENCE I, II. (3 cr per qtr; prereq 8202; offered alt yrs) Lundgren
8216: Analysis of turbulent flows. Reynolds equations, mixing length theory, classical boundary layer, pipe and wake flows, more general models. **8217:** Theories of homogeneous turbulence.

8219. COMPUTERS IN THE LABORATORY. (4 cr; offered alt yrs) Abrahamson
 Overview of computer organization, including external communications and A/D, D/A conversion. Measurement techniques, such as pressure measurements, hot-wire and laser Doppler anemometry. Signal processing and uncertainty, computer control of experiments.

8220. RHEOLOGICAL FLUID MECHANICS I. (3 cr; prereq 8201 or 8510 or #; offered alt yrs) Joseph
 Methods of solution for flows of simple fluids with general constitutive equations. Topics from viscometric flow, extensional flow, perturbations of the rest state with steady and unsteady flow, secondary flow.

8221. RHEOLOGICAL FLUID MECHANICS II. (3 cr; prereq 8220 or #; offered alt yrs) Joseph
 Structure theories of constitutive relations. Suspension rheology. Anisotropic fluids.

8232. PHYSICAL GAS DYNAMICS. (3 cr; prereq undergrad fluid mechanics, compressible flow, thermodynamics)
 Molecular and chemical effects in gas flows. Use of collision theory to determine mean free path, velocity distributions. Statistical mechanics. Partition function. Maxwellian and Boltzmann distributions. Nonequilibrium flows. Applications in rarefied and hypersonic flows.

8240. PERTURBATION METHODS IN FLUID MECHANICS. (3 cr; prereq 8202 or #; offered alt yrs) Joseph, Lundgren
 Method of matched asymptotic expansions presented through simple examples and applied to viscous flows at high and low Reynolds numbers, lifting wings, hypersonic flow, acoustics, and other problems in fluid mechanics.

8250. COMPUTATIONAL AERODYNAMICS. (4 cr; prereq FORTRAN) Lyrintzis
 Navier-Stokes equations and different levels of approximations. Finite difference approximations; accuracy, consistency, conservation form, and stability. Solution of Burger's equation; project: shock generation. Solution of Euler's equations; project: flow inside shock tube. Subsonic potential flow and transonic flow around airfoil. Multi-grid techniques and grid generation.

8251. FINITE VOLUME METHODS IN COMPUTATIONAL FLUID DYNAMICS. (4 cr; prereq grad-level numerical analysis course or #)
 Developing methods for solving compressible Navier-Stokes equations. High-resolution upwind shock-capturing schemes. Explicit and implicit formulations. Treating boundary conditions. Recent developments and other advanced topics.

8260. NONLINEAR WAVES IN MECHANICS. (3 cr; prereq 8201 or 8510 or #; offered alt yrs) Lundgren
 Theory of kinematic, hyperbolic, and dispersive waves, with application to traffic flow, gas dynamics, elastodynamics, and water waves.

8410. ADVANCED DYNAMICS. (4 cr; prereq 5438 or #) Warner
 Lagrange's equations; ignorable coordinates and momentum integrals; Routh's procedure; impulsive motion; constraints and Lagrange multipliers; calculus of variations and Hamilton's principle of stationary action; linearization; classical vibration theory; gyroscopic, circulatory, and non-stationary linear systems.

8411. LINEAR SYSTEMS. (4 cr; prereq 5438, # or 8410) Posbergh, Warner
 Linearization of equations of motion; Jordan form; singular value decomposition; numerical methods; solution procedures: matrix methods; qualitative properties; stability; observability and controllability; frequency domain methods.

8412. NONLINEAR SYSTEMS. (4 cr; prereq 8411 or #)
 Introduction to nonlinear dynamical systems. Method of averaging and its applications. Center manifold and normal form theories. Codimension one bifurcation analysis. Introduction to chaotic phenomena.

8413. ADVANCED NONLINEAR SYSTEMS. (3 cr; prereq 8411, 8412 or #)
 Dynamical systems with emphasis on higher dimensional (more than three) systems and global and chaotic phenomena. Bifurcation analysis with codimension greater than one, Melnikov method, and Silnikov phenomena. Concepts of symmetry. Application to problems modeled by partial differential equations.

8414. HAMILTONIAN SYSTEMS ON MANIFOLDS. (3 cr; prereq 8410, 8411 or #) Posbergh
 Geometric formulation for Hamiltonian mechanics, classical formulations, mechanics on manifolds; configuration and tangent spaces, Lie algebras. Cotangent spaces, symplectic forms and momentum maps. Rigid body dynamics, reduction, stability. Applications in engineering.

8415. ADVANCED TOPICS IN DYNAMICAL SYSTEMS. (3 cr [may be repeated for cr]; prereq 8411, 8412 or #; offered when feasible)

8420. TRAJECTORY OPTIMIZATION TECHNIQUES. (4 cr; prereq 5321 or #) Zhao
 Review of parameter optimization problems. Topics in calculus of variations. Necessary conditions of nonlinear optimal control problems. Classification of trajectory optimization algorithms. Steady-state aircraft flight. Minimum-time climb aircraft trajectory. Aero-assisted orbital transfer trajectories. Optimal space trajectories.

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8421. MODERN CONTROL THEORY FOR AEROSPACE SYSTEMS. (4 cr; prereq 5321, 8410 or #) Balas, Zhao

State space theory for multiple-input-multiple-output (MIMO) aerospace systems. Singular value decomposition (SVD) technique and its applications to performance and robustness. Linear quadratic gaussian (LQG) and eigenstructure assignment design methodologies. Topics in H_{∞} . Examples of aerospace systems and synthesis.

8422. ROBUST MULTIVARIABLE CONTROL DESIGN. (3 cr; prereq 8410, 8421 or similar courses in mech eng or elec eng) Balas

Emphasizes application to aerospace systems. Role of model uncertainty/modeling errors in design process. Control analysis and synthesis, including H_2 and H_{∞} optimal control design and structural singular value (μ).

8425. ADVANCED TOPICS IN AEROSPACE GUIDANCE AND CONTROL. (3 cr [may be repeated for cr]; prereq 8410, 8421 or #; offered when feasible)

8501, 8502, 8503. RESEARCH SEMINAR IN THE MECHANICS OF MATERIALS. (2-4 cr) Fosdick, James, Leo, Truskinovsky
Developing research programs from the macroscopic point of view. Topics drawn from current research and student interests.

8510. CONTINUUM MECHANICS I. (4 cr; prereq Δ) Fosdick

Concepts that are common to all continuous media. Elements of tensor analysis. Motion, deformation, and vorticity. Material derivatives. Mass and the continuity equation. Balance of linear and angular momentum. Stress and its geometric characterization. Need for constitutive equations.

8511, 8512. CONTINUUM MECHANICS II, III. (4 cr per qtr; prereq 8510 or #; 8512 offered alt yrs) Fosdick, James

Balance of energy. Principle of frame indifference. Constitutive equations of mechanics and characterization of solid and fluid type behavior including materials with memory. Principle of fading memory. Position of classical and approximate constitutive theories. Variational principles; virtual work and fundamental applications. Thermodynamics; entropy, Clausius-Duhem inequality. Solution of special problems.

8522. THEORY OF PLASTICITY. (4 cr; prereq 5580 or 8510 or #; offered alt yrs)

General theory of plane plastic strain for a rigid, perfectly plastic material. Applications to incipient plastic flow, steady flow, and pseudosteady flow. General theory of work hardening and perfectly plastic materials. Drucker postulates. Uniqueness and existence. Minimum principles and limit analysis. Applications.

8540. THEORY OF VISCOELASTICITY. (4 cr; prereq 5580 or 8510 or #; offered alt yrs) Fosdick, James
Principles of physics and mechanics of viscoelastic media. General balance of a physical law and field equations. General constitutive behavior of materials, methods of obtaining constitutive equations. General viscoelastic behavior and nonlinear large deformations. Microstructural consideration of viscoelastic systems.

8570. FRACTURE MECHANICS. (4 cr; prereq Δ ; offered alt yrs) Truskinovsky

Theories of mechanical breakdown. Kinetic rate theories and instability considerations. Formation of equilibrium cracks and circular crack propagation under pulses. Statistical aspects of strength and fracture of micromolecular systems. Time and temperature dependency in fracture problems and instability of compressed material systems.

8585, 8586, 8587. ADVANCED TOPICS IN CONTINUUM MECHANICS. (3 cr per qtr; prereq 8510, 8511, 8512 or #) Fosdick, James

Finite elasticity theory; theoretical study of exact solutions and experimental significance of selected problems, inequalities and work theorems, plane problems, iterative solutions and second-order effects, small deformations superposed on large, and relationship to stability. Singular surfaces and waves. Viscometric flows of non-Newtonian fluids; viscometric functions. Solution of special problems that illustrate the normal stress effect. Selected experimental results. Possible additional topics: Cosserat materials, multipolar continuum mechanics, modern theories of plasticity, mixtures, hypoelasticity, elastic dielectric and electrified materials.

8589. MECHANICS OF CRYSTALLINE SOLIDS. (4 cr; prereq 8510 or #) James

Molecular theory of crystals and origins of stress in crystals. Relation between atomic and macroscopic motion and constitutive equations for crystals; phase transformations and analysis of microstructure; effects of shear stress, pressure, temperature, electromagnetic fields, and composition on transformation temperatures and microstructure; surface energy in solids.

8594. ELASTOSTATICS I. (4 cr; prereq 5580 or 8510 or #, 8511 recommended; offered alt yrs) Fosdick, James, Leo

Principles and field equations of elasticity. Fundamental boundary value problems. Topics selected from energy theorems, St. Venant beam theory, plane problems, three-dimensional stress function methods, fundamental solutions.

8595. ELASTOSTATICS II. (3 cr; prereq 8594; offered alt yrs) Fosdick, James, Leo
(Continuation of 8594) Contact stress; finite deformations; other special topics.

8596. ELASTODYNAMICS. (4 cr; prereq 5580 or 8510 or #; offered alt yrs) Fosdick, James, Warner

Waves and vibrations in rods, beams, and plates. Dispersion. Volume and surface waves; reflection. Energy theorems. Vibrations of bounded media and relation to technical theories. Elements of nonlinear waves, inelastic waves, stability of motion of elastic systems.

8601. FINITE ELEMENT METHODS IN COMPUTATIONAL MECHANICS. (4 cr; prereq IT grad student or Δ) Tezduyar

Fundamental concepts and techniques of finite element analysis. Variational equations and Galerkin's method; weak formulations for problems with nonsymmetric differential operators; Petrov-Galerkin methods; examples from solid and fluid mechanics; properties of standard finite element families, implementation.

8602. FINITE ELEMENT METHODS IN COMPUTATIONAL FLUID DYNAMICS. (4 cr; prereq 8601) Tezduyar

Finite element methods for time-dependent problems; stability, convergence, and accuracy concepts. Analysis and applications of Petrov-Galerkin formulations for convection-diffusion equations. Incompressible Navier-Stokes equations; vorticity-stream function formulation and velocity-pressure formulation. Hyperbolic systems, compressible Euler equations.

8800, 8801, 8802. SELECTED TOPICS IN MECHANICS AND MATERIALS. (1-4 cr per qtr; prereq Δ) Fosdick, James, Leo, Shield, Truskinovsky
Topics of current interest. Individual student projects completed under guidance of faculty sponsor.

8810, 8811, 8812. SELECTED TOPICS IN FLUID MECHANICS. (1-4 cr per qtr; prereq Δ) Abrahamson, Alving, Candler, Joseph, Longmire, Lundgren, Lyrintzis, Tezduyar, Wilson
Topics of current interest. Individual student projects completed under guidance of faculty sponsor.

8880. PLAN B PROJECT. (1-4 cr [max 4 cr]; prereq grad major in aerospace engineering or mechanics, Δ)
Satisfies project requirement for Plan B master's degree. May appear on M.S. program but does not count toward 20-credit minimum in the major field. Topic arranged by student and adviser; written report required.

Agricultural and Applied Economics (AgEc)

Regents' Professor: Vernon W. Ruttan

Professor: James P. Houck, *head*; Robert P. King, *director of graduate studies*; Dale C. Dahl; K. William Easter; Vernon R. Eidman; Earl I. Fuller; Hans M. Gregersen; Jerome W. Hammond; Beth W. Honadle; Jean D. Kinsey; Richard A. Levins; Wilbur R. Maki; George W. Morse; Glenn D. Pederson; Willis L. Peterson; Philip M. Raup (*emeritus*); Terry L. Roe; C. Ford Runge; G. E. Schuh; Benjamin H. Senauer; Thomas Stinson; Harald von Witzke; Delane E. Welsch

Associate Professor: Jeffrey D. Apland; Sandra O. Archibald; Buddy G. Crewdson; Jeremiah E. Fruin; William C. Gartner; William F. Lazarus; Kent D. Olson; Philip G. Pardey; Claudia A. Parliament; Stanley C. Stevens; Steven J. Taff; Yacov Tsur

Assistant Professor: Richard D. Alderfer; Brian L. Buhr; Frances R. Homans; Scott T. Loveridge; Rodney B. Smith

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Graduate study requires an operational knowledge of economic theory and modern methods of quantitative analysis as well as practical application in specialized fields of inquiry, which include production economics and farm management, business management, finance, marketing, agricultural prices, food and agricultural policy, consumption economics, regional economics, resource and environmental economics, and agricultural development and trade.

Prerequisites for Admission—An undergraduate grade point average (GPA) of 3.00 or better is required. Students lacking background work in economics, calculus, linear algebra, and intermediate statistics may be required to complete deficiencies before acceptance in the graduate program. Applicants with at most a bachelor's degree are usually advised to begin at the M.S. level.

Special Application Requirements—Graduate Record Examination scores are required for all students. A minimum TOEFL score of 550 is required for applicants whose native language is not English, including those with other academic study in the United States. Applicants should provide evidence of superior scholarship, professional experience, and general aptitude for graduate study. Students are admitted any quarter but should keep in mind that most assistantships are allocated by the end of February to begin fall quarter. Applicants seeking fellowships should submit their application for admittance usually by January 1.

Master's Degree Requirements—All M.S. students are required to complete graduate-level courses in micro- and macro-economic theory and statistics, or to have completed equivalent courses. Under Plan A, the thesis counts for 16 of 44 credits. Under Plan B, the project counts for 6 to 9 of 44 credits.

A minimum GPA of 3.00 in the graduate program is required for graduation. A final oral examination is required.

Doctoral Degree Requirements—Students follow a study program in the major that includes micro- and macro-economic theory,

Graduate Programs

quantitative techniques, and three fields of specialization selected from the following: production economics and agricultural business management, agricultural prices and marketing, agricultural policy, agricultural development and trade, natural resource and environmental economics, regional economics, and consumption economics. A field may be replaced by a minor in such programs as health economics, statistics, or general economics.

Preliminary written examinations cover economic theory and fields in agricultural economics. Oral examinations are required for approval of the dissertation proposal and for its defense.

Language Requirement—None.

Minor Requirements for Students

Majoring in Other Fields—Master's

students must take Econ 5151 and Econ 5152 (or substitute), plus three agricultural economics courses at the 5xxx or 8xxx level, for a total of 15 credits. Students must also take two graduate-level quantitative courses. Specific courses are approved by the director of graduate studies in the Department of Agricultural and Applied Economics. All courses must be taken for a letter grade (A-F) and completed with a GPA of 3.00 or better.

Doctoral students must complete 20 credits of coursework in economics or agricultural economics with a minimum of 12 credits in agricultural economics at the 5xxx or 8xxx level. Courses are approved by the director of graduate studies in the Department of Agricultural and Applied Economics. All courses must be taken for a letter grade (A-F) and completed with a GPA of 3.00 or better.

For Further Information and

Applications—Contact the Department of Agricultural and Applied Economics, University of Minnesota, 231 Classroom Office Building, 1994 Buford Avenue, St. Paul, MN 55108 (612/625-3777).

AgEc 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

AgEc 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

AgEc 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5020. APPLIED LINEAR PROGRAMMING. (4 cr; prereq 1101 or Econ 1101, Math 1111 or Math 1131) Fuller

Application of linear programming to farm and agribusiness firms. Emphasizes economic concepts using minimal mathematics. Develops skills in computer use for decision making. Profit maximization, cost minimization, and transportation analysis.

5030. METHODS OF ECONOMIC DATA

ANALYSIS. (4 cr; prereq Stat 5021 or equiv; familiarity with matrix algebra recommended) Tsur
Emphasizes practical aspects. Econometric methods and models commonly used in applied economics; economic and statistical theory underlying these methods. Primarily for M.S. students.

5400. INTERMEDIATE MARKET AND PRICE ANALYSIS.

(4 cr; prereq 3003 or Econ 3101 or #)

Hammond
Development of analytical models and their application in various market situations. Unique market institutions developed in response to marketing problems and policies.

5440. COOPERATIVES AND AGRIBUSINESS ORGANIZATION.

(4 cr; prereq 1101, 1102 or Econ

1101, 1102 or #) R Dahl
Economic problems and issues facing agricultural cooperatives, including changing market organization, financing, taxation, antitrust regulations, and others.

5480. FUTURES MARKETS AND PRICES.

(4 cr; prereq 1101, 1102 or Econ 1101, 1102 or #) R Dahl

Economics of futures trading; basis and theoretical price relationships in storable and nonstorable commodities; hedging and commercial use of futures markets, with illustrations; arbitrage; options on agricultural futures; financial futures; speculation; futures market performances and regulation.

5500. FINANCIAL MARKETS AND

AGRICULTURAL CREDIT INSTITUTIONS. (4 cr;

prereq 3500 or BF 3000 or grad student or #) Pederson
Analysis of financial institutions and financial markets. Managerial policy issues confronting managers of financial intermediaries with particular reference to those operating in an agricultural setting. Current problems confronting financial intermediaries.

5550. FOOD MARKETING ECONOMICS.

(4 cr; prereq 3001 or Econ 3101 or #) Senauer
Economics of food marketing in the United States. Food consumption trends; consumer food behavior; food expenditure and consumption data; consumer survey methodology; food distribution and retailing system; food policy issues related to food marketing. Individual and group projects required.

5580. HUMAN CAPITAL AND HOUSEHOLD

ECONOMICS. (3 cr; prereq 3001 or Econ 3101 or #)

Kinsey
Investment in household formation, children, education, health, labor force participation, and non-market work analyzed in context of household economics and national productivity. Effects of economic variables on investment decisions and returns.

5600. LAND AND WATER ECONOMICS. (3 cr; prereq 3002 or Econ 3101 or #) Taff
Land and water as public resources and as factors of production; economic analysis of policies that influence asset use; sale and rental markets; valuation of rights to land and water; taxation and regulation as instruments for influencing private management decisions; comparative land and water legal and market settings.

5620. REGIONAL ECONOMIC ANALYSIS. (3 cr; prereq 1101 or Econ 1101) Maki
Analysis of regional industry and community structure; role of resource, transportation, and institutional constraints, trade, migration and investment in regional growth and change. Use of regional economic information in business investment and location planning.

5630. REGIONAL DEVELOPMENT SYSTEMS. (3 cr; prereq 1101 or Econ 1101) Maki
Population, income, and employment disparities in regional growth and development in selected countries. Regional development strategies and institutions for public intervention in regional development process. Regional systems analyses and forecasts for economic policy and development planning.

5640. FINANCING STATE AND LOCAL GOVERNMENTS. (4 cr; prereq 3001 or Econ 3101 or #)
Problems and issues in financing state and local public services in the United States, state and local revenue systems, debt and expenditures. Intergovernmental fiscal relations. Budget analysis.

5650. ECONOMICS OF NATURAL RESOURCE AND ENVIRONMENTAL POLICY. (4 cr; prereq 3002 or 3610 or Econ 3101 or #) Easter
Application of economic analysis, including project evaluation, to current natural resource and environmental issues. Emphasis on conservation and resource scarcity, environmental quality, and resource use issues and their implications for public policy.

5710. U.S. AGRICULTURE: FARM, FOOD, AND ENVIRONMENTAL POLICY. (3 cr; prereq 3003, 3006, 3007) Runge
Development of U.S. agriculture and U.S. agricultural and trade policy; agricultural input and commodity markets; design and economic effects of U.S. agricultural policy; determinants of U.S. agricultural and trade policies.

5720. ECONOMICS OF WORLD AGRICULTURE. (3 cr; prereq 3001, 3006 or Econ 3101, 3102 or #) Ruttan
Theories of agricultural development, comparative agricultural organization and structure, technical and institutional change in agricultural development, national development policies, bilateral and multilateral assistance, international policy conflicts.

5730. EUROPEAN AGRICULTURE: FARM, FOOD, AND ENVIRONMENTAL POLICY. (4 cr; prereq 3003 or Econ 3101 or #) von Witzke
Characteristics of agriculture in Europe; determinants of the development of European agriculture; goals and instruments of European Community's agricultural policy.

5740. AGRICULTURAL POLICY IN PLANNED ECONOMIES. (4 cr; prereq 3003 or Econ 3101 or #)
Principles of economics used to analyze agricultural policy and performance in centrally planned economies. Emphasis on Soviet agriculture, China and Eastern Europe also covered.

5750. AGRICULTURAL TRADE AND COMMERCIAL POLICIES. (3 cr; prereq 3001, 3006 or Econ 3101, 3102 or #) Houck
Patterns of trade in agricultural products; trade policies and practices of export and import nations; commodity agreements; agricultural trade policies of common market areas; negotiations and potential trade developments.

5790. WORLD FOOD PROBLEMS. (3 cr, §Agro 5200, §CAPS 5280, §FScN 5643; prereq sr or grad student) Peterson
A multidisciplinary examination of social, economic, and technical problems of feeding the world's growing population. Principles sought from economic, plant, animal, and food sciences for their application to food problems.

5860. ECONOMICS OF AGRICULTURAL PRODUCTION. (3 cr; primarily for grad students; prereq 3003 or #) Apland
Production economics applied to agriculture, profitable combination of production factors; comparative advantage and location of production.

5890. INDEPENDENT STUDY: ADVANCED TOPICS IN FARM MANAGEMENT. (1-6 cr; prereq #) Eidman, King
Special topics or individual work arranged on subjects suited to needs of particular groups of students.

5990. SPECIAL TOPICS AND INDEPENDENT STUDY IN AGRICULTURAL AND APPLIED ECONOMICS. (Cr ar; prereq #) Staff
Special classes, independent study, and supervised reading and research on subjects and problems not covered in regularly offered courses.

8100. GRADUATE SEMINAR. (2 cr; prereq 2 qtrs regis in AgEc MS prog, exam committee selected, #) Levins
Writing, critiquing, and oral presentation skills for master's students. Oral presentation of research proposal for thesis or Plan B paper critiqued by peers and committee members.

8110. MASTER'S PAPER: PLAN B PROJECT. (1-9 cr per qtr [max 9 cr]; prereq #; S-N only)

8200. ADVANCED TOPICS IN AGRICULTURAL AND APPLIED ECONOMICS. (1-9 cr [may be repeated for cr]; may be used to develop PhD thesis proposal on S-N only) Staff
Special seminars or individual work on subject suited to needs of students.

8210. APPLIED ECONOMETRICS. (3 cr; prereq Econ 8201 or Econ 5261, Econ 8202 or Econ 5262) Tsur
Basic skills for using econometrics in actual practice. Choosing functional forms and selecting variables; collinearity and outliers; limited dependent variable models in a single- and simultaneous-equation context. Emphasis on application to real-world data.

Graduate Programs

8220. APPLIED MATHEMATICAL PROGRAMMING.

(3 cr; prereq Math 1142 or equiv, Econ 5151 or #) Apland
Application of linear, integer, nonlinear, and simulation techniques to problems of the firm, market, economy, and regional or sectorial planning.

8231. AGRICULTURAL PRICES. (3 cr; prereq Econ 5151, 5152 or equiv) Smith
Nature of demand for farm products; supply considerations; price formation and markets; price variation and instability; dynamic analysis; methodological considerations.

8245. AGRICULTURAL MARKETING ECONOMICS. (3 cr; prereq Econ 5151, Econ 5152 or #) Staff

Time, space, and form dimensions of markets studied for cases of static and stochastic environments. Emphasis on use of current conceptual constructs. Implications of markets for contingent claims, incomplete information, and rent seeking on welfare.

8264. RESOURCE ECONOMICS. (3 cr; prereq Econ 5162 or #) Econ 5162 or #) Tsur

Economic analysis of resource use and management. Emphasis on capital theory and dynamic resource allocation, uncertainty and irreversibility in resource decision-making, and dynamic game analysis of common property resources. Applications to exhaustible forestry, fishery, and water resources.

8270. APPLIED WELFARE ECONOMICS AND PUBLIC POLICY. (3 cr; prereq calculus and intermediate economic theory) Runge

Basic concepts underlying measurement of welfare change, problems of market failure and externalities, social welfare functions, and distribution within and across generations. Application of concepts, based on case studies of the environment, returns to research, technical change, and agricultural policy.

8278. AGRICULTURAL AND ECONOMIC DEVELOPMENT. (3 cr; prereq Econ 5301 or equiv) Roe

Theories of socioeconomic growth; models of economic growth; consumption, production, and supply relations in agricultural development; agricultural development policy.

8287. PRODUCTION AND SUPPLY. (3 cr; prereq

5860 or equiv, Stat 5302 or equiv) Peterson
Functional forms and specification of production functions; measurement problems; specification bias; dummy variables; evaluating marginal products and returns to scale; supply estimation; distributed lags; demand for factors of production; project evaluation; technical change; returns to research; human capital.

8288. DYNAMIC PRODUCTION ECONOMICS.

(3 cr; prereq 5860, Econ 8101) Eidman
Analysis of firm-level production economics problems in dynamic setting. Alternative theories of the firm and techniques of analysis evaluated.

8345. SEMINAR: AGRICULTURAL MARKETING. (3 cr; offered when demand warrants) Hammond, Roe

8346. SEMINAR: LAW AND AGRICULTURAL ECONOMICS. (3 cr; offered to both law and grad students) D Dahl

8360. SEMINAR: LAND AND INSTITUTIONAL ECONOMICS. (3 cr; offered when demand warrants) Runge

8364. SEMINAR: RESOURCE ECONOMICS AND POLICY. (3 cr; offered when demand warrants)

8366. SEMINAR: APPLIED REGIONAL ECONOMICS. (3 cr; offered when demand warrants) Maki

8370. AGRICULTURAL AND TRADE POLICY IN DEVELOPED COUNTRIES. (3 cr; prereq 8270 or #) von Witzke

Agriculture in developed countries and the world economy; goals, principles, instruments of agricultural and trade policy intervention; implementation and problems of agricultural and trade policies in developed countries; political economy of agricultural policy decision making.

8378. SEMINAR: AGRICULTURAL DEVELOPMENT. (1 or 3 cr; offered when demand warrants) Roe, Ruttan

8382. SEMINAR: FARM MANAGEMENT AND PRODUCTION ECONOMICS. (3 cr; offered when demand warrants)

8590. ECONOMICS OF FOOD AND CONSUMER POLICY. (3 cr; prereq 8270 or equiv, Econ 5113 or Econ 5151 or equiv) Kinsey

Economic analysis of issues and impact of public policies relating to food pricing and distribution, product quality and information, food safety and liability; international comparisons of food and agricultural policy and its impact on consumers' welfare.

8591. CONSUMPTION ECONOMICS. (3 cr; prereq microeconomic theory at the 5xxx level at least, basic regression analysis) Senauer

Analytical and empirical treatment of consumer behavior. Modern adaptations of theory to explain household economics, Lancaster models, consumer demand, and expenditure models and estimations.

Agricultural Education

See Vocational and Technical Education.

Agricultural Engineering

Professor: R. Vance Morey, *head:* Kevin A. Janni, *director of graduate studies;* Frederick G. Bergsrud; Theodore P. Labuza; Cletus E. Schertz

Associate Professor: Mrinal Bhattacharya; James J. Boedicker; Jonathan Chaplin; Charles J. Clanton; Philip R. Goodrich; Larry D. Jacobson; John L. Nieber; William F. Wilcke; Bruce N. Wilson; Robert A. Young

Assistant Professor: John P. Chastain; Chang-Ho Park; Rongsheng R. Ruan; John M. Shutske

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S.Ag.E. (Plan A and Plan B); M.Ag.E.; and Ph.D.

Curriculum—Areas of emphasis include bioprocessing; food engineering; livestock environment; water quality, surface and subsurface flow, contaminant transport; waste management and resource utilization; terramechanics; safety; and grain quality. With approval from the department faculty, supporting courses in other fields of engineering and the physical, biological, or agricultural sciences may be included in the major.

Prerequisites for Admission—A B.S. degree in biological, agricultural, or related field of engineering, or equivalent coursework in mathematics, physics, engineering science, and engineering design, is required. A strong academic record is also required.

Special Application Requirements—Graduate Record Examination scores, while not required, are encouraged. Students are admitted each quarter.

Master's Degree Requirements—The M.S.Ag.E. degree is normally taken under Plan A, but may be completed under Plan B with approval from the department faculty. The M.Ag.E. program is recommended for those desiring design-oriented study beyond the B.S. degree. See Professional Master's Degree in Engineering in the General Information section of the bulletin for a program description. The final examination for both master's degrees is oral.

Doctoral Degree Requirements—Coursework for the major should provide in-depth knowledge in a specific area. It may include closely related topics, and should provide adequate background for the thesis investigation. A minimum of 16 credits in mathematics, statistics, and numerical analysis, including two or more mathematics courses, is required. The student may use these credits as a supporting program or may choose a designated minor in a single, related field.

Enrichment Program—In lieu of a language requirement for the Ph.D., the department requires completion of an enrichment program, consisting of 2 or more credits of nontechnical courses in a single area. Possible areas include (a) communication, educational methods, (b) foreign language and culture, (c) sociology, psychology, humanities, or (d) some other field related to the candidate's career objectives and approved by the department faculty.

Language Requirements—For the master's degree, none. For the Ph.D. degree, see above under Enrichment Program.

For Further Information and Applications—Contact the director of graduate studies, Department of Agricultural Engineering, University of Minnesota, 1390 Eckles Avenue, St. Paul, MN 55108 (612/625-7733; fax 612/624-3005).

AgEn 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr: doctoral PhD student who has not passed oral prelims)

AgEn 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

AgEn 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Agricultural Engineering (AgEn)

Courses That Carry Graduate Credit for Majors or Minors

5070. AUTOMATIC CONTROL AND INSTRUMENTATION. (4 cr; prereq CE 3400 or equiv, forest products major or upper div IT or grad student; 3 lect and 2 lab hrs per wk) Chaplin
Control of machines and processes. Linear feedback control. Linking of physical and biological control systems. Instrumentation for control systems and industrial development studies.

5072. FINITE ELEMENT METHOD: FUNDAMENTALS AND APPLICATIONS. (4 cr; prereq differential equations, upper div IT or grad student or #; 4 lect hrs per wk) Bhattacharya
Basic theory and principles of implementation of the finite element method for a number of fundamental engineering areas. Applications in heat transfer, fluid mechanics, solid mechanics, radial and axisymmetric field problems, and time-dependent field problems.

5074. MICROCOMPUTER INTERFACING. (4 cr; prereq upper div IT or grad IT major, AgET 3030 or CSci 3101 or CSci 3102; 2 lect and 4 lab hrs per wk) Goodrich
Introduction to digital components, integrated circuits, and microcomputers. Interfacing of microcomputers for data acquisition and control.

Graduate Programs

5140. THERMAL PROCESSES FOR FOOD. (4 cr; prereq heat transfer, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Bhattacharya
Engineering principles of thermal processing of food, pasteurization, microwave heating, heat exchange, evaporation, refrigeration, and freezing. Process design and evaluation.

5150. BIOLOGICAL PROCESS ENGINEERING. (4 cr; prereq BioC 3031 or Biol 5001 or #) Park
Reaction kinetics of hydrolysis of hemicellulose, cellulose, and starch to fermentable sugars. Fundamentals of fermentation and separation of alcohols, organic acids, insecticides, and biodegradable plastics.

5191-5192. SPECIAL PROBLEMS IN AGRICULTURAL ENGINEERING. (2-5 cr per qtr; prereq #)
Individual study project in agricultural engineering at advanced level. Application of engineering principles to a specific problem.

5350. AGRICULTURAL MACHINERY AND TERRAMECHANICS. (4 cr; prereq AEM 3016, AEM 3036, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Chaplin
Engineering principles governing performance of agricultural machinery. Soil-machine interaction (traction and tillage), off-road vehicle dynamics, operator-machine interaction, drive-line design, power unit selection, and duty cycle analysis.

5540. WATERSHED ENGINEERING. (4 cr; prereq 3052 or CE 3300, CE 3400, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Wilson
Applying engineering principles to management of surface runoff and soil water in agricultural, range, and urban lands. Designing facilities to control surface runoff to mitigate problems of flooding and degradation of surface water quality.

5550. WATER MANAGEMENT ENGINEERING. (4 cr; prereq 3052 or CE 3300, CE 3400, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Nieber
Applying engineering principles to management of water for production and environmental protection in agricultural systems. Designing facilities to irrigate and drain croplands and enhance water quality.

5560. MECHANICS OF FLOW IN THE UNSATURATED ZONE. (4 cr; prereq Soil 5232, Math 3261 or #, upper div IT or grad IT or grad College of Agriculture major; 4 lect hrs per wk) Nieber
Fluid retention and transmission properties of unsaturated porous media. Equations of mass conservation and Darcy's law for unsaturated porous media. Simultaneous flow of immiscible fluids. Analytical, finite difference and finite element solutions to governing equations.

5745. VENTILATING SYSTEMS FOR INDOOR AIR QUALITY. (4 cr; prereq ME 3301, AEM 3200 or CE 3400, upper div IT or grad IT major; 4 lect hrs per wk) Janni
Impact of indoor air quality on humans, animals, and plants. Contaminant sources. Ventilating processes, systems, control strategies, and equipment for indoor air quality control. Case studies from residential, commercial, and agricultural systems.

5751. BIOCHEMICAL ENGINEERING I. (3 cr, §ChEn 5751; prereq ag eng major or chem eng major or grad or #; 3 lect hrs per wk) Park
Applications of material and energy balances and of concepts from thermodynamics, kinetics, and transport phenomena to cellular and enzyme systems.

5910. AGRICULTURAL WASTE MANAGEMENT ENGINEERING. (4 cr; prereq 3052, Chem 1052, CE 3400, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Clanton
Sources and characteristics of agricultural wastes, including livestock, food processing, and domestic wastes. Physical, biological, chemical, rheological, and microbiological properties. Effects on environment. Collection, storage and treatment (aerobic and anaerobic), and use/disposal. Land application of livestock and food processing wastes, municipal effluents, and sludges. On-site sewage treatment.

8000. SUPERVISED TEACHING EXPERIENCE. (2 cr, §Agro 8000, §Hort 8000, §Soil 8000; prereq #) Janni
Classroom or extension teaching experience in one of the following departments: Agricultural Engineering, Agronomy and Plant Genetics, Horticultural Science, or Soil Science. Students strengthen skills and develop personal teaching philosophy.

8100. SEMINAR. (1 cr; prereq #, grad IT major) Schertz
Reports on current topics and department research.

8190, 8191. ADVANCED PROBLEMS AND RESEARCH. (2-6 cr per qtr; prereq 5191, 5192, Δ)
Research problems in agricultural engineering.

8500. HYDROLOGIC MODELING—SMALL WATERSHEDS. (4 cr; prereq CE 5405, grad IT major; 3 lect and 1 rec hrs per wk; offered alt yrs) Wilson
Study and representation of hydrologic processes by mathematical models; infiltration, overland flow, return flow, evapotranspiration, channel flow, and storage. Time-flow relationships. Linear and nonlinear methods. Frequency relationships. Emphasis on parametric methods.

8700. MOISTURE AND HEAT TRANSFER. (3 cr; prereq knowledge of differential equations, #, grad IT major; offered alt yrs) Nieber
Mathematical study of transfer of moisture and heat in agricultural crops and soils.

Agricultural Engineering Technology (AgET)

Courses That Carry Graduate Credit for Nonengineering Students Only

5027. APPROPRIATE TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT. (4 cr; prereq basic understanding of math, chem, physics; 3 lect and 3 lab hrs per wk) Goodrich

Definitions, history, successes, and failures of appropriate technology. Social and technical appropriateness. Water supply, treatment, storage, and conveyance. Water pumps, sanitation. Power: pedal, wind, water, solar, rice-hull furnace, methane, Stirling-cycle engine. Building materials. Agricultural machinery and storage. Transfer and adoption of technology.

5091-5092. SPECIAL PROBLEMS IN AGRICULTURAL ENGINEERING. (2-5 cr per qtr; prereq #)

Individual study project in agricultural engineering at advanced level. Application of engineering principles to a specific problem.

5410. HYDROLOGY AND WATER QUALITY. (5 cr; prereq Math 1111, Phys 1041, Chem 1052; 3 lect, 3 lab, 1 rec hr per wk) Wilson

Hydrologic cycle: precipitation, infiltration, evaporation, surface and subsurface run-off, ground water recharge. Flow in streams and in aquifers, flow measurement; soil erosion, sediment transport and deposition; chemical pollution of surface water and groundwater.

Agronomy (Agro)

Regens' Professor: Ronald L. Phillips

Professor: R. Kent Crookston, *head*; Craig C. Sheaffer, *director of graduate studies*; Donald K. Barnes; Orvin C. Burnside; Robert H. Busch; Vernon B. Cardwell; Burle G. Gengenbach; Leland L. Hardman; Dale R. Hicks; Robert J. Jones; Hans-Joachim G. Jung; William E. Lueschen; Neal P. Martin; Ervin A. Oelke; James H. Orf; Donald C. Rasmusson; Steve R. Simmons; Lawrence H. Smith; David A. Somers; Deon D. Stuthman; Carroll P. Vance; Donald L. Wyse

Associate Professor: Roger L. Becker; Beverly R. Durgan; Nancy J. Ehlke; Jeffrey L. Gunsolus; John V. Wiersma

Adjunct Associate Professor: John W. Gronwald

Adjunct Assistant Professor: Frank Forcella; Mark E. Westgate

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Training is provided in basic and applied aspects of management,

physiology, production, and weed control of field crops, with emphasis on sustaining the environment and profitable practices. The program is closely aligned with the interdepartmental programs of plant breeding and plant biological sciences. Prospective students should consult other sections of this bulletin which describe these programs. The Department of Agronomy and Plant Genetics can supply information about all three programs on request.

Prerequisites for Admission—Applicants should have university-level training in agronomy, biology, chemistry, and mathematics. Applicants must have a background in biochemistry and biometrics, or must acquire this background as part of the degree program.

Special Application Requirements—Three letters of recommendation and a statement by the applicant outlining career objectives and experience are required. Graduate Record Examination scores are strongly recommended. Students may enter the program at any time, but most assistantships begin in the summer or fall, and applications are usually acted on by mid-February.

Master's Degree Requirements—Most programs are Plan A. Students plan their course program and thesis research in consultation with their adviser and a department advisory committee. A final oral examination which includes a department seminar covering the thesis research or Plan B project is required.

Doctoral Degree Requirements—Course programs normally range from 60 to 75 quarter credits, depending on previous preparation. Students plan their course program and thesis research in consultation with their adviser and a department advisory committee. The final oral examination includes a department seminar covering the thesis research.

Minor Requirements for Students

Majoring in Other Fields—Ph.D. minors must complete a minimum of 20 credits in agronomy including 8020.

Graduate Programs

Language Requirements—None.

For Further Information and

Applications—Contact the Department of Agronomy and Plant Genetics, University of Minnesota, 411 Borlaug Hall, 1991 Buford Circle, St. Paul, MN 55108 (612/625-7773).

Agro 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Agro 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Agro 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5001f,w,s,su. PROBLEMS IN AGRONOMY FOR ADVANCED STUDENTS. (1-5 cr; prereq 20 cr agronomy, #) Staff

Independent research or study in agronomy. For advanced students who wish to pursue aspects of agronomy in greater depth than that offered in formal courses or who wish to investigate areas not presently offered in courses.

5010w. FORAGE PRODUCTION AND UTILIZATION. (3 cr; prereq 1010 or #; not offered after wtr 1995) Sheaffer

Interrelationships between plants and animals as they are involved in the selection, production, and use of forage crops. Crop management practices including establishment, maintenance, and harvesting of forages such as pasture, hay, or silage. Physiological basis of forage management of various species. Forage quality and use for livestock feeding with emphasis upon ruminant nutrition. Lecture.

5020w. INTRODUCTION TO PLANT BREEDING. (4 cr; prereq GCB 3022 or Hort 3003 or equiv) Orf
Applying genetic principles to improve crop plants. Includes self-pollinated, cross-pollinated, and asexually propagated crops. Lecture.

5030f. WEED CONTROL. (5 cr; prereq 1010 or #) Wyse

Survey of the magnitude of the weed problem. Regulatory aspects of weed control and herbicide usage. Principles and methods of weed control. Lecture and discussion.

5050f. MANAGEMENT TECHNOLOGIES FOR CROP PRODUCTION IN MINNESOTA. (4 cr; prereq agro course)

Solutions to crop production problems. Quality, productivity, and profitability. Principles needed for decisions. Corn/soybean, small grains, and forage crops. Lecture and discussion.

5070w. ECOLOGY OF FIELD CROPS. (3 cr; prereq 3010, 3 cr agronomic sciences or #) Simmons
Concepts and approaches to crop community interactions, field conditions, density relationships, plant competition, growth analysis, allelopathy, multiple cropping, weed crop interactions, crop rotations, crop diversity, canopy architecture, and whole-system productivity. Lecture and discussion.

5120s. GROWTH AND DEVELOPMENT OF FIELD CROPS. (4 cr; prereq 1007 or Biol 1009, Chem 1002, Chem 1051 or equiv) Cardwell

Principles and mechanisms that affect crop productivity. Physiological and morphological basis of growth and development; effects of physical and biological environmental factors. Lecture and lab.

5130f. HARVEST, STORAGE, AND UTILIZATION OF FIELD CROPS. (4 cr; prereq 1007 or Biol 1009, Chem 1002, Chem 1051 or equiv) Smith

Crop quality traits associated with utilization: their influence on harvesting, processing, and storage. Principles and technology used in crop storage to minimize damage from fungi and insects and maximize crop quality. Lecture, lab, and discussion.

5200f. WORLD FOOD PROBLEMS. (3 cr, §AgEc 5790, §CAPS 5280, §FScN 5643; prereq sr or grad student) Hardman

Multidisciplinary examination of social, economic, and technical problems of feeding the world's growing population. Principles sought from social, economic, plant, animal, and food sciences for their application to food problems.

5310su,f. ORIENTATION TO FIELD CROP BREEDING. (1 cr; prereq 5020 or #) Stuthman

Field study of plant breeding programs and techniques.

5320. ORIENTATION TO AGRONOMY AND SOILS FIELD RESEARCH. (1 cr; prereq 5040 or equiv; S-N only) Cardwell

Field survey and discussion of research techniques in crop physiology, crop and soil management, and weed science programs.

5330w. PLANT BIOTECHNIQUES. (2 cr; prereq 3xxx genetics and biochem courses)

Molecular and traditional biotechniques discussed by postdoctoral research associates to give broader understanding of molecular and quantitative techniques in agricultural research.

8000f. SUPERVISED TEACHING EXPERIENCE.

(2 cr, §Hort 8000, §Soil 8000; prereq #) Simmons
Classroom or extension teaching experience in one of the following departments: Agronomy and Plant Genetics, Horticultural Science, or Soil Science. Participation in teaching topic discussions to strengthen skills and develop personal teaching philosophy.

8010f,w,s,su. RESEARCH IN AGRONOMY. (Cr ar; prereq #) Staff

Problems in physiology and production of crop plants.

8020f,w. SEMINAR: AGRONOMY. (1 cr) Staff

Reviews and discussions of important agronomic literature.

8030f. MODE OF ACTION OF HERBICIDES. (3 cr; prereq 5030, P1Ph 5182, Biol 5001 or #; offered alt yrs) Gronwald

Classification and structure of herbicides, physiological processes affecting and affected by herbicides, review of selected literature on mode of action of herbicides.

8050f. PHYSIOLOGY OF FIELD CROPS. (3 cr; prereq 5120, PIPh 5131 or #; offered alt yrs) Jones
Physiology of crop productivity with emphasis on improving yield or quality. Assimilation and partitioning of nitrogen and carbon, transpiration, water stress, temperature stress, and vernalization.

8070. COLLOQUIUM IN AGROECOLOGY. (1-3 cr; prereq 5070, 8050 or #) Simmons
Critical literature review. Topics may include competition, allelopathy, weed-crop interaction, intercropping, tillage systems, insect-plant or pathogen-plant interactions, systems analysis, modeling.

8080f. CURRENT TOPICS IN AGRONOMY. (2 cr; prereq 5040, 8050, #; offered alt yrs) Sheaffer
Current developments in agronomy and crop physiology.

8200w. PLANT BREEDING PRINCIPLES AND METHODS I. (3 cr; prereq 5020, Stat 5301 or equiv) Rasmusson
Principles and current methods involved in breeding, emphasizing self-pollinated crops. Parent selection, modifications of traditional breeding procedures, priority setting and allocation of resources, breeding for special traits.

8210s. PLANT BREEDING PRINCIPLES AND METHODS II. (3 cr; prereq 8200, Stat 5301, GCB 5042) Stucker
Principles and methods of breeding, emphasizing cross-pollinated crops. Population concepts, constructing source populations, recurrent selection techniques, varietal development, and new approaches.

8220f. APPLICATION OF QUANTITATIVE GENETICS TO PLANT BREEDING. (3 cr; prereq 8210, 8260, GCB 5042 or #) Ehlike
Covariance of relative concepts in cross- and self-pollinated crops. Use of quantitative genetics in decision making in plant breeding. Genotype/environment interaction in relation to stability parameter estimation and interpretation. Selection index theory and application.

8230f. CYTOGENETICS. (4 cr; prereq GCB 5034 or #; 3 lect and 2 lab hrs per wk) Phillips
Genetic principles in relation to the eukaryotic chromosome. Molecular cytogenetics of chromosome structure, replication, pairing, and crossing over. Behavior of deficiencies, duplications, inversions, interchanges. Aneuploidy, autopolyploidy, allopolyploidy, and uses of cytogenetic stocks in molecular and classical genetics and plant breeding.

8240w. CELLULAR AND MOLECULAR GENETICS OF PLANT IMPROVEMENT. (3 cr; prereq GCB 5034) Gengenbach, Somers
Principles of genetic modification of higher plants by application of cellular and molecular biotechnology approaches, including tissue culture mutant selection and characterization, somaclonal variation, protoplast fusion, gene tagging and isolation, gene and genome transfer, and organelle genetics.

8250s. ADVANCED PLANT GENETICS. (2 cr; prereq 8240 or GCB 8131) Gengenbach, Somers
Current literature in cellular and molecular plant genetics, including gene transfer concepts and applications, analysis of gene structure and function in transgenic plants, molecular genetics of transposable elements and organelle genomes, and applications of new plant biotechnologies.

8270f,w. SEMINAR: PLANT BREEDING. (1 cr) Staff

8280s. CURRENT TOPICS IN PLANT BREEDING. (2 cr; prereq 8210 or #) Stuthman

8330f,w,s,su. RESEARCH IN PLANT GENETICS. (Cr ar) Staff

8340f,w,s,su. DIRECTED STUDIES FOR THESIS RESEARCH. (Cr ar; prereq PhD student in agro or in plant breeding or #; S-N only) Staff
For planning and implementation of thesis research, before passing preliminary oral examination.

AnPI 5060s. INTEGRATED MANAGEMENT OF CROPPING SYSTEMS. (4 cr; Agro 3020 or Hort 3002, Soil 3125 or #) Simmons
Case study/simulation and discussions considering integrated production management of selected agronomic and horticultural cropping systems in Minnesota. Problem analysis, principle application, and decision making involving integration of disciplines.

American Legal Institutions

Professor: Robert A. Stein, *dean*, Law School; Steve H. Nickles, *director of graduate studies*; Carl A. Auerbach; Stephen F. Befort; David Bryden; Laura Cooper; John J. Cound; Daniel A. Farber; Barry C. Feld; Richard S. Frase; Philip P. Frickey; Daniel J. Gifford; Robert E. Hudec; William D. Kilbourn, Jr.; K. Bart Koeppen; Victor H. Kramer; Robert J. Levy; Donald G. Marshall; John H. Matheson; C. Robert Morris; Fred L. Morrison; Roger C. Park; M. Kathleen Price; Stephen B. Scallen; Ferdinand P. Schoettle, Jr.; Suzanna Sherry; Michael Tonry; Gerald Torres; Thomas L. Waterbury; David Weissbrodt; Judith T. Younger

Associate Professor: Karen C. Burke; Ann M. Burkhart; Carol L. Chomsky

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.A. (Plan B only).

Curriculum—The master's degree in American Legal Institutions is intended to give lawyers who have completed law degrees in foreign universities an understanding of the American legal system and a background in the social, economic, and political framework within which it operates.

Graduate Programs

A joint degree program in law and public affairs is also available. See Public Affairs.

Prerequisites for Admission—Applicants should hold a law degree from a foreign institution and have the requisite facility in the English language.

Special Application Requirements—Applications should be accompanied by a detailed outline of the desired course of study. The program does not provide financial assistance for admitted students.

Master's Degree Requirements—Students select most of their courses from the professional offerings of the Law School (see the *Law School Bulletin*). The related field requirement for the Plan B degree is fulfilled with courses from one or more other departments of the University. At least one full year in residence is necessary to complete the degree, although students may spend as long as two years in residence.

Minor Requirements for Students Majoring in Other Fields¹—A minor for either the master's (M.A. and M.S.) or doctoral degree may be earned in law when it logically relates to the major field. The minor program is shaped to suit the particular needs and interests of the student. Courses must be selected from among those offered in the regular professional curriculum of the Law School (see the *Law School Bulletin*). Many law courses have prerequisites or enrollment limitations, so early planning of a minor in law is essential. Moreover, students who minor in law are usually required to take one or two first-year law courses as prerequisites to any upper-level course.

For Further Information and Applications—Contact the American Legal Institutions Program, University of Minnesota, 285 Law Building, 229 19th Avenue South, Minneapolis, MN 55455 (612/625-1000).

¹ The faculty for the minor in law is the same as for American Legal Institutions with the addition of Professor Steven D. Penrod, Clinical Professor Beverly Balos, and Research Associate Keith Bellairs.

American Studies (AmSt)

FACULTY

Professor: Elaine T. May, *chair*; Roland A. Delattre; David W. Noble

Associate Professor: Thomas H. King; Lary L. May; Carol A. Miller; Riv-Ellen Prell; Gayle Graham Yates

Assistant Professor: Kevin J. Mumford

AFFILIATED FACULTY

Professor: Chester G. Anderson (English); Ayers L. Bagley (educational policy and administration); Kent R. Bales (English); Terence W. Ball (political science); Hyman Berman (history); David O. Born (health ecology); Kinley J. Brauer (history); Roger D. Clemence (architecture); Hazel Dicken-Garcia (journalism); Sara M. Evans (history); Philip G. Furia (English); Philip J. Gersmehl (geography); Donald M. Gillmor (journalism); Edward M. Griffin (English); Karen N. Hoyle (Children's Literature Research Collections); Sally G. Kohlstedt (history of science and technology); Barbara Laslett (sociology); Edwin T. Layton (mechanical engineering; history of science and technology); Richard D. Leppert (cultural studies and comparative literature); Marion Lundy-Dobbert (educational policy and administration); Karal Ann Marling (art history); Toni A. H. McNaron (English); Russell R. Menard (history); Paul L. Murphy (history); Barbara J. Nelson (public affairs); Martin Roth (English); Harvey B. Sarles (cultural studies and comparative literature); Ellen J. Stekert (English); Roger H. Stuewer (physics; history of science and technology); Richard E. Sykes (speech-communication); Rudolph J. Vecoli (history); Jean W. Ward (journalism); Jack D. Zipes (German)

Associate Professor: Paula Rabinowitz (English), *director of graduate studies*; Ronald R. Aminzade (sociology); W. John Archer (cultural studies and comparative literature); Rose M. Brewer (Afro-American and African studies); Maria Damon (English); John M. Dolan (philosophy); Arthur I. Geffen (English); George D. Green (history); Mary Jo Kane (kinesiology and leisure studies); March L. Krotee (kinesiology and leisure studies); Judith A. Martin (geography); Roger P. Miller (geography); Gail K. Noble (General College); Joanna O'Connell (Spanish and Portuguese); Nancy L. Roberts (journalism); Guillermo Rojas (Chicano studies); Steven Ruggles (history); Thomas M. Scanlan (rhetoric); Robert B. Silberman (art history); Allan H. Spear (history); Dennis N. Valdes (Chicano studies); John S. Wright (English; Afro-American and African studies)

Assistant Professor: Leola A. Johnson (journalism); Lisa A. Norling (history); Jean O'Brien-Kehoe (history); Janice A. Peck (speech communication)

Other: William C. Beyer (coordinator, College of Liberal Arts Student Academic Support Services); Harry C. Boyte (senior fellow, Humphrey Institute of Public Affairs); Nobuya Tsuchida (director, Asian/Pacific American Learning Resource Center)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—American Studies is an interdepartmental degree program. The graduate faculty of the program consists of core faculty members and graduate faculty members from participating departments.

Prerequisites for Admission—An undergraduate major in a field related to American Studies or other preparation acceptable to the Admissions Committee for American Studies is required.

Special Application Requirements—The following should be sent to the program office: a special application form available through the program office, a personal statement, three letters of recommendation, a writing sample, scores from the General (Aptitude) Test of the Graduate Record Examination, and transcripts of all college work. Applications must be submitted by December 15. Entry is only in fall quarter.

Master's Degree Requirements—The master's degree is offered under Plan A and Plan B. A minimum of 15 courses is required, distributed as follows: introductory seminars 8201, 8202, and 8203; 1 two-quarter sequence from the American Studies specialty seminars; 2 comparative culture courses covering international or non-U.S. subjects; 2 courses in cultural pluralism within the American experience; and 6 other adviser-approved courses. A final oral examination is required for both plans.

Doctoral Degree Requirements—A minimum of 24 courses is required, distributed as follows: introductory seminars 8201, 8202, and 8203; dissertation seminars 8801, 8802; practicum in American Studies 8401; 2 two-quarter series from the American Studies specialty seminars; 2 comparative culture courses; 2 courses in cultural pluralism within the American experience; and 10 adviser-approved courses in three different departments. Preliminary

written and oral examinations covering coursework, and a dissertation and final oral defense of it, are required.

Language Requirements—For both the M.A. and the Ph.D. degrees, reading knowledge of one foreign language is required.

Minor or Supporting Field Requirements for Students Majoring in Other Fields—Students are expected to choose courses consistent with or complementary to their major. Students should complete six courses in American Studies, one of which must be 8201, 8202, or 8203.

For Further Information and Applications—Contact the Program in American Studies, University of Minnesota, 104 Scott Hall, 72 Pleasant Street S.E., Minneapolis, MN 55455 (612/624-4190).

AmSt 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

AmSt 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

AmSt 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5101. RELIGION IN AMERICAN CULTURE. (4 cr, §RelS 5101) Delattre
Not a survey, but a representative profile of religion in American, past and present, organized each quarter around a theme or problem.

5920. TOPICS IN AMERICAN STUDIES. (2-4 cr per qtr [max 12])
Topics specified in the *Class Schedule*.

8201. INTRODUCTION TO AMERICAN STUDIES: HISTORY, THEORY, METHODOLOGY. (4 cr; prereq admission to AmSt grad program)
Exposition of American studies as a field of inquiry, including its history, major theoretical frameworks, and interdisciplinary methodologies.

8202. INTRODUCTION TO AMERICAN STUDIES: CURRENT RESEARCH AND PRACTICE. (4 cr; prereq admission to AmSt grad program)
Review of contemporary interdisciplinary scholarship in the field.

8203. INTRODUCTION TO AMERICAN STUDIES: FIELD LEARNING. (4 cr; prereq admission to AmSt grad program)
Application of American Studies methods to various types of cultural materials.

Graduate Programs

8219, 8220. AMERICAN CULTURAL REGIONS. (4 cr per qtr [max 12 for 8220]; prereq # or Δ for 8219; 8219 or # or Δ for 8220) Staff

Regional, ethno-cultural investigation of United States, including national and regional cultures. Interdisciplinary use of historical, geographic, literary, and artistic approaches to describe and analyze regional character and to define and defend regional boundaries. 8219: Research strategies. 8220: Topical development.

8229, 8230. THE UNITED STATES IN INTERNATIONAL PERSPECTIVE. (4 cr per qtr [max 12 cr for 8230], §Hist 8229-8230; prereq # or Δ for 8229, 8229 or # or Δ for 8230) Staff

Relationship between American culture and role of United States in world; how United States has been imagined, defined, responded to by other cultures; historical, cultural, economic, political factors. 8229: Research strategies. 8230: Topical development.

8239, 8240. GENDER, RACE, CLASS, AND/OR ETHNICITY IN AMERICA. (4 cr per qtr [max 12 cr for 8240], §Hist 8239-8240; prereq # or Δ for 8239, 8239 or # or Δ for 8240) Staff

Social, psychological, historical, and artistic modes of self-expression and intellectual analysis of people in the United States identified as female and male or as members of racial, ethnic, or national-origin groups. 8239: Research strategies. 8240: Topical development.

8249, 8250. MATERIAL CULTURE AND/OR POPULAR CULTURE. (4 cr per qtr [max 12 cr for 8250], §Hist 8249-8250; prereq # or Δ for 8249, 8249 or # or Δ for 8250) Staff

Patterns of American building, artifacts, customs; human-made plans and procedures for use of space and conduct of daily life in physical and social environments. 8249: Research strategies. 8250: Topical development.

8259, 8260. LITERATURE, HISTORY, AND CULTURE. (4 cr per qtr [max 12 cr for 8260]; prereq # or Δ for 8259, 8259 or # or Δ for 8260) Staff
Interdisciplinary study of connections between literary expression and history, particularly as they articulate themes in American culture. 8259: Research strategies. 8260: Topical development.

8269, 8270. POLITICS, ECONOMICS, AND/OR THE LAW. (4 cr per qtr [max 12 cr for 8270]; prereq # or Δ for 8269, 8269 or # or Δ for 8270) Staff
Interdisciplinary investigation of underlying ideas of politics, economics, and the law in American culture. Draws upon research by historians, literary critics, political scientists, economists, and sociologists. 8269: Research strategies. 8270: Topical development.

8289, 8290. RELIGION AND SPIRITUALITY IN AMERICA. (4 cr per qtr [max 12 cr for 8290]; prereq # or Δ for 8289, 8289 or # or Δ for 8290) Staff
Forms, practices, and history of religious life and institutions in the United States. 8289: Research strategies. 8290: Topical development.

8401. PRACTICUM IN AMERICAN STUDIES. (4 cr; prereq #)
Application of American studies expertise, either inside or outside the classroom.

8801-8802. DISSERTATION SEMINAR. (4 cr per qtr; prereq # or Δ)

Intended for doctoral students beginning work on dissertations in American studies.

8970. READINGS IN AMERICAN CIVILIZATION. (Cr ar)

Independent study of interdisciplinary aspects of American civilization under guidance of members of various departments.

Anatomy (CBN)

Professor: David W. Hamilton, *head, director of graduate studies*; G. Eric Bauer; Robert P. Elde; Stanley L. Erlandsen; Glenn J. Giesler; Ryoko Kuriyama; Paul C. Letourneau; Richard W. Linck; Steven C. McLoon; Jonathan A. Parsons; Arlen R. Severson¹; Virginia S. Seybold; Robert L. Sorenson

Associate Professor: Stephen W. Downing¹; Lillian A. Repesh¹; Donald W. Robertson

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A only).

Curriculum—Major research interests in the department focus on the cell biology of reproduction, development, transplantation, and endocrinology in mammals, as well as on the neurobiology of peptidergic pathways and the basic mechanisms of pain, cancer, and diabetes. Students thus have a broad range of opportunities for research at the cellular level using biochemical, electron microscopical, and cell physiological techniques.

Prerequisites for Admission—9 credits of general biology, and at least one course each in chemistry and physics are required. Advanced mathematics (calculus) is recommended.

Special Application Requirements—Individuals interested in the M.S. program should consult the director of graduate studies before applying. Graduate Record Examination scores (General Test and Subject Test in biology) are required.

Language Requirements—None.

¹ University of Minnesota, Duluth.

Minor Requirements for Students Majoring in Other Fields—Required coursework for the minor in anatomy includes two of the four introductory courses in anatomy (5100-5101, 5103, 5104, and 5111) and at least 6 credits of advanced courses.

For Further Information and Applications—Contact the Department of Cell Biology and Neuroanatomy, University of Minnesota, 4-135 Jackson Hall, 321 Church Street S.E., Minneapolis, MN 55455 (612/624-1123).

CBN 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

5100-5101†. HUMAN GROSS ANATOMY A-B. (8 cr for 5100, 4 cr for 5101, §5107 and §5108 for 5100, §5109 for 5101; prereq regis med fr or grad student with #) Parsons, staff
Lectures and dissections of the human body.

5103. HUMAN HISTOLOGY. (3-8 cr [7 cr for med/dent fr]; prereq regis med/dent fr, Anat grad student or grad student with #) Letourneau, staff
Microscopic structure, cytochemical and functional aspects of cells, tissues, and organs.

5104. BIOCHEMISTRY, MOLECULAR AND CELLULAR BIOLOGY. (1 cr; prereq regis med fr, ¶MdBc 5100)
Integrated introduction to biochemistry, molecular biology, genetics, cell biology, and developmental biology.

5110. NEUROSCIENCE FOR DENTAL STUDENTS. (1.5 cr, ¶Phsl 5100; prereq regis dentistry fr, #) Elde, staff
Introduction to structure and function of central nervous system. Correlation between morphology and physiology emphasized.

5111. HUMAN NEUROSCIENCE A. (3-4 cr [3 cr for med students]; prereq regis med fr or grad student or #; 5111-Phsl 5112†) Ebner, staff
Structure and function of the nervous system including the organs of special sense.

5190. ADVANCED ANATOMY. (1-10 cr; prereq regis med, 5103, #) Staff
Teaching methods, supervision of student's original research or combination of both.

5304. HEAD AND NECK ANATOMY FOR MEDICAL/DENTAL RESIDENTS. (5 cr; prereq participation in a residency program in the medical or dental schools) Robertson, staff
Detailed consideration of head and neck anatomy from the gross morphological, functional, developmental, and radiographic aspects, with emphasis on areas of interest by specialty. Lab participation required.

8135. BIOLOGICAL ELECTRON MICROSCOPY: TECHNICS. (1-5 cr; prereq #; offered alt yrs) Erlandsen
Introduction to principles and technics of electron microscopy. Lab emphasis on acquisition of skills in tissue preparation, photography, use of electron microscope and ancillary equipment.

8136. BIOLOGICAL ELECTRON MICROSCOPY: TECHNICS. (1-5 cr; prereq #; offered alt yrs) Erlandsen
Specialized ultrastructural technics and their application to biologic problems. Lab emphasis on high resolution microscopy and use of scanning electron microscope.

8137. BIOLOGICAL ELECTRON MICROSCOPY: INTERPRETATION. (1-5 cr; prereq 5103, 8135-8136, and #; hrs ar; offered alt yrs) Erlandsen
Structure and function of cell organelles. Individual projects using advanced technics for both transmission and scanning electron microscopy.

8148. ADVANCED CELL BIOLOGY I. (4 cr, §GCB 8148; prereq Biol 5004 or #)
Eucaryotic systems with emphasis on structure, function, and chemistry of cell organelles; specialized cells. Membranes and secretion, including membrane methodologies, structure, function, synthesis, and turnover; cell surfaces, protein synthesis, glycosylation, membrane fusion, lysosomes, endocytosis, role of peroxisomes, and detoxification by endoplasmic reticulum.

8149. ADVANCED CELL BIOLOGY II. (4 cr, §GCB 5049, §GCB 8149; prereq Biol 5003, Biol 5004)
Eucaryotic systems with emphasis on structure, function, and chemistry of cell organelles; specialized cells. Motility and cell nucleus, including roles of microtubules and microfilaments in cell locomotion, shape changes, cytokinesis, ciliary beating, and organelle redistribution; cell cycle, chromosomal structure, replication, mitosis; compartmentalization and autonomy of mitochondria and chloroplasts.

8153, 8154, 8155, 8156. ADVANCED ANATOMY. (1-6 cr per qtr; prereq #) Staff
Cytochemistry, embryology, gross anatomy, hematology, histology, neurology, or experimental morphology.

8166. SEMINAR: PANCREATIC ISLET BIOLOGY. (3 cr; prereq #; offered alt yrs) Bauer, staff
Structure, development, physiology, and cell biology of pancreatic islets of Langerhans. Primary sources; original publications supplemented by recent reviews.

8200. RESEARCH. (1-10 cr [max 20 cr]; prereq #) Staff
Faculty-directed research in cell and developmental biology and neuroscience.

8205, 8206, 8207. SEMINAR: CELL BIOLOGY AND NEUROANATOMY. (1 cr per qtr; prereq #) Hamilton
Reviews of current literature and discussion of research work being carried on in the department.

8210. DEVELOPMENTAL NEUROBIOLOGY. (3 cr; prereq 5111, Phsl 5112 or #; offered alt yrs) McLoon
Nervous system development. General mechanisms and experimental approaches.

Graduate Programs

8215. MOLECULAR AND CELLULAR BASIS OF DEVELOPMENT. (3 cr; prereq Biol 5003, Biol 5004)

Yost

Molecular and cellular mechanisms of animal development; lectures, readings, and discussions of primary research literature; focus on historical concepts and principles of developmental biology and modern experimental analysis of these principles.

8221. NEUROBIOLOGY OF PAIN AND

ANALGESIA. (3 cr; prereq #; offered in alt sequence

with 8222 and 8223) Giesler, Seybold
Neural systems underlying pain perception, production of analgesia. Series of weekly lectures coordinated with student presentations on relevant topics.

8222. CENTRAL REGULATION OF AUTONOMIC

FUNCTION. (3 cr; prereq #; offered in alt sequence

with 8221 and 8223) Elde, Seybold
Morphology and physiology of autonomic ganglia and enteric nervous system, discussions of neuronal circuitry underlying central regulation of the adrenal medulla, cardiovascular system, respiratory system, and pelvic viscera. Weekly lectures and presentations of student papers.

8223. NEUROBIOLOGY OF ENDOCRINE

REGULATION. (3 cr; prereq #; offered in alt sequence

with 8221 and 8222) Elde, Seybold
Neural systems involved in regulating endocrine function. Lectures and student-led discussions on the hypothalamic-pituitary-target organ axes.

8301s. MOLECULAR BIOLOGY OF THE

CYTOSKELETON. (2 cr; prereq #; S-N only) Linck

Seminar with lecture and discussion and visiting speakers.

Animal Physiology

Professor: Alan G. Hunter (animal science), *chair, director of graduate studies*; Bo G. Crabo (animal science); Gary E. Duke (veterinary biology); Mohamed El-Halawani (animal science); Esther M. Gallant (veterinary pathobiology); Shirley Johnston (small animal clinical sciences); Benjamin S. Leung (obstetrics and gynecology); Richard E. Phillips (ecology, evolution, and behavior); William D. Schmid (ecology, evolution, and behavior); Jonathan E. Wheaton (animal science)

Associate Professor: Brian A. Crooker (animal science); Douglas N. Foster (animal science); Mathur S. Kannan (veterinary pathobiology); Scott M. O'Grady (animal science); John W. Osborn (animal science); Michael E. White (animal science)

Assistant Professor: Hugh Hensleigh (obstetrics and gynecology)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Emphases are reproductive, behavioral, and gastrointestinal physiology with a species orientation toward domestic and wild mammals and birds. In reproduction, research specializations include epithelial electrolyte transport, neuroendocrinology, spermatogenesis, immunoreproduction, and sperm-oocyte-embryo physiology. In behavior, research specializations include neuroendocrinology and electrophysiology. In gastrointestinal physiology, research specializations include cecal function, intestinal motility, and electrolyte transport across intestinal epithelium. In cardiovascular physiology, research is focused on nutritional determinants of cardiovascular disease. Other aspects of physiological research are also available.

Prerequisites for Admission—A bachelor's degree in animal science, fisheries and wildlife, biology, veterinary medicine, or zoology is required. Applicants should have completed coursework in zoology, biology, chemistry, physics, and mathematics. Deficiencies must be made up before a student can begin work toward the degree.

Special Application Requirements—A complete set of transcripts is required. Graduate study may begin in any term, but usually begins during the fall term.

Master's Degree Requirements—Course requirements, designed to accommodate the physiological research or career interests of the student, are flexible. A final oral examination is required.

Doctoral Degree Requirements—Students must complete a basic core curriculum that includes courses in animal science, veterinary anatomy, animal and veterinary physiology, biochemistry, and statistics. If a minor is chosen, it must be approved by the student's adviser and the director of graduate studies.

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—VB 5306 (4 cr), VB 5308 (4 cr), and VB 5310 (3 cr), or equivalent courses, and 9 credits of specialized physiology courses (e.g., avian, reproductive) are required.

For Further Information and Applications—Contact the Animal Physiology Program, University of Minnesota, 495 Animal Science/Veterinary Medicine Building, 1988 Fitch Avenue, St. Paul, MN 55108 (612/624-7455).

Note—The following is a list of courses from which selections for the major program are commonly made; other courses are also available. Descriptions of all courses can be found in the course listings of the departments offering them.

AnPh 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

AnPh 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

AnPh 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

AnSc 5322f. PHYSIOLOGY OF REPRODUCTION. (5 cr; prereq 6 cr systemic physiology or #) Crabo

AnSc 5327w. GENERAL ENDOCRINE PHYSIOLOGY. (3 cr; prereq 3301 or #) Wheaton

AnSc 5328s. GENERAL ENDOCRINE PHYSIOLOGY LABORATORY. (2 cr; prereq 5327 or #) Wheaton

AnSc 8325w. PHYSIOLOGY OF FERTILIZATION AND GESTATION. (4 cr; prereq 5322 or #; offered alt yrs) Hunter

AnSc 8326s. IMMUNOREPRODUCTION. (4 cr; prereq 5322 or #; offered alt yrs) Hunter

AnSc 8332s. PRESERVATION OF SPERMATOZOA AND EMBRYO. (5 cr; prereq 5322, 3 cr upper div biochemistry, #) Crabo

EEB 5156. COMPARATIVE ANIMAL PHYSIOLOGY. (5 cr; prereq Biol 1106 or 3011, Chem 3302 or #)

GCB 5114f. GENERAL PHYSIOLOGY. (3 cr; prereq Biol 3011 or Biol 3111, Biol 5001 or BioC 3021 or BioC 5331, Phys 1109 or Phys 1253 or Phys 1295)

VB 5306w, 5308s, 5310f. ANIMAL PHYSIOLOGY. (4 cr for 5306, 4 cr for 5308, 3 cr for 5310; prereq regis vet med or #) Duke, Hunter, O'Grady, Osborn, Redig, Wheaton

VB 5320w. AVIAN PHYSIOLOGY. (4 cr; prereq 3301 or 5 cr systemic physiology or equiv, #; offered alt yrs) Duke, El-Halawani, Redig

Animal Science (AnSc)

Professor: Richard D. Goodrich, *head*; Leslie B. Hansen, *director of graduate studies*; Paul B. Addis; William J. Boylan; Bernard J. Conlin; Craig N. Coon; Bo G. Crabo; William R. Dayton; Mohamed E. El-Halawani; Franklin D. Enfield; Richard J. Epley; Melvin L. Hamre; Alan G. Hunter; Dennis G. Johnson; James G. Linn; Charles F. Louis; George D. Marx; Jay C. Meiske; Sally L. Noll; Donald E. Otterby; James E. Pettigrew; Richard E. Phillips; Jeffrey K. Reneau; Lawrence B. Schook; Anthony J. Seykora; Marshall D. Stern; Paul E. Waibel; Jonathan E. Wheaton

Adjunct Professor: Hans-Joachim G. Jung

Associate Professor: Hugh Chester-Jones; Brian A. Crooker; Douglas N. Foster; Marcia R. Hathaway; Lee J. Johnson; Scott M. O'Grady; William G. Olson; John W. Osborn; Gerald C. Shurson; Michael E. White

Assistant Professor: Alfredo DiCostanzo; Brent W. Woodward

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Students emphasize one of the animal science subdisciplines such as breeding and genetics, growth and muscle biology, nutrition, physiology, or systems analysis. They have the option of taking a management component in conjunction with the subdisciplines. Technical training involves both animal and laboratory experience.

Prerequisites for Admission—A bachelor's degree in agriculture or a biological field with training in chemistry, physics, and mathematics is required.

Special Application Requirements—A complete set of transcripts in addition to that required by the Graduate School, two letters of recommendation evaluating the applicant's potential, and a statement of career goals are required. Graduate Record Examination scores are recommended for applicants without previous graduate records. Applicants are admitted every quarter.

Degree Requirements—For both the M.S. and Ph.D. degrees, students must complete basic courses in the chosen subdiscipline. The final examination for the M.S. degree is oral.

Graduate Programs

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—Requirements are designed to fit the student's needs.

Doctoral students must complete a minimum of 18 credits in areas not closely related to the major; no more than 3 of these credits may be in research or special problems.

For Further Information and Applications—Contact the Department of Animal Science, University of Minnesota, 122 Peters Hall, 1404 Gortner Avenue, St. Paul, MN 55108 (612/624-3491).

AnSc 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

AnSc 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

AnSc 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5231w. DAIRY CATTLE BREEDING. (4 cr; prereq 3220 or #) Hansen

Application of quantitative genetic principles to the breeding of dairy cattle. Emphasis on evaluation of males, females, and systems of breeding. Rates of genetic improvement with and without artificial insemination.

5322f. PHYSIOLOGY OF REPRODUCTION. (5 cr; prereq 6 cr systemic physiology or #) Crabo
Principles of reproductive physiology with emphasis on endocrinological aspects.

5327w. GENERAL ENDOCRINE PHYSIOLOGY. (3 cr; prereq 3301 or #) Wheaton
Biological effects, biochemistry, methods of assay, and regulatory aspects of hormones.

5328s. GENERAL ENDOCRINE PHYSIOLOGY LABORATORY. (2 cr; prereq 5327 or #) Wheaton
Demonstration of concepts in endocrinology using basic experimental approaches.

5330s. CURRENT TOPICS IN ENDOCRINOLOGY. (1 cr; prereq 3301, Biol 5001) Wheaton
Discussion of current developments in endocrinology, including introductory and review material, methodology, applicability of results to basic and applied research, and impact on existing endocrine principles.

5401f. SWINE NUTRITION AND FEEDING. (4 cr; prereq 3401) Shurson
Nutrient requirements of swine, nutrition interrelationships, nutritive value of feed ingredients, formulation of diets for optimum biological performance, nutritional management of all phases of pork production, quality control of on-farm feed manufacturing and feeding systems.

5403w. RUMINANT NUTRITION. (4 cr; prereq 1401 or 3401) Crooker, Otterby, Stern
Nutrient requirements of ruminants (beef and dairy cattle, sheep); nutrient content of feedstuffs, primarily forages; protein and nonprotein nitrogen use; energy use; nutritional disorders, formulation of adequate rations.

5405w. POULTRY NUTRITION. (3 cr; prereq 3401) Waibel
Nutrition and feeding of chickens and turkeys emphasizing nutrition concepts and feeding programs using least cost methods.

5601s. SWINE PRODUCTION. (4 cr; prereq 3401; 3220 recommended) Shurson
Integration of economics, environment and facilities, nutrition, health, reproduction, genetics, management, and current industry issues in a systems approach to understanding pork production and solving pork production management problems.

5602w. SHEEP PRODUCTION. (3 cr; prereq 3401 or #; 3220, 5403 recommended) Christians, Wolfe
Status and characteristics of the sheep industry; application of principles of animal breeding, nutrition, physiology, and economics to sheep flock management. Sheep production systems, including breeding programs, selection of breeds and breeding animals, feeding, health programs, dairy sheep, marketing, and budgets.

5603s. BEEF CATTLE PRODUCTION. (4 cr; prereq 1401 or 3401; 3220, 5403 recommended) DiCostanzo, Woodward
Status and characteristics of the beef cattle industry; application of principles of animal breeding, nutrition, physiology, and economics to management of beef cattle breeding herds. Ration formulation, management, and marketing of feedlot cattle.

5604s. DAIRY FARM MANAGEMENT. (4 cr, §5614; prereq 5403 or #; 3220 recommended) Reneau
Application of the principles of animal breeding, nutrition, physiology, and economics to the planning and management of the dairy farm; genetic influences, housing requirements, health programs for large herds, feed budgets, and record analysis.

5605f. POULTRY PRODUCTION. (4 cr; prereq 1401 or 3401; 5405 recommended) Hamre
Physiology, genetics, diseases, and nutrition of poultry examined in relation to current management practices for production of eggs, broilers, and turkeys. Technical and practical phases of production and marketing and their underlying principles. Visits to commercial production units.

5609w. PRINCIPLES OF FARM ANIMAL ENVIRONMENT. (4 cr; prereq jr, 3301 or #) El-Halawani
Processes involved in the adjustment of animals to ambient environments, with applications to farm animal management.

5710f,w,s,su. SPECIAL PROBLEMS. (Cr ar; open to students who have completed pertinent prereqs; prereq #) Staff
Research in an area of animal science under supervision of a staff member. Written report of research is required.

5715f,w,s,su. TUTORIAL. (Cr ar; prereq #) Staff
Informally structured course to encourage study in depth of a specific discipline in animal science. Pertinent readings, centered around fundamental propositions; preparation of written essays of high quality. Available in cryobiology, cytogenetics, genetics, nutrition, and physiology.

8210w. GENETIC IMPROVEMENT OF ANIMALS. (4 cr; prereq #) Seykora
Application of population genetics to livestock breeding; selection index theory and practice; basis of relationship and covariances among relatives; selection based on multiple sources of information.

8230s. LINEAR MODEL METHODS. (2-4 cr; prereq Stat 5022; GCB 5033, Math 3142 recommended) Hansen
Techniques and statistical tools for analysis of data. Matrix manipulations, least-squares procedures, correction for environmental factors, estimation of components of variance, and standard errors of estimates.

8325w. PHYSIOLOGY OF FERTILIZATION AND GESTATION. (4 cr; prereq 5322 or #; offered alt yrs) Hunter
Physiological events occurring during gametogenesis; capacitation and fertilization; the period of the embryo; the period of the fetus; and parturition.

8326s. IMMUNOREPRODUCTION. (4 cr; prereq 5322 or #; offered alt yrs) Hunter
Blood groups and polymorphic proteins affecting reproduction; immunoglobulin formation; antigens of semen, ova and genital secretions; immunopathology; maternal-fetal incompatibility, and antibodies to hormones.

8332s. PRESERVATION OF SPERMATOZOA AND EMBRYO. (5 cr; prereq 5322, 3 cr upper div biochemistry, #) Crabo
Chemical, physical, and physicochemical properties of gametes, reproductive secretions. Preservation of gametes using cryogenic techniques.

8335. MOLECULAR BIOLOGY TECHNIQUES IN ANIMAL SCIENCE. (4 cr; prereq Biol 5001, Biol 5003 or equiv or #) Foster
Basic theory and current methodologies of molecular biology and recombinant DNA technology. Lab work includes DNA and RNA hybridization, gene transfer, and polymerase chain reaction techniques. Primarily for students with limited exposure to molecular biology.

8420f. ANIMAL BIOENERGETICS AND NUTRITIONAL PHYSIOLOGY. (3 cr; prereq #; BioC 5002 recommended; offered alt yrs) Crooker
Integrated systems approach to nutritional physiology and energy metabolism of animals. Application of classical techniques of calorimetry and comparative slaughter, development of systems for expressing energy content of feeds, and techniques for measuring whole body and organ metabolism of specific nutrients in vivo.

8421s.* PROTEIN AND AMINO ACID NUTRITION. (3 cr; prereq BioC 5002 or equiv or #, BioC 5743 recommended; offered alt yrs) Coon
Role; sources, how determined; measurements of protein quality; fat and use of ingested protein and amino acids and interrelationships with other nutrients.

8440w.* RUMINANT NUTRITION. (4 cr; prereq BioC 5002 or #; MicB 5321 recommended; offered alt yrs) Stern, staff
Development, physiology, and function of the rumen; role of rumen microflora in digestion and synthesis and factors influencing these phenomena.

8441w. RESEARCH TECHNIQUES IN RUMINANT NUTRITION. (4 cr; prereq 8440 or #; MicB 5321 recommended; offered alt yrs) Stern
Techniques for measuring rumen fermentation and digestion in the gastrointestinal tract, including batch culture fermentation, in situ digestion, continuous culture fermentation, ruminal and intestinal cannulation, and blood sampling techniques.

8740w. CONCEPTS AND DEVELOPMENTS IN RUMINANT NUTRITION. (2 cr; prereq #) Stern
Review and critical evaluation of recent research reports of relevance to ruminant nutrition.

8742s. CONCEPTS AND DEVELOPMENTS IN SWINE NUTRITION. (2 cr; prereq #; offered alt yrs) Pettigrew
Review and evaluation of scientific literature pertinent to swine nutrition.

8743. CONCEPTS AND DEVELOPMENTS IN NUTRITIONAL PHYSIOLOGY. (2 cr; prereq #) Crooker
Review and critical evaluation of scientific literature.

8810.* RESEARCH IN ANIMAL SCIENCE. (Cr ar; prereq #)
Research including experimental studies in disciplines associated with animal production and research, with emphasis on interdisciplinary studies embracing environmental and managerial considerations.

8820.* RESEARCH IN ANIMAL GENETICS. (Cr ar; prereq #)
Research in quantitative genetics, cytogenetics, molecular genetics, and other areas related to animal breeding.

8830.* RESEARCH IN ANIMAL PHYSIOLOGY. (Cr ar; prereq #)
Individual research under faculty direction. Topic to be determined by consultation—may be a specialized aspect of a thesis problem or an independent problem of mutual interest to graduate student and adviser.

8840.* RESEARCH IN ANIMAL NUTRITION. (Cr ar; prereq #)
Research in selected areas of animal nutrition. Research topics and animal species determined by consultation.

Graduate Programs

Anthropology (Anth)

Professor: Luther P. Gerlach; Guy E. Gibbon; Stephen F. Gudeman; Glenn L. Hendricks; John M. Ingham; Marion L. Lundy-Dobbert; Frank C. Miller; Eugene Ogan; William L. Rowe; Peter S. Wells

Associate Professor: Gloria Goodwin Raheja, *chair*; David M. Lipset, *director of graduate studies*; Timothy Dunnigan; Mischa Penn; Riv-Ellen Prell; Janet D. Spector

Assistant Professor: Lisette E. Josephides

Lecturer: Bettina Arnold; Kathleen Barlow

Other: John M. Weeks

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—The department offers M.A. and Ph.D. degrees in the subfields of sociocultural anthropology and archaeology. Strong supporting programs in related fields are available. A special M.A. track in public archaeology is offered.

Prerequisites for Admission—None. Any necessary background work may be completed after admission.

Special Application Requirements—Three letters of recommendation on a form furnished by the department and scores from the General (Aptitude) Test of the Graduate Record Examination should be sent to the director of graduate studies. Admission is usually in fall quarter; the deadline for all materials is January 15.

Master's Degree Requirements—For the regular M.A. degree, 8001, 8002, 8003 or 8004, and a course in the method of one subfield are required. The rest of each student's program is individually designed with the provision that one-half of degree courses must be at the 8xxx level. The special M.A. and public archaeology track requirements are individually designed. A final oral examination is required of all students.

Doctoral Degree Requirements—Course requirements are the same as for the master's degree, with additional courses and seminars selected in consultation with the student's advisory committee.

Language Requirements—For the M.A. degree, none. For the Ph.D. degree, students must demonstrate a basic reading knowledge of one language other than English for which there is an anthropological literature or a long-standing literate tradition (e.g., Chinese, Hindi).

Minor Requirements for Students Majoring in Other Fields—The minor program is individually designed by each student.

For Further Information and Applications—Contact the Department of Anthropology, University of Minnesota, 215 Ford Hall, 224 Church Street S.E., Minneapolis, MN 55455 (612/625-3400).

Anth 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Anth 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Anth 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5102. PRINCIPLES OF CULTURAL ANTHROPOLOGY. (4 cr, §1102; prereq jr or #) Penn Introduction to elements of cultural anthropology. Range and variability of human behavior. Principles of cultural dynamics.

5104. HISTORY OF ANTHROPOLOGY. (4 cr; prereq 1102, 15 cr in 3xxx- and 5xxx Anth courses) Penn Principal themes in 19th- and 20th-century anthropological thought: diffusionism, autonomy of culture, evolutionism, and emerging methodological viewpoints such as functionalism, structuralism, cultural materialism, and interpretivism. Whether or not anthropological theory has a logic.

5112. GENDER AND KINSHIP. (4 cr; prereq 1102 or 5102, 3201 or #) Gudeman Gender, sexuality, marriage, and kinship in cross-cultural perspective; role of kinship studies in anthropological theory, including contemporary feminist critiques.

5114. STRUCTURAL ANTHROPOLOGY. (4 cr; prereq 1102 or 5102, 3201 or #) Gudeman, Penn Assumptions, methods, and problems of structural and semiotic anthropology; theory and analysis of kinship, myth, and social organization.

5115. ECONOMIC ANTHROPOLOGY. (4 cr; prereq 1102 or 5102, 3201 or #) Gudeman Systems of production and distribution, especially in nonindustrial societies; history, comparison, and critique of major theories in the field; development of anthropological approach to facts and processes of economy in the United States and other societies.

5117. NATURAL RESOURCES ANTHROPOLOGY. (4 cr) Gerlach

Cultural ecological and systems approach to examining how social institutions and cultural concepts are applied and changed across world societies to develop, use, and manage key environmental resources. Comparative studies from contemporary and historical United States, Western Europe, Africa, Asia, and the Caribbean.

5118. POLITICAL ANTHROPOLOGY. (4 cr; prereq 1102 or 5102 or #) Lipset

Anthropological approaches to politics: the structural-functionalists, Manchester School, and others. Key political concepts: authority, legitimacy, power, ideology, order and conflict. Focus on how symbols and rituals shape political process. Symbolic dimensions of ethnic and class consciousness.

5121. ANTHROPOLOGY OF LAW. (4 cr; prereq 1102 or 5102—waived for majors in political science and law) Lipset

Theory and method of various legal systems. Cultural background of law and relation of law to society. Functions and evolution of law in cultures ranging from small-scale to complex.

5131. ANTHROPOLOGY OF RELIGION. (4 cr; prereq 1102 or 5102 or #) Penn, Prell

Comparative study of beliefs, myths, and rituals in folk and indigenous religions. Analysis of how religion and social relations are integrated.

5132. SYMBOLIC ANTHROPOLOGY. (4 cr; prereq 1102 or 5102 or #) Ingham

Introduction to semiotic or symbolic interpretation of cultures in anthropology. General problems in theory and method, structure and motivation of cultural symbolism in particular societies.

5141. PSYCHOLOGICAL ANTHROPOLOGY. (4 cr; prereq 1102 or 5102 or #—waived for majors in public health, nursing, psychology, sociology, and social work) Ingham

Self, emotion, cognitive processes, and child development in cross-cultural perspectives.

5145. ANTHROPOLOGY AND EDUCATION. (4 cr; prereq 1102 or 5102 or #) Dobbert

Cross-cultural perspectives in examining educational patterns, implicit and explicit cultural assumptions underlying them. Methods and approaches to cross-cultural studies in education.

5151. CULTURAL CHANGE AND DEVELOPMENT. (4 cr; prereq 1102 or 5102 or #) Miller

Processes of cultural change: invention, innovation, diffusion, and acculturation. Theories of modernization, dependency, and world systems. Roles of anthropologists in development programs.

5152. ANTHROPOLOGY OF SOCIAL MOVEMENTS. (4 cr) Gerlach

Cross-cultural study of nature, process, and function of social, political, and religious movements of change. Examination of theories and case studies including Christianity, Islam, Asia, Africa, the United States.

5153. URBAN ANTHROPOLOGY. (4 cr; prereq 1102 or 5102 or #) Rowe

Structure and process in non-Western urban centers; role of rural migrants, relationship of urbanism to political and economic development, role of voluntary associations, adjustment of kinship groups to urban life.

5154. ANTHROPOLOGY OF COLONIALISM. (4 cr; prereq 1102 or 5102 or #) Rowe

Social, structural, symbolic, and psychological aspects of the societies of colonizers and colonized; emphasis on South Asia, Oceania, and Puerto Rico.

5157. THE POLITICAL DISCOURSE OF SOCIAL CHANGE. (4 cr) Josephides

Tension between tradition and innovation of ideas, techniques, and material development in contexts of rapid social change, especially when local cultures come into contact with outside, politically more forceful ones. Tradition as an already politicized discourse.

5161. CULTURAL SEMANTICS. (4 cr; prereq #) Dunnigan

Language-based approaches to study of cultures.

5176. ENVIRONMENTAL ARCHAEOLOGY. (4 cr; prereq 1101, 3111 or #) Spector

Archaeological and natural scientific approaches to studying past human society: human impact on and use of environment, reconstructing past environmental conditions. Field and lab techniques in association with archaeological research problems.

5191. FOLKLORE, POWER, AND CULTURAL DESCRIPTION. (4 cr; prereq 1102 or 5102 or #) Raheja

Song, oral poetry, story, and other performed speech genres as sites of cultural contestation, in arenas of gender, class, and colonial relations. Politics of expressive forms in contemporary and colonial societies; implications for practice of ethnography.

5258. ANTHROPOLOGICAL ANALYSIS OF AMERICAN CULTURE. (4 cr; prereq 1102 or 5102 or #) Ingham, Rowe

Anthropological perspectives on contemporary American culture and society with emphasis on values, family organization, socialization and kinship, education, community integration.

5301. ADVANCED METHOD AND THEORY IN ARCHAEOLOGY. (4 cr; prereq 3111 or #; recommended for anth majors specializing in archaeology)

Contemporary theoretical and methodological issues and approaches in archaeology. Projects incorporating theories and methods, including simple computer analysis.

5305. STUDIES IN ETHNOGRAPHIC CLASSICS. (4 cr) Penn

Intensive studies of notable theoretical and ethnographic works in the past and recent history of anthropology. Topics and works selected yearly.

Graduate Programs

5325. GENDER AND POWER IN SOUTH ASIA.

(4 cr; prereq 1102, 3261 or 5102 or #) Raheja
Multiple perspectives on gender, power, kinship, and sexuality in South Asian society; theoretical issues this multiplicity poses for ethnographic writing. Textual traditions, folklore, ritual and exchange, politics of everyday life, colonialism, and post-colonialism.

5331. CULTURE THEORY: AN INTRODUCTION.

(4 cr; prereq jr or sr or grad student or #) Penn
Selected issues in the development of culture theory, e.g., do cultural phenomena have an independent reality, or are they a derived aspect of social systems?

5392. PHILOSOPHICAL ANTHROPOLOGY.

(4 cr; prereq 1102 or 5102) Penn
Survey of traditional problems associated with certain major and broad ranging views on human nature and culture. Variations on these views; specific arguments of relativists, phenomenologists, behaviorists, and others. Recent ethnographic theory.

5394. PHENOMENOLOGY AND ETHNOGRAPHY.

(4 cr) Josephides
Phenomenological/existentialist thought conceived as "the end of ideology"; its politicization during World War II; its use in reflexive anthropology conscious of its own colonial foundations; its use in attempts to understand The Other and concepts of the person.

5520. CURRENT ISSUES IN ARCHAEOLOGY.

(4 cr; prereq 3111 or #)
Discussion/review/analysis of specific theoretical and/or methodological issues in archaeology.

5524. ARCHAEOLOGICAL RESEARCH DESIGN.

(4 cr; prereq #)
Recommended for undergraduate anthropology majors specializing in archaeology who select senior project option.

5592. HISTORY OF ARCHAEOLOGY.

(4 cr; prereq 12 cr in 3xxx- or 5xxx Anth courses) Gibbon
Survey course emphasizing development of major concepts and research goals.

5910, 5920. TOPICS IN ANTHROPOLOGY.

(Cr ar)
Special courses in all branches of anthropology. Topic, prerequisites, and instructor specified in the *Class Schedule*.

5960. SENIOR SEMINAR.

(4 cr; prereq sr major)
Research seminar. Topics vary according to staff and student interests.

5970. DIRECTED READINGS.

(2-4 cr; prereq #, Δ, CLA approval)
Qualified students may register for work on tutorial basis.

8001, 8002. FOUNDATIONS OF SOCIAL AND CULTURAL ANTHROPOLOGY I, II.

(3 cr per qtr; prereq anth grad student or #) Staff
Classical and contemporary foundations.

8003. FOUNDATIONS OF SOCIAL AND CULTURAL ANTHROPOLOGY III.

(3 cr; prereq anth grad student or #) Staff
Theoretical foundations in contemporary perspective.

8004. FOUNDATIONS OF ANTHROPOLOGICAL ARCHAEOLOGY.

(3 cr; prereq anth grad student or #) Staff

Theoretical foundations in contemporary perspective.

8124. PROBLEMS IN ARCHAEOLOGY.

(3 cr) Gibbon, Spector

8125. PROBLEMS IN LINGUISTIC ANTHROPOLOGY.

(3 cr) Dunnigan

8201. METHOD AND THEORY IN ARCHAEOLOGY.

(3 cr) Gibbon, Spector

8202. RESEARCH METHODS IN SOCIAL AND CULTURAL ANTHROPOLOGY.

(3 cr; prereq grad major in anth or #) Staff

8211. ADVANCED FIELD TECHNIQUES IN ARCHAEOLOGY.

(3 cr) Gibbon, Spector

8320. SEMINAR: SOCIAL ANTHROPOLOGY.

(3 cr) Staff

8330. SEMINAR: ECONOMIC ANTHROPOLOGY.

(3 cr) Gudeman

8340. SEMINAR: POLITICAL ANTHROPOLOGY.

(3 cr) Lipset

8350. SEMINAR: CULTURE AND PERSONALITY.

(3 cr) Ingham

8370. SEMINAR: SYMBOLISM.

(3 cr) Ingham, Prell

8390. SEMINAR: PHILOSOPHICAL ANTHROPOLOGY.

(3 cr) Penn

8420. SEMINAR: CULTURAL CHANGE.

(3 cr) Gerlach, Miller, Dunnigan

8460. SEMINAR: ANTHROPOLOGY OF GENDER.

(3 cr) Lipset, Prell, Spector

8510. SEMINAR: ARCHAEOLOGY.

(3 cr) Gibbon, Spector

8810. SEMINAR: SPECIAL TOPICS.

(Cr ar) Staff

8950. DIRECTED STUDIES.

(Cr ar; prereq #) Staff

Arabic (Arab)

Professor: Caesar E. Farah

Assistant Professor: Teirab AshShareef, *director of graduate studies;* Charles Ben Pike

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.A. (Plan B only).

Curriculum—The program focuses on the Arabic language and the literature and culture of the Arab world.

Prerequisites for Admission—Two years of Arabic (Arab 3103 or equivalent) is required, and a minimum of 16 credits in Arabic literature or culture, 12 credits of which must be at the upper division level.

Special Application Requirements—A short statement of purpose (in Arabic) and three letters of recommendation are required. Students are admitted fall, winter, and spring quarters.

Master's Degree Requirements—The minimum requirement is 44 credits in addition to one Plan B research paper (nine courses plus 8 credits for the research paper). The coursework must include 28 credits (seven courses) in Arabic literature or culture, including Arab 5001 (4 credits), and two 8xxx seminars (8 credits). The coursework must also include 8 credits (2 courses) in related fields outside Arabic depending on the student's academic goals and subject to the approval of the director of graduate studies. The final examination is an oral defense of the research paper.

Language Requirements—Three years of Arabic (Arab 5103 or equivalent) is required. A reading knowledge of one classical or one modern language appropriate to the student's academic goals and approved by the director of graduate studies is also required.

For Further Information and Applications—Contact the Arabic Program, Department of Afro-American and African Studies, University of Minnesota, 808 Social Sciences Building, 267 19th Avenue South, Minneapolis, MN 55455 (612/624-9847).

5001. INTRODUCTION TO RESEARCH IN ARABIC STUDIES. (4 cr) Youssif
Survey of most important research bibliographies in Arabic and Islamic studies. Bibliographic references in English and possibly in Arabic if sufficient interest.

5101, 5102, 5103 (formerly 5111-5112-5113). ADVANCED LITERARY ARABIC AND COMPOSITION. (5 cr per qtr; prereq 3101 or #) AshShareef
Literary styles and genres in classical and modern writings; compositions based on texts studied.

5501. MODERN ARABIC POETRY. (4 cr) AshShareef

The free verse movement and its radical departure from traditional ode form. Major trends: post-romantic, social-realist, symbolist, resistance, prose poem. Emphasis on leading poets: al-Mala'ika, al-Sayyab, al-Bayati, Adunis, Hawi, al-Khal, Abd-al-Sabur, al-Fayturi, Darwish, Sayigh, Jabra, and al-Maghut. Theoretical and critical essays. All readings in English.

5502. THE ARABIC NOVEL. (4 cr) AshShareef
The novel as a new genre in modern Arabic literature. Its relation to narrative genres in Arabic literary tradition, both written and oral. Trends: realist, psychological, existentialist, feminist, post-modernist/fantastic/experimentalist. Emphasis on major novelists: Mahfouz, Ghanem, Salih, Jabra, Kanafani, El Saadawi, al-Shaykh, Munif, Habibi, al-Qa'id, al-Ghitany, and Khoury. Novels discussed in cultural and historical context. Theoretical and critical essays. All readings in English.

5503. ARABIC DRAMA. (4 cr) AshShareef
Drama as a new genre in modern Arabic literature under influence of European drama. Relation with traditional dramatic forms in Arabic literature and culture. Trends: "Theater of the Mind," social realist, existentialist, absurdist, experimentalist, epic, and verse drama. Emphasis on major playwrights: al-Hakim, Abd-al-Sabur, Diyab, Salem, Faraj, Idris, al-Maghut, al-'Ani, Wannus, and al-Madani. Plays discussed in cultural and historical context. Theoretical and critical essays. All readings in English.

5900. TOPICS: READINGS IN ARABIC TEXTS. (4 cr per qtr [max 12 cr]; prereq 5103 or #) AshShareef, Farah
Reading and discussion of selected classical works in Arabic.

5970. DIRECTED READINGS. (Cr ar; prereq #, Δ, CLA approval) AshShareef, Farah, Youssif
Special problems for advanced students. Reading and periodic consultations.

5990. HONORS COURSE: RESEARCH. (Cr ar; prereq 5970 or #) AshShareef, Farah, Youssif
Individual studies for honors work at advanced level.

8801. SEMINAR: MODERN ARABIC LITERATURE. (4 cr; prereq 5103 or #) AshShareef
In-depth study of single author (e.g., Mahfouz, Adunis, al-Hakim) or single theme (e.g., modern Arabic critical theory, Arabic modernism, free verse movement). Topic specified in *Class Schedule*. Readings in Arabic and English.

8802. SEMINAR: ORIENTALISM. (4 cr) AshShareef
Orientalist discourse on Islam and Arabs. Orientalist texts. Theoretical and critical essays.

See South Asian and Middle Eastern Studies and Studies in Africa and the African Diaspora (in the Graduate Programs section) and Jewish Studies (in the Related Courses section).

Graduate Programs

Architecture (Arch)

Professor: Harrison Fraker, *dean*; Garth C. Rockcastle, *head*; Julia W. Robinson, *director of graduate studies*; Roger D. Clemence; Dennis Grebner; Lance LaVine; Roger B. Martin; Dale Mulfinger; John G. Rauma; Leon Satkowski; James E. Stageberg; Milo H. Thompson; Duane E. Thorbeck

Associate Professor: Gunter Dittmar; Thomas A. Meyer; William R. Morrish; Robert D. Sykes; Lee Tollefson; J. Stephen Weeks

Assistant Professor: Martha J. Abbott-Ladner; Lee B. Anderson; Thomas J. DeAngelo; Paul F. Emmons; Mary M. Guzowski; Cynthia Jara; Bruce A. Parker; Andrzej Piotrowski; Timothy G. Quigley; Todd J. Rhoades; Jeff Scherer; Julie V. Snow; Katherine M. Solomonson

Lecturer: Robert C. Mack

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.Arch.

Curriculum—The three-year professional curriculum accredited by the National Architectural Accreditation Board (NAAB) consists of a minimum of 126 graduate credits, including the thesis. Because the admitted student will already have a broad educational background and will have completed fundamental courses, the program focus is on professional and disciplinary coursework, including required and elective lecture, seminar, and design studio courses. For most students, the first-year integrated curriculum is followed by two years of less-structured coursework that culminates in a thesis.

Prerequisites for Admission—Applicants to the M.Arch. program must hold a baccalaureate degree and must have completed the equivalent of at least a year of preparatory work, including coursework in calculus, physics, architectural history, drawing, and architectural design.

In exceptional circumstances, students who have a nonprofessional baccalaureate degree in architecture and have completed the equivalent of the first year of the M.Arch. program requirements may qualify for advanced placement in the program. Depending on their academic record, their previous coursework, and their portfolio

review, these students could complete the M.Arch. degree in a minimum of two years.

A small number of students who hold a Bachelor of Architecture professional degree (B.Arch.) are admitted each year to pursue a second professional degree. Admission is based on the quality of the previous academic work and the quality of the portfolio. Depending on their background, these students could complete the M.Arch. degree in a minimum of four quarters.

For more complete information, please see the *College of Architecture and Landscape Architecture Bulletin* and contact the Department of Architecture.

Special Application Requirements—

Admission to the M.Arch. program is highly competitive. In addition to meeting Graduate School application requirements, students applying to the program must demonstrate design talent in a portfolio and must submit all of the following: a one-page statement of interest, transcripts of all coursework, three faculty recommendations, a recent paper written in English, and Graduate Record Examination scores. The portfolio should be a notebook no larger than 10" x 12" (other portfolio formats will be rejected). International students must submit scores from the Test of English as a Foreign Language (TOEFL). Priority for admission and financial aid is given to students who apply by January 10.

Degree Requirements—The three-year, 126-credit M.Arch. program is a Plan A program consisting of required and elective courses distributed as follows: 8 each in design studio and technology; 2 each in history, theory, and professional practice; and 1 each in urban design and visual communication; and 16 thesis credits.

Students who hold a B.Arch. degree (i.e., those who seek a post-professional degree) must take a minimum of 44 graduate credits in an individually developed program of study. Students may choose either Plan A or Plan B: the 44 credits include 16 thesis credits for Plan A and two or three major papers for Plan B.

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—Students who want to minor in architecture should contact the director of graduate studies.

For Further Information and Applications—Contact the Department of

Architecture, University of Minnesota, 110 Architecture Building, 89 Church Street S.E., Minneapolis, MN 55455 (612/624-7866; fax 612/624-5743; e-mail drasi001@maroon.tc.umn.edu).

Note—See also the program in Landscape Architecture.

Arch 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Design

5111-5112-5113. ARCHITECTURAL DESIGN. (6 cr per qtr; prereq 3093, 3064-3065 or ¶3064-3065, CE 3600-3601-3602 or ¶CE 3600-3601-3602, Arch major; not offered after 1995-96)

Advanced architectural problems of complex requirements, involving thorough study and detailed solution; electrical and mechanical equipment, structure as an integral part of design; research techniques and design process. Individual effort and group collaboration.

5250. TOPICS IN ARCHITECTURE DESIGN. (1-6 cr; prereq 5283 or grad Arch major)

5281. ARCHITECTURE STUDIO I: FUNDAMENTALS OF SPACE AND FORM. (6 cr; prereq 3311, 3412, Arch major or #; A-F only)

Introduction to elements of architecture, qualities of space, principles of design, and systems of order found in everyday objects, experiences, and forms of nature. Application of visual tools (models, drawings, and graphics) and design principles to three-dimensional form and composition. Lecture, critique, and small design problems.

5282. ARCHITECTURE STUDIO II: STRUCTURE AND ORDER. (6 cr; prereq 3311, 3412, 5281, Arch major or #; A-F only)

Design methods in conception of architectural form and space within context of current cultural and technological conditions. Application of design processes in understanding relationship between architecture and meaning. Lecture, design projects, and critiques.

5283. ARCHITECTURE STUDIO III: SITE, CONTEXT AND FORM. (6 cr; prereq 5282, Arch major or #; A-F only)

Development of architectural form and space within context of specific site and building program. Exploration of materials and structure systems within context of increasingly complex design projects. Lecture, design projects, and critiques.

5292. PRINCIPLES OF DESIGN PROGRAMMING.

(4 cr, §5952; prereq 5111 or 8253, Arch or grad Arch major; A-F only) Emmons, Robinson
Concepts and techniques of architectural programming, including space and activity analysis, site selection, precedent study, code review, appropriate technology identification, hypothesis formulation and evaluation. Emphasizes conceptual development, research, and analytic drawing.

8250. TOPICS IN DESIGN. (2-4 cr; prereq 1st-yr design or 8101 or #; A-F only)

8251, 8252, 8253, 8254, 8255, 8256.*

ARCHITECTURAL DESIGN. (6 cr per qtr; prereq Arch grad student; A-F only)
Problems involving analysis, program, and design; individual and collaborative effort.

8261, 8262, 8263. SELECTED PROBLEMS IN ARCHITECTURE. (1-9 cr per qtr; prereq Arch grad student)

Advanced architectural design problems; research and development of significant architectural form. Individual and collaborative effort.

8271, 8272, 8273. PROBLEMS IN CITY AND COMMUNITY DESIGN. (1-9 cr per qtr; prereq Arch grad)

Studies in the development of city spaces and urban character as they relate to changing socioeconomic needs and advancing technologies.

Representation and Communication

5309. REPRESENTATION IN ARCHITECTURE. (3 cr, §LA 5309; prereq 3311 or LA 3311, grad Arch or Land Arch major or #)

Historical and theoretical study of representation and its depiction in architecture and landscape architecture. Media, conventions, and techniques used to visualize or reproduce architecture and how they affect production of ideas.

5313. VISUAL COMMUNICATION TECHNIQUES IN ARCHITECTURE. (3 cr, §3033; prereq 3311 or #)

Professional delineation, exploration and use of variety of presentation and study techniques, methods/media investigation, modern techniques. Intended primarily for more advanced students in architectural design.

5321. ARCHITECTURE IN WATERCOLOR. (4 cr, §3110; prereq Arch/BED major, 3311 or #)

Watercolor as representation and communication in design process. Foundation principles, techniques, medium, tools, and materials. Color relationships, mixing, composition, and applications to design.

5350. TOPICS IN ARCHITECTURAL REPRESENTATION. (Cr ar; prereq Arch or grad Arch major or #; A-F only)

Theory and practice of visual representation.

5381. COMPUTER-AIDED ARCHITECTURAL DESIGN. (4 cr, §5961; prereq Arch or grad Arch major or #; A-F only) Anderson, staff

Introduction to computing and Pascal programming. Hardware, software, and problems and potentials of CAAD; weekly lab projects using Terak microcomputers as design tool.

Graduate Programs

5382. COMPUTER-AIDED ARCHITECTURAL DESIGN. (4 cr, §5962; prereq 5381, Arch or grad Arch major or #; A-F only) Anderson, staff
Applying principles and practice of computer-aided design and drafting to architecture.

5383. ADVANCED COMPUTER-AIDED ARCHITECTURAL DESIGN. (4 cr, §5963; prereq 5382, Arch or grad Arch or #; A-F only) Anderson, staff
Large-scale computer-aided drafting, site modeling, facilities management, solid modeling, and design simulation. Expert systems language and application to design processes.

8350. ADVANCED TOPICS IN REPRESENTATION. (2-4 cr; prereq 1st-yr design or 8101 or #)
Theory and practice of visual representation in architecture.

History

5410. TOPICS IN ARCHITECTURAL HISTORY. (Cr ar; prereq #)
Advanced study. Readings, research, seminar reports.

5411. HISTORIC PRESERVATION PROCESS. (4 cr, §5141; prereq Arch major or #; 4 lect hrs per wk) Mack
Philosophy and theory of historic preservation, historic origins, descriptive analysis of buildings, building documentation, technology of building conservation, historical archaeology, economic considerations, preservation law, guidelines for preservation, neighborhood conservation, international preservation, and case studies of representative preservation projects.

5413. HISTORIC BUILDING RESEARCH AND DOCUMENTATION. (4 cr, §5143; prereq Arch major or #; 2 lect and 2 lab hrs per wk) Mack
Philosophy, theory, and methods of historic building research, descriptive analysis of buildings, building documentation, historical archaeology, and architectural taxonomy.

5417. ASIAN ARCHITECTURE. (4 cr, §5057; prereq Arch major or #; A-F only)
Topics from history of architecture and urban design in West, South, and East Asia.

5418. INDIGENOUS ARCHITECTURE. (4 cr, §5058; prereq Arch major or #; A-F only)
Case studies of indigenous environments in selected cultures.

5421. ANCIENT ARCHITECTURE. (4 cr, §5051; prereq 3411, Arch major or #; 3 lect and 1 seminar hrs per wk)
History of development of architecture and urban design in Egypt, Mesopotamia, Crete, Mycenae, and classical Greece and Rome until the advent of Christianity.

5422. EARLY MEDIEVAL ARCHITECTURE. (4 cr, §5052; prereq 3411 or Arch major or #; 3 lect and 1 seminar hrs per wk; A-F only)
History of the development of architecture and urban design during early Christian, Byzantine, Islamic, Carolingian, and Romanesque periods in the Near East and Western Europe until 1150 A.D.

5423. GOTHIC ARCHITECTURE. (4 cr, §5053; prereq 3411 or Arch major or #; 3 lect and 1 seminar hrs per wk; A-F only)
History of development of architecture and urban design in Western Europe from 1150 until 1400 A.D.

5424. RENAISSANCE ARCHITECTURE IN ITALY. (4 cr, §5054; prereq 3411, Arch major or #; 3 lect and 1 seminar hrs per wk; A-F only) Satkowski
History of architecture and urban design in Italy, 1400-1600 A.D. Emphasis on major figures (Brunelleschi, Alberti, Bramante, Palladio) and evolution of major cities (Rome, Florence, Venice).

5425. BAROQUE ARCHITECTURE IN ITALY. (4 cr, §5064; prereq Arch major or #; 3 lect and 1 seminar hrs per wk) Satkowski
Architecture and urban design in Italy, 1600-1750 A.D. Emphasis on major figures (Bernini, Borromini, Cortona, Guarini) and evolution of major cities (Rome, Turin).

5426. ARCHITECTURE AND NATURE, 1500-1750. (4 cr; prereq 3411, 3412 or #) Satkowski
History of interaction between architecture and nature in Italy, England, and France in 16th and 17th centuries. Major monuments and their relationship to theories of architecture and gardening; urban and rural life.

5431. EIGHTEENTH-CENTURY ARCHITECTURE AND THE ENLIGHTENMENT. (4 cr, §5055; prereq 3412 or Arch major or #; 2 lect hrs per wk; A-F only) Solomonson
Architecture, urban planning, and garden design in Europe, 1700-1850.

5432. MODERN ARCHITECTURE. (4 cr, §5056; prereq 3412 or Arch major or #; 3 lect and 1 seminar hrs per wk; A-F only) Solomonson
Architecture and urban design from early 19th-century sources in Europe and America to World War II.

5433. AMERICAN ARCHITECTURE AND URBANISM TO 1870. (4 cr; prereq 3412 or #) Solomonson
American vernacular landscape and architect-designed structures and spaces, from colonization through Civil War. Topics range from colonial architecture in Southwest and New England to development of an expression of national identity, from Southern plantations and Midwestern farms to architecture of industrial city.

5434. CONTEMPORARY ARCHITECTURE. (4 cr, §5061; prereq Arch major or #; 3 lect and 1 seminar hrs per wk) Solomonson
Developments, theories, movements, and trends in architecture and urban design from World War II to the present.

5439. HISTORY IN ARCHITECTURAL THEORY. (4 cr, §5067; prereq 3412 or #) Satkowski, Solomonson
From antiquity to 20th century.

8410. TOPICS IN HISTORY. (2-4 cr; prereq 1st-yr design or 8101 or #; A-F only)

Theory and Criticism

5401. PRINCIPLES OF DESIGN THEORY. (4 cr; prereq grad Arch or #; A-F only) Jara
Principles of design and their instrumentation. How and why architecture theory is generated. Types and significance of formal analysis. Theoretical positions and modes of criticism.

5450. TOPICS IN ARCHITECTURAL THEORY. (Cr ar; prereq Arch or grad Arch major or #; A-F only)
Topics in theory and criticism.

5451. ARCHITECTURE: THEORY AND PHILOSOPHY. (3 cr, §5851; prereq 5401 or #; A-F only) Dittmar
Architecture within general, philosophical, theoretical context: its nature, role, purpose, meaning, etc. Potential, limitations, and implications of paradigms through which architecture has attempted to define itself and derive its mode of operation.

5452. ARCHITECTURE: THOUGHT AND DESIGN PROCESS. (3 cr, §5852; prereq 5401 or #; offered when feasible; A-F only) Dittmar

5453. ARCHITECTURE: FORM AND MEANING. (3 cr, §5853; prereq 5401 or #; A-F only) Dittmar
Investigates issues of meaning through exploring fundamental, constituent elements of architectural form and order; inherent tectonic, phenomenal, and experiential characteristics of these elements and their potential and implications for creation and structure of meaningful, human place(s).

5454. SEMIOTICS AND DECONSTRUCTION IN ARCHITECTURE. (3 cr, §5854; prereq 5401, grad Arch major or #; A-F only) Rockcastle
Expressive and cultural dimensions of architecture, especially as they relate to linguistic analogies, knowledge production, and contemporary philosophy, including broad critical perspective of architectural discussion and argumentation which addresses current aspects of the debates.

5455. TYPOLOGY AND ARCHITECTURE: THEORIES OF ANALYSIS AND SYNTHESIS. (3 cr, §5855; prereq 5401, grad Arch major or #; A-F only) Rockcastle
Theoretical traditions and development of the use of typology in architecture. Historical works of Laugier, Quatremère de Quincy, Viollet-Le-duc, Ledoux, Durand, Camillo Sitte, and Le Corbusier. Recent developments and theoretical positions of the "neorationalist" and "contextual" arguments for contemporary applications of idea of type.

5458. ARCHITECTURE AND CULTURE. (3 cr, §5951; prereq 3412, Arch major or #) Robinson
Architecture as a cultural medium; relation between architecture, people, and culture; physiological and symbolic messages; relation between research findings and design and between vernacular and high-style architecture; reception theory in architecture; cultural critique and cultural change; implications for architectural practice.

8450. TOPICS IN THEORY. (2-4 cr; prereq 8101 or 8401 or #; A-F only)

Technology

5511. CONSTRUCTION MATERIALS IN ARCHITECTURE. (4 cr, §3061; prereq grad Arch major or #; A-F only)
Study and analysis of building materials, assemblies, and operations affecting construction of building designs. Considerations of materials performance, durability, workmanship, and compatibility in detailing of masonry, wood, and metal framing designs. Examination of building partner relationships and their implications for materials, elements, components, and assembly selections.

5512. HISTORIC BUILDING CONSERVATION. (4 cr, §5142; prereq Arch major or #; 2 lect and 2 lab hrs per wk) Mack
Historic building systems and materials and methods for their conservation; introduction to use of contemporary systems in historic buildings.

5521. BUILDING METHODS IN ARCHITECTURE. (4 cr, §3062; prereq grad Arch major or #; A-F only) Rauma, Weeks
Analysis of architectural materials, building products, and construction operations related to structural and enclosure systems in design and detailing of noncombustible and fire-resistive constructions. Emphasizes concrete system and structural steel frames and composite structures. Application of legal constraints and regulations, cost controls, and life safety factors in preparation of construction documents, specifications, and drawings.

5522. TECHNIQUES AND FORM. (4 cr per qtr, §5116; prereq 5511, 5571, grad Arch major or #; A-F only) Rauma
Form as interface between programmatic requirements for environmental change and physical means available to the architect: social and cultural paradigms and physical environment; search for organizational principles of architectural form; geometrical order, properties of materials, distribution of forces, construction techniques, accommodation of building infrastructure.

5523. LIGHT FRAME BUILDINGS: DESIGN FOR ENERGY EFFICIENCY, HEALTH, AND DURABILITY. (4 cr; prereq 5521, 5541, grad Arch major or #) Weeks
Design principles and construction methods for resolution of problems of comfort, energy efficiency, and durability. Problems integrating building systems and envelope assemblies with design solutions for moisture, infiltration, indoor air quality, and material degradations.

5531. LIGHTING AND ACOUSTIC DESIGN. (4 cr, §3065; prereq Arch or grad Arch major or #; A-F only) Guzowski
Principles of daylighting, electric lighting, and acoustic design in architecture. Relation between luminous and acoustic environments, human comfort, and architectural experience. Analytic methods, design process, and modeling of daylighting.

Graduate Programs

5539. DAYLIGHTING AND ARCHITECTURAL DESIGN. (4 cr, §3065, §5959; prereq 5551, grad Arch major or #; A-F only) Guzowski
Principles, strategies, energy and environmental issues, psychology of light and color, and integration of electric lighting. Design projects investigate qualitative and quantitative issues through drawing, physical models, and photometric analyses.

5541. THERMAL DESIGN IN ARCHITECTURE. (4 cr, §3064; prereq Arch or grad Arch major or #; A-F only) LaVine

Thermal and climatic issues in design of small and midsize buildings. Built and mechanical means to modify climate. Evaluation of design techniques in terms of potential impacts on energy use, environment, and architectural meaning.

5542. BUILDING ENERGY SYSTEMS. (4 cr, §5966; prereq 5541, grad Arch major or #; A-F only)

Through case studies, conceptual understanding of functions of building mechanical systems and their integration with other building components. Residential and commercial HVAC systems, alternative energy sources, energy efficiency, and structural implications of mechanical systems, indoor air quality, and environmental control strategies.

5543. CLIMATE AND ARCHITECTURE. (4 cr, §5957; prereq 5541, grad Arch major or #; A-F only)

Role of climate in architectural design and theory. Environmental and energy implications at site, building, and component scales. Design projects explore graphic analysis, physical modeling, and quantitative assessment.

5550. TOPICS IN ARCHITECTURE TECHNOLOGY. (Cr ar; prereq Arch or grad Arch major or #)

Construction, environmental management, energy performance, lighting, or materials.

8550. TOPICS IN TECHNOLOGY. (2-4 cr; prereq 5535, 5541, 5551 or 8101 or #)

Structures

5571. INTRODUCTION TO ARCHITECTURAL STRUCTURES. (4 cr, §3511; prereq Arch major, 1 qtr calculus, Phys 1042, Phys 1046; A-F only)

General theories and methods of analysis and design of architectural structures within context of modern engineering. Fundamentals of structural behavior: bending, elasticity, tension aggression, shear, and deflection. Properties and limitations of structural elements and systems; emphasizes architectural applications.

Practice

5621. PROFESSIONAL PRACTICE IN ARCHITECTURE. (4 cr, §5126; prereq grad Arch major or #) Scherer

Legal, ethical, business, and practical requirements to practice architecture. Contemporary and historical models of contract formation, business principles, accounting, project management, and design services marketing.

5631. LEGAL CONTRACTS IN ARCHITECTURE I. (4 cr, §5127; prereq 3093 or #; A-F only)

Legal subject matter relevant to work of architects and design professionals.

5632. CONTRACTS FOR PRACTICE. (4 cr, §5128; prereq grad Arch major, 5621 or #)

Principles of contract formation for practice of architecture. Ethical, legal, and contractual requirements between owner, contractor, subcontractor, and architects.

5650. TOPICS IN ARCHITECTURAL PRACTICE. (Cr ar; prereq Arch major, 5621 or #)

Topics in architectural practices, methods of design production, marketing, operation, and relationships between clients, architects, and society.

8650. TOPICS IN ARCHITECTURAL PRACTICE. (2-4 cr; prereq 1st-yr design or 8101 or #; A-F only)

Urban Design

5711. DESIGN PRINCIPLES OF THE URBAN LANDSCAPE. (4 cr, §5137; prereq Arch/BED major or #) Morrish, staff

Art and design of making city, neighborhood, and development plans. Public policies, planning tools and process, and physical models for design professionals and private and civic institutions to shape physical environment.

5724. THE MEANING OF PLACE. (4 cr, §5956; prereq upper div undergrad or grad Arch major or grad Land Arch major; A-F only) Clemence

Analyzing meanings and messages of surroundings. What present-day environments reveal about the past; links between sense of place and feelings of well-being. Twin Cities central districts and selected neighborhoods and other settings within and outside Minnesota.

5725. HOUSING AND VALUES. (4 cr, §5953; prereq upper div undergrad or grad student; A-F only)

Meanings and values attached to housing in different cultures at various stages in life cycle and in different climatic situations. Impact of housing heritage on housing choice; potential impact of emerging constraints (such as energy ability) on current and future housing decisions.

5750. TOPICS IN URBAN DESIGN. (Cr ar; prereq 5711, grad Arch major for #; A-F only)

Theory and practice of urban design.

8750. TOPICS IN URBAN DESIGN. (2-4 cr; prereq 1st-yr design or 8101 or #)

General

8101. SEMINAR: SUBJECTS AND METHODS IN ARCHITECTURE. (2 cr)

Art (ArtS)

Professor: Wayne E. Potratz (sculpture), *chair*; Curtis C. Hoard (ceramics), *director of graduate studies*; Karl Bethke (printmaking); Diane Katsiaficas (drawing and painting); Clarence E. Morgan (drawing and painting); Thomas A. Rose (sculpture)

Associate Professor: Guy A. Baldwin (sculpture); Victor Caglioti (drawing and painting); Thomas R. Cowette (drawing and painting); David L. Feinberg (drawing and painting); Lynn A. Gray (drawing and painting); Gary L. Hallman (photography); James V. Henkel (photography); Jerald Krepps (printmaking and papermaking); Thomas J. Lane (ceramics and neon); Susan M. Lucey (sculpture); Joyce Lyon (drawing and painting); Mark Pharis (ceramics); William N. Roode (drawing and painting)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.F.A. (Plan B).

Curriculum—The master of fine arts program places major emphasis on studio work of high quality. The program normally takes three years to complete. Most students concentrate in one area of study, but may take courses in studio areas outside the major concentration. The following areas of concentration are available: ceramics; drawing and painting; photography; printmaking; and sculpture.

Prerequisites for Admission—A bachelor of fine arts or its equivalent, or an undergraduate major in studio arts, is required.

Special Application Requirements—All applications for the M.F.A. are reviewed once a year for fall quarter entry. Applicants must submit from 10 to 20 color slides of work completed in their chosen medium to the director of graduate studies in art. Printmaking applicants must submit a minimum of 4 original prints in addition to slides. Photography applicants may submit a minimum of 10 finished prints. Three letters of recommendation are required from all applicants.

Completed Graduate School applications (including official transcripts) must reach the Graduate School by January 5. Slides, letters of recommendation, the statement of purpose, along with a second set of

transcripts and other supporting materials, must reach the director of graduate studies in the Department of Art also by January 5.

Degree Requirements—Students must complete a minimum of 75 graduate credits, at least 45 of which must be earned at the University of Minnesota. Additional credits may be required by the graduate faculty. Upon completing the required credits, students must present an acceptable thesis exhibition accompanied by a supporting paper. The related fields requirement may be satisfied by completing either (a) 15 credits in art history or (b) 8 credits in art history plus 8 credits in another field outside of studio arts. The individual program, although designed by the student, must be approved by the adviser and director of graduate studies. Final oral examinations are taken after the thesis exhibition and the supporting paper are completed.

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—A minor in art consists of a minimum of 16 credits for the M.A. degree, chosen in consultation with the director of graduate studies, and a minimum of 18 credits for the Ph.D. degree, as approved by the director of graduate studies. The minor must include ArtS 8400.

For Further Information and Applications—Contact the Department of Art, University of Minnesota, 208 Art Building, 216 21st Avenue South, Minneapolis, MN 55455 (612/625-8096 or 612/625-1848; fax 625-7881).

Drawing and Painting

5110. DRAWING. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3110 or #) Caglioti, Cowette, Feinberg, Gray, Katsiaficas, Lyon, Morgan, Roode
Drawing in all mediums from life.

5120. PAINTING. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3120 or #) Caglioti, Cowette, Feinberg, Katsiaficas, Lyon, Morgan, Roode
Various media. Individual problems.

5130. WATERCOLOR. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3130) Caglioti
Advanced watercolor techniques, aesthetic directions. Individual concepts and development of sensibilities.

Graduate Programs

5160. DRAWING AND ELECTRONIC MEDIA. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3160) Katsiaficas
Expands traditional drawing methods and materials with use of electronic technology. Access to computers, scanner, and color copier to aid in image making.

8110. DRAWING. (4 cr per qtr [max 12 cr]) Caglioti, Cowette, Feinberg, Gray, Katsiaficas, Lyon, Morgan, Roode

8120. PAINTING. (4 cr per qtr [max 24 cr]) Caglioti, Cowette, Feinberg, Katsiaficas, Lyon, Morgan, Roode

Sculpture

5310. SCULPTURE: DIRECT METAL. (4 cr per qtr [max 16 cr]; prereq 3301) Baldwin
Advanced work in welding and brazing; metal construction.

5320. SCULPTURE: SPATIAL PROJECTS AND PROBLEMS. (4 cr per qtr [max 16 cr]; prereq 3302) Rose
Physical relationships between objects, elements, and materials and how these can be manipulated to affect space.

5330. SCULPTURE: CAST METAL. (4 cr per qtr [max 16 cr]; prereq 3303) Potratz
Lost-wax and sand casting in bronze, aluminum, iron.

5340. SCULPTURE: WOOD AND STONE. (4 cr per qtr [max 16 cr]; prereq 3304) Lucey
Examination of possibilities of wood and stone with emphasis on construction, assemblage, and arrangement.

5350. SCULPTURE: KINETICS. (4 cr per qtr [max 16 cr]; prereq 3305) Baldwin
Constructions, kinetics, electronics.

5370. SCULPTURE: MODELING AND CASTING. (4 cr [max 16 cr]; prereq 3307) Baldwin, Potratz, Rose
Modeling with clay and other materials from human figure and other subjects; moldmaking with plaster and rubber; casting in plaster and other materials.

8310. SCULPTURE: DIRECT METAL. (4 cr per qtr [max 12 cr]) Baldwin

8320. SCULPTURE: SPATIAL PROJECTS AND PROBLEMS. (4 cr per qtr [max 12 cr]) Rose

8340. SCULPTURE: WOOD AND STONE. (4 cr per qtr [max 12 cr]) Lucey

8350. SCULPTURE: KINETICS. (4 cr per qtr [max 12 cr]) Baldwin

8370. SCULPTURE: MODELING AND CASTING. (4 cr [max 12 cr]; prereq #) Potratz

Printmaking

5510. PRINTMAKING: INTAGLIO. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3510 or #) Bethke, Krepps
Color processes, intaglio, and combined techniques.

5520. PRINTMAKING: LITHOGRAPHY. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3520 or #) Krepps
Specialized work in color printing and planographic techniques.

5530. PRINTMAKING: RELIEF. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3530 or #) Bethke
Relief processes. Letter press and combined techniques.

5540. PRINTMAKING: SCREEN. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3540 or #) Bethke
Screen processes and combined techniques.

5550. PRINTMAKING: EXPANDED APPROACHES/MONOPRINTS. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3550 or #) Krepps
Advanced, contemporary approach to printmaking that investigates variations of, departures from, and alternatives to traditional print processes and results. Focuses on immediacy and flexibility of monoprint in conjunction with handmade paper and other print processes.

8510. PRINTMAKING. (4 cr per qtr [max 36 cr]) Bethke, Krepps

8511. PHOTOMECHANICAL PRINTMAKING. (4 cr; prereq MFA candidate, print concentration or #; offered when feasible) Bethke

8512. PROBLEMS IN PHOTOMECHANICAL PRINTMAKING. (4 cr; prereq 8511 or #; offered when feasible) Bethke

Photography

5710. PHOTOGRAPHY. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3710 or #) Hallman, Henkel
Continued individual work in photographic controls, processes; related photosensitive media.

8710. PHOTOGRAPHY. (4 cr per qtr [max 24 cr]) Hallman, Henkel

Ceramics

5810. CERAMICS. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3810 or #) Hoard, Lane, Pharis
Aesthetic awareness and development; techniques and materials.

5821. CERAMIC MATERIALS ANALYSIS. (4 cr; prereq 1811, 1812, 8 cr of 3810) Pharis
Glaze analysis and calculation; glaze types, formulation, materials. Procedures for investigation of unidentified ceramic materials.

8810. CERAMICS. (4 cr per qtr [max 24 cr]) Hoard, Lane, Pharis

Advanced Entrance Courses

The following are courses in which students from one area of concentration bring skills and insights into another area for application to new materials, processes, and approaches.

All courses: (4 cr per qtr [max 16 cr per area]; prereq #, Δ)

5190. DRAWING AND PAINTING

5390. SCULPTURE

5590. PRINTMAKING

5790. PHOTOGRAPHY

5890. CERAMICS AND GLASS

General Courses

5360. PERFORMANCE ART. (4 cr per qtr [max 16 cr]; prereq 3306) Lucey
Development of individual performance artworks and research on pioneers of this art form.

5430. PAPER: PULP TO PLASTIC EXPRESSION. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3430 or #) Krepps
Creative and traditional approaches to papermaking.

5830. GLASS: NEON. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3830) Lane
Advanced conceptual and aesthetic applications of neon tube manipulation; applications to other media.

5970. DIRECTED STUDIES. (1-5 cr [max 12 cr]; prereq 24 cr studio arts, #, Δ, CLA approval)

8410. POST STUDIO. (4 cr; prereq ArtS grad student, 16 8xxx cr or #)
Conceptual concern and aesthetic awareness across media boundaries. Critical and theoretical inquiry into individual graduate projects from diverse media areas. Readings, projects, and topics depend on instructor and student interests.

Seminars

8100. TWENTIETH-CENTURY ART THEORIES IN PAINTING. (2 cr; required of painting majors)

8300. TWENTIETH-CENTURY ART THEORIES IN SCULPTURE. (2 cr per qtr [6 cr required]; MFA candidate in studio arts or #)

8400. CONCEPTS IN CONTEMPORARY ART. (required) (4 cr; prereq ArtS grad student or #)

8402. PRESENTATION AND INSTRUCTION. (4 cr; prereq MFA candidate or #)

Art Education

See Curriculum and Instruction.

Art History (ArH)

Professor: Frederick M. Asher, *chair*; Norman W. Canedy; Frederick A. Cooper; Karal Ann Marling; Sheila J. McNally; Robert J. Poor; Leon G. Satkowski (architecture); Gabriel P. Weisberg

Associate Professor: Catherine E. B. Asher, *director of graduate studies*; W. John Archer (humanities); Timothy T. Blade (design, housing, and apparel); Robert B. Silberman; John W. Steyaert; Michael W. Stoughton

Assistant Professor: Joseph D. Alchermes (Classical and Near Eastern studies); Katherine M. Solomonson (architecture)

Other: Lyndel I. King (director, Weisman Art Museum); Patricia McDonnell (associate curator, Weisman Art Museum)

Adjunct Faculty: Michael P. Conforti (Minneapolis Institute of Arts); Robert D. Jacobsen (Minneapolis Institute of Arts); Bruce L. Jenkins (Walker Art Center); George S. Keyes (Minneapolis Institute of Arts); Evan M. Maurer (Minneapolis Institute of Arts)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan B only) and Ph.D.

Curriculum—Areas of specialization (all of the following pertain to the M.A.; those with an asterisk also pertain to the Ph.D.):

*American art, architecture, and popular culture; Baroque art; *East Asian art and Bronze Age archaeology; *film and photography studies; Greek and Roman art and archaeology; *Islamic art and architecture; Italian Renaissance and mannerist art; Late Gothic and northern Renaissance art; *nineteenth- and twentieth-century art; *South Asian art and architecture.

Prerequisites for Admission—For the M.A. program, a bachelor's degree is required, preferably in art history or a closely related field. Ability and scholarly promise must be demonstrated by a past record of academic excellence. For the Ph.D. program, an M.A. degree in art history or in a field closely related to the chosen area of specialization is required, as well as coursework or other experience indicating substantial background in art historical methods and knowledge.

Special Application Requirements—For the M.A. program: results from the Graduate Record Examination (GRE) General Test, at least one substantial research paper in art history, and three letters of recommendation from persons well acquainted with the applicant's research and writing skills. In addition, M.A. applicants must provide a detailed statement describing previous experience and academic training as related to the projected course of study and academic goals. For the Ph.D. program: results from the GRE General Test, an M.A. thesis or a minimum of two substantial M.A. papers in art history, and three letters of

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recommendation from persons well acquainted with the applicant's research and writing skills. In addition, Ph.D. applicants must provide a statement describing previous experience and academic training as related to the projected course of study and academic goals. Ph.D. candidates are urged to contact the director of graduate studies before application.

Applications for the Ph.D. program (if not previously enrolled in the department) and M.A. program are reviewed in January for admission in the fall quarter only. For both of these, the application form, statement of purpose, official transcripts, and official GRE scores must reach the Graduate School by early in January (contact the Department of Art History for the precise date); duplicates of these materials, as well as the three letters of recommendation and research paper(s), must reach the department by the same deadline. Internal Ph.D. applicants should contact the department for details and deadlines. All applications for financial aid (M.A. and Ph.D.) are due on the same date in early January as the applications for admission.

Master's Degree Requirements—Because new requirements for this degree will be established by fall 1994, applicants should contact the Department of Art History for details.

Doctoral Degree Requirements—Because new requirements for this degree will be established by fall 1994, applicants should contact the Department of Art History for details.

Language Requirements—For the M.A. degree, students must attain reading proficiency in a second language directly related to their course of study by no later than the third quarter of residence. For the Ph.D., reading proficiency of two second languages directly related to their course of study is required. Students should contact the director of graduate studies for details.

Minor Requirements for Students

Majoring in Other Fields—For an M.A. degree, a minimum of 16 graduate credits in art history is required for a designated minor. For a Ph.D. degree, the Graduate School requirement of a minimum of 18 graduate credits in art history is necessary for a designated minor.

For Further Information and

Applications—Contact the Department of Art History, University of Minnesota, 107 Jones Hall, 27 Pleasant Street S.E., Minneapolis, MN 55455 (612/624-0847 or 612/624-4500; fax 612/626-8679).

Arth 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Arth 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5052. EARLY MEDIEVAL ARCHITECTURE. (4 cr, §Arch 5052; prereq Arch 1021 or #) Architecture and urban design during early Christian, Byzantine, Islamic, Carolingian, and Romanesque periods in the Near East and Western Europe until 1150 A.D.

5055. EIGHTEENTH-CENTURY ARCHITECTURE AND THE ENLIGHTENMENT. (4 cr, §Arch 5055; prereq Arch 1021 or #) Satkowski, Solomonson Architecture, urban planning, and garden design in Europe, 1770-1850.

5102. CLASSICAL GREEK ART. (5 cr, §Clas 5102) McNally Architecture, sculpture, and painting in Greece from Persian Wars to conquests of Alexander.

5104. ROMAN ARCHITECTURE. (5 cr, §Clas 5104; prereq jr or sr or #) Cooper, McNally Buildings in Rome and the empire from the 5th century B.C. to the 4th century A.D. Major archaeological sites.

5105. ROMAN PAINTING AND MOSAICS. (5 cr, §Clas 5105; prereq jr or sr or #) McNally Roman painting and mosaics, specific problems; sites such as Pompeii and Antioch.

5106. GREEK PAINTING. (5 cr, §Clas 5106; prereq jr or sr or #; offered every 3rd yr) McNally Research and analysis in classical art as applied to study of vases; original objects and sources.

5107. ROMAN SCULPTURE. (4 cr, §Clas 5107; prereq jr or sr or #) Cooper, McNally Sculpture from Rome and its provinces from the 1st century B.C. to the 4th century A.D.; the role of sculpture in Roman politics and religion.

5108. GREEK ARCHITECTURE. (4 cr, §Clas 5108; prereq jr or sr or #) Cooper, McNally Archaic and classical examples of religious and secular architecture; their setting in major archaeological sites.

5111. BRONZE AGE ART AND ARCHITECTURE IN GREECE: CA. 3000-1100 B.C. (4 cr, §Clas 5111; prereq one ancient art or archaeology course) Cooper
Artistic and architectural forms in the Neolithic period in the Aegean area and the Cycladic, Minoan, and Mycenaean cultures.

5112. GREEK SCULPTURE: ARCHAIC, CLASSICAL, AND HELLENISTIC. (5 cr, §Clas 5112; prereq jr or sr or #) McNally
Style in Greek sculpture; the human figure. Basic methodology, interpretations of meaning.

5113. ARCHAIC AND CLASSICAL GREEK ART AND ARCHAEOLOGY. (4 cr, §Clas 5113; prereq jr or sr or #) McNally
Greek architecture, sculpture, and painting from 9th through 5th centuries B.C. Material remains of Greek culture; archaeological problems such as identifying and dating buildings; analysis of methods and techniques.

5120. FIELD RESEARCH IN ARCHAEOLOGY. (3-6 cr, §Clas 5120; prereq #) Alchermes, Cooper
Field excavation, survey, and research in archaeological sites in Mediterranean area. Techniques of excavation and exploration; interpretation of archaeological materials.

5175. TOPOGRAPHY OF A MEDIEVAL CITY: CONSTANTINOPLE. (4 cr, §Clas 5175) Alchermes
Study of Constantinople, a world capital and imperial residence for more than a millenium. Original and translated texts and archeological evidence used to reconstruct individual monuments and broader patterns of urban life and urban development from ca. 200 until the Turkish conquest of 1453.

5234. GOTHIC SCULPTURE OF THE CATHEDRAL AGE. (5 cr; prereq 3009 or grad student or #) Steyaert
Sculpture in France and Germany from 1150 to 1350. Emphasis on stylistic evolution.

5252. HISTORY OF EARLY CHRISTIAN AND BYZANTINE ART. (4 cr, §Clas 5252) Alchermes
Architecture, sculpture, and painting in Eastern Christian regions from founding of Constantinople to its fall in 15th century. Emphasis on meaning and broader cultural context in which works of art were created.

5307. FIFTEENTH-CENTURY ITALIAN ARCHITECTURE, SCULPTURE, AND PAINTING. (4 cr; prereq 3011 or #) Canedy
Early Renaissance art from Brunelleschi to Bellini, with emphasis on development of the "repertory" of monument types that survived to modern times.

5313. ITALIAN HIGH RENAISSANCE ARCHITECTURE, SCULPTURE, AND PAINTING. (4 cr; prereq 3011 or grad student or #) Canedy
Works of Leonardo da Vinci, Michelangelo, Raphael, and Titian and those of outstanding lesser artists working in Florence, Rome, Venice, and northern Italy. Painting emphasized.

5314. LATER 16TH-CENTURY ITALIAN ARCHITECTURE, SCULPTURE, AND PAINTING. (5 cr; prereq 5313 or grad student or #) Canedy
Mannerism and other trends from the high Renaissance to the Baroque.

5315. DRAWINGS AND GRAPHICS OF RENAISSANCE. (5 cr; prereq 5307 or 5313 or grad student or #) Canedy
Drawings and graphics from the early Renaissance to the Baroque. Original works used.

5324. FIFTEENTH-CENTURY PAINTING IN NORTHERN EUROPE. (5 cr; prereq 3009 or 3011 or grad student or #) Steyaert
Painting in the Netherlands, France, and Germany during the late Gothic period and its influences.

5346. BAROQUE ART IN ITALY AND SPAIN. (5 cr; prereq 3011 or grad student or #; offered alt yrs) Stoughton
Italian sculpture, painting, and architecture and Spanish painting of the 17th century.

5347. BAROQUE ART IN FRANCE AND THE LOWLANDS. (5 cr; prereq 3011 or grad student or #; offered alt yrs) Stoughton
French architecture, painting, and sculpture; Flemish and Dutch painting of the 17th century. Major artists: Rembrandt, Rubens, Poussin.

5357. EIGHTEENTH-CENTURY ART IN FRANCE. (4 cr, §3303; prereq 3011 or grad student or #; offered alt yrs) Stoughton
Rococo and neoclassical painting, sculpture, and architecture in France.

5358. EIGHTEENTH-CENTURY ART IN ITALY, GERMANY, AUSTRIA. (4 cr; prereq 3011 or grad student or #) Stoughton
Italian painting, sculpture, and architecture; German and Austrian architecture.

5422. HISTORY OF 19TH-CENTURY GRAPHIC ARTS. (5 cr, §3422; prereq one 3xxx art history course or grad student or #) Weisberg
History and theory of creation and evolution of lithography, social caricature (e.g., Daumier, Gavarni), revival of etching at mid-century, and emergence of color lithography at turn of century (e.g., Toulouse-Lautrec, Vuillard, Bonnard). Major artistic figures and revolutionary nature of new media. Local print collections used.

5423. GOTHIC ARCHITECTURE. (4 cr, §5053, §Arch 5053, §Arch 5423; prereq Arch major or Arch 3411 or #) Steyaert
History of development of architecture and urban design in Western Europe from 1150 until 1400 A.D.

5425. BAROQUE ARCHITECTURE IN ITALY. (4 cr, §5064, §Arch 5064, §Arch 5425; prereq Arch major or Arch 3411 or #) Stoughton
Architecture and urban design in Italy, 1600-1750 A.D. Emphasis on major figures (Bernini, Borromini, Cortona, Guarini) and evolution of major cities (Rome, Turin).

5431. AGE OF REVOLUTION: FRENCH PAINTING FROM 1789 TO 1848. (5 cr; prereq one 3xxx art history course or grad student or #) Weisberg
Major styles and movements in France and their leading exponents: neoclassicism—David; romanticism—Corot and Delacroix; early landscape painting—the Barbizon group.

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- 5432. REALISM TO IMPRESSIONISM: FRENCH PAINTING FROM 1848 TO 1886.** (5 cr; prereq one 3xxx art history course or grad student or #) Weisberg
Major movement of French painting from realism of Courbet through end of impressionism. Roots of popular imagery, critical study of realism, and radical innovations of impressionism.
- 5433. THE ADVENT OF MODERNISM: LATER 19TH-CENTURY FRENCH PAINTING FROM 1886 TO 1905.** (5 cr; prereq one 3xxx art history course or grad student or #) Weisberg, staff
Major styles and movements: post-impressionism, symbolism, fin de siècle, Jugendstil.
- 5434. CONTEMPORARY ARCHITECTURE.** (4 cr)
Developments, theories, movements, and trends in architecture and urban design from World War II to present.
- 5435 (formerly 5056). MODERN ARCHITECTURE.** (4 cr; §Arch 5432; prereq Arch 1021 or 3411 or #) Solomonson
Architecture and urban design from early 19th-century sources in Europe and America to World War II.
- 5454. ART NOUVEAU.** (5 cr; prereq one 3xxx art history course or grad student or #) Weisberg
History and evolution of art nouveau movement in France, England, Belgium, Germany, Austria, Scotland, and the United States. Innovations in architecture, graphics, and decorative arts; continental variants of style (e.g., Liberty Style). Major promoters (e.g., S. Bing) and pioneers of modern design (e.g., William Morris).
- 5463. EARLY 20TH-CENTURY PAINTING.** (5 cr; prereq one modern art course or #) Weisberg, staff
Fauvism, cubism, surrealism, dadaism, and early abstraction.
- 5464. LATER 20TH-CENTURY PAINTING.** (5 cr; prereq one American or modern art course or #) Staff
Modern painting after the mid-1920s.
- 5521. TWENTIETH-CENTURY ART IN THE UNITED STATES.** (5 cr; prereq one art history or American studies course) Marling
Contemporary movements in American painting and sculpture beginning in early 20th century with the emergence of "the eight" and the exhibition of the Armory Show, 1913.
- 5535. ART IN THE UNITED STATES.** (5 cr; prereq 4 cr art history or #; offered alt yrs) Marling
Painting and sculpture in the United States. Selected key works and artists from early settlement to the early 20th century.
- 5536. TOPICAL STUDIES: ART IN THE UNITED STATES.** (5 cr; prereq 5535 or #; offered alt yrs) Marling
Proseminar dealing with selected problems in American painting and sculpture from their origins to early 20th century.
- 5546. AMERICAN ARCHITECTURE FROM 1860 TO 1914.** (5 cr; prereq sr or grad student or #) Archer, Marling
American developments and European influences from Civil War to about 1914. New materials and structural methods. Emphasis on Hunt, Richardson, McKim, Mead and White, Sullivan, early Wright, others.
- 5711. JAPONISME: THE JAPANESE INFLUENCE ON WESTERN ART, 1854-1910.** (5 cr; prereq one 3xxx art history course or grad student or #) Weisberg
Influence of Japanese prints and decorative art on succeeding generations of European painters, printmakers, and decorative designers, especially the postimpressionist generation and craftspeople at end of century. Promoters of Japonisme, including critics, writers, and business people.
- 5725. CERAMICS IN THE FAR EAST.** (4 cr; offered alt yrs) Poor
Survey of ceramic art in the Far East: China, Korea, and Japan, from Neolithic times to the present.
- 5765. EARLY CHINESE ART.** (5 cr; offered alt yrs) Poor
Development of ancient ceramics and ritual bronzes, early Buddhist sculpture, and early Chinese painting.
- 5766. CHINESE PAINTING.** (5 cr; offered alt yrs) Poor
Survey of major works from the 4th to the 17th centuries. Development of the landscape tradition and the literary genre of later Chinese painting.
- 5767. JAPANESE PAINTING.** (4 cr; offered alt yrs) Poor
Japanese pictorial arts from earliest to modern times; works that best exemplify development of indigenous traditions.
- 5769. CONNOISSEURSHIP IN ORIENTAL ART.** (5 cr; prereq jr or sr or #; offered alt yrs) Poor
Examination of Oriental art objects in local collections.
- 5775. EARLY INDIAN ART.** (5 cr; prereq 4 cr art history or #) F Asher
Sculpture and architecture of India from the Indus Valley civilization through the Kushana period.
- 5776. THE ART AND ARCHITECTURE OF HINDU INDIA.** (5 cr; prereq 4 cr art history or #) F Asher
Development of sculpture and temple architecture from time of earliest Hindu images through great periods of temple building around the 13th century. Perspective of both form and meaning.
- 5777. PAINTING OF INDIA.** (5 cr; prereq 4 cr art history or #) C Asher
Entire history of Indian painting beginning with the early tradition of mural painting but concentrating primarily on miniature painting from the 12th century onward.
- 5781. AGE OF EMPIRE: THE MUGHALS, OTTOMANS, SAFAVIDS.** (4 cr) C Asher
Development of art and architecture in three contemporary Islamic empires: the Mughals of India, Safavids of Iran, and Ottomans of Turkey.

5783. ART OF ISLAMIC INDIA. (4 cr) C Asher
Development of art and architecture in Indian subcontinent during period of Islamic domination into colonial period.

5785. EASTERN ISLAMIC WORLD: IRAN TO INDIA. (4 cr) C Asher
Development of art and architecture in Iranian-dominated eastern Islamic world (Iran, the former southern Soviet Union, Afghanistan, and Indian subcontinent) from inception of Islam to present.

5787. ART OF THE WESTERN ISLAMIC WORLD. (4 cr) C Asher
Development of art and architecture in western Islamic world from inception of Islam to present.

5895. METHODS OF RESEARCH IN ART HISTORY. (4 cr, §8801; prereq sr art history major, #)
For highly qualified undergraduate majors intending to pursue professional training and for incoming master's majors.

5921. MAJOR FILM DIRECTORS AND MOVEMENTS. (4 cr; prereq 3921-3922 or #)
Silberman
Major film movements and directors, including Griffith, Ford, Welles, Hitchcock, Eisenstein, Bunuel, Bergman, Dreyer, and Renoir and such styles as New Wave, Neo-Realism, and German Expressionism.

5922. FILM GENRES. (4 cr; prereq 3921-3922 or #)
Silberman
Topics include westerns, gangster movies, comedies, musicals, sci-fi, horror films, political films, film noir, and documentaries.

5925. HISTORY OF PHOTOGRAPHY AS ART. (4 cr; prereq 3012 or #) Silberman
Origins and development of photography with attention to both technology and cultural impact. Investigation of major aesthetic achievements in photography from beginnings to present.

5940. TOPICS: ART OF THE FILM. (4 cr; prereq 3921-3922 or #) Silberman
Film and society. Topics include sex and violence in the cinema, race and ethnicity in the cinema; films of the 30s, 50s, or 60s.

5950, 5960. TOPICS IN ART HISTORY. (2-5 cr per qtr; prereq jr or sr or #)
Topics specified in the *Class Schedule*.

5970. DIRECTED READINGS. (1-5 cr; prereq sr, #, Δ, CLA approval) Staff

5990. DIRECTED RESEARCH. (1-5 cr; prereq sr, #, Δ, CLA approval) Staff

8190. SEMINAR: PROBLEMS IN ANCIENT ART. (4 cr, §Clas 8190; prereq #) Cooper, McNally
Selected topics in ancient art.

8200. SEMINAR: PROBLEMS IN MEDIEVAL SCULPTURE. (4 cr; prereq #) Steyaert

8230. SEMINAR: PROBLEMS IN MEDIEVAL ART. (4 cr; prereq 9 cr art history or #) Steyaert

8340. SEMINAR: PROBLEMS IN BAROQUE ART. (4 cr; prereq #) Stoughton

8400. SEMINAR: 19TH-CENTURY ART. (4 cr; prereq #) Weisberg

8440. SEMINAR: 20TH-CENTURY ART. (4 cr; prereq #)

8520. SEMINAR: AMERICAN ART. (4 cr; prereq #) Marling

8720. SEMINAR: ASIAN ART. (4 cr; prereq #) Poor

8770. SEMINAR: ART OF INDIA. (4 cr; prereq #) C Asher, F Asher

8801. HISTORIOGRAPHY. (4 cr; prereq #) Staff
History of art history and study of contemporary philosophies of art history and criticism.

8910. SEMINAR: PROBLEMS IN CLASSICAL ARCHAEOLOGY. (4 cr [may be repeated for cr], §Clas 8910; prereq #) Cooper, McNally

8950. SEMINAR: ISSUES IN THE HISTORY OF ART. (4 cr; prereq #)
Theoretical or topical issues; topic varies.

8970. DIRECTED STUDIES. (1-5 cr; prereq #) Staff

8975. DIRECTED MUSEUM STUDIES. (1-3 cr; prereq #) Staff
Projects in museum studies based on the literature, practice, or internship.

Astrophysics (Ast)

Professor: Thomas W. Jones, *chair*; Lawrence Rudnick, *director of graduate studies*; Kris D. Davidson; John M. Dickey; Robert D. Gehrz; Roberta M. Humphreys; Terry J. Jones; Paul J. Kellogg; Leonard V. Kuhl; Robert L. Lysak; Keith A. Olive; Robert O. Pepin; Wayne A. Stein; C. J. Waddington; Paul R. Woodward

Associate Professor: Evan D. Skillman

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—The program offers emphases in observational, theoretical, and computational astronomy and astrophysics and in instrument development. Current research emphasizes the properties and dynamics of normal and active galaxies, quasars, stellar evolution, interaction of stars with their environments, the interstellar medium, astrophysical magnetohydrodynamics, and galactic and cosmological

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structure. Observational research includes ultraviolet, optical, infrared, and radio astronomy. Extensive research programs in space physics and the elementary particle-cosmology interface are also carried out in the School of Physics and Astronomy.

Facilities—The University operates a 60-inch telescope on Mt. Lemmon, near Tucson, Arizona, which is well equipped for both optical and infrared observations. A 30-inch telescope with a CCD camera and infrared instruments is maintained at the O'Brien Observatory about 40 miles from the Twin Cities campus. Both telescopes are fully computer controlled and can be operated remotely. Plans are under development for a major (3.5 meter) observatory. Excellent shop facilities support our instrument development for the telescopes at O'Brien and Mt. Lemmon, for the University of Wyoming's infrared telescope, and for major national observatories such as the NASA Infrared Telescope Facility (IRTF) in Hawaii.

The Automated Plate Scanner (APS) is a high-speed, high-precision measuring engine. It is unique in its ability to scan two photographic plates simultaneously. The APS is currently used to digitize the famous Palomar Sky Survey to produce a massive database of stars and galaxies. The associated computer reduction system can analyze 100,000 images per hour.

Another image-processing system is coupled to the departmental SUN network for the reduction and analysis of optical, infrared, single-dish radio, and Very Large Array (VLA) radio interferometry data. The department is connected through an ethernet backbone to clusters of CRAY and Connection Machine supercomputers at the University's Supercomputer Institute and Army High Performance Computing Research Center. These facilities are available to faculty and students for their research.

In addition, members of the department regularly use such national facilities as the Kitt Peak National Observatory; Cerro

Tololo Inter-American Observatory in Chile; National Radio Astronomy Observatory's single-dish facilities in Green Bank and Kitt Peak and its VLA; Arecibo Radio Observatory; the International Ultraviolet Explorer satellite; the Hubble Space Telescope; and the IRTF in Hawaii.

Prerequisites for Admission—For major work, an undergraduate degree in astronomy or physics or the equivalent. Contact the director of graduate studies for exceptions.

Special Application Requirements—A statement of career goals, scores from the Graduate Record Examination General (Aptitude) Test and Subject (Advanced) Test in physics, and three letters of recommendation are required. Applications for financial aid are due January 15. Applications are accepted for entry in fall quarter only.

Master's Degree Requirements—Two quarters of the classical physics sequence Phys 5051-5052-5053 and three 5xxx astronomy courses are required. Additional requirements depend on whether the student chooses the thesis (Plan A) or non-thesis (Plan B) option. Completion of the degree normally takes two years. An oral examination is required.

Doctoral Degree Requirements—Five 5xxx astronomy courses are required along with Phys 5051-5052-5053. Competence in quantum physics at the level of Phys 5101-5102 is expected. A comprehensive written examination in astrophysics is taken during spring of the second year. A research project that must be completed before fall quarter of the third year serves as a focus for the preliminary oral examination.

Language Requirement—None.

Minor Requirements for Students

Majoring in Other Fields—Ast 3051 or the equivalent, differential and integral calculus, and one year of college physics are prerequisites for admission to the minor.

For Further Information and

Applications—Contact the Department of Astronomy, University of Minnesota, 356 Tate Lab of Physics, 116 Church Street S.E., Minneapolis, MN 55455 (612/624-0211; fax 612/626-2029; e-mail astdept@astro.spa.umn.edu).

Ast 8666. DOCTORAL PRE-THESIS CREDITS. (max 1r cr per qtr; doctoral PhD student who has not passed oral prelims)

Ast 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Ast 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5061. COMPUTATIONAL METHODS IN THE PHYSICAL SCIENCES I. (4 cr, §Phys 5061; prereq CLA jr or sr or IT upper div student or grad student or #; 2 lect, 6 lab hrs per wk)
Introduction to solution of problems in physical sciences with computer programs. Selected numerical methods and general spirit of mapping problems onto computational algorithms. Arranged lab at scientific computer workstation.

5062. COMPUTATIONAL METHODS IN THE PHYSICAL SCIENCES II. (4 cr, §Phys 5062; prereq CLA jr or sr or IT upper div student or grad student, Phys/Ast 5061 or #; 2 lect, 6 lab hrs per wk)
Introduction to advanced techniques in computer simulation through examples from classical statistical mechanics, classical electrodynamics, and fluid dynamics. Computer experiments using SUN systems and their graphics capabilities.

5161.* ASTROPHYSICS OF DIFFUSE MATTER. (4 cr; prereq 3051, Phys 5024 or #; offered alt yrs)
Physical processes in diffuse matter: gas dynamics, MHD, excitation processes and equilibria in atoms and molecules. Emission and absorption by gas and dust. Dynamical processes in interstellar space, HII regions and molecular clouds.

5162.* STARS AND STELLAR EVOLUTION. (4 cr; prereq 3051, Phys 3513 or 3501 or #)
Stars and stellar evolution. Stellar atmospheres, structure and evolution of single stars. White dwarfs, neutron stars, black holes, novae and supernovae. Formation of stars.

5163.* GALACTIC ASTRONOMY AND THE INTERSTELLAR MEDIUM. (4 cr; prereq 3051 or #; offered alt yrs)
Structure, kinematics, and evolution of Milky Way galaxy and its constituents, stars, star clusters, and interstellar medium. Observed properties of the galaxy.

5164.* EXTRAGALACTIC ASTRONOMY. (4 cr; prereq 5163 or #; offered alt yrs)
Structure and evolution of external galaxies. Classification, stellar and gaseous contents, kinematics and dynamics, extragalactic distance scale, clusters, galactic nuclei and associated activity.

5165.* COSMOLOGY. (4 cr; prereq Phys 3513 or #; offered alt yrs)
Large-scale structure and history of universe. Newtonian and relativistic world models, Big Bang model, microwave background, physics of early universe; cosmological tests, measurement of Hubble constant and deceleration parameter, galaxy formation.

5201. METHODS OF EXPERIMENTAL ASTROPHYSICS. (4 cr; prereq 3051, Phys 3513; offered alt yrs)
Introduction to contemporary techniques and instrumentation in astronomy. Astronomical observations including data acquisition and instrument control at O'Brien Observatory and data reduction and image processing using department computing facilities.

5321.* RADIATION PROCESSES IN ASTROPHYSICS. (4 cr; prereq Phys 5024, 5102 or #; offered alt yrs)
Physics of radiation by atoms and molecules. Radiation by energetic charged particles and plasma emission processes. Emission and absorption by solid particles. Transfer of continuum radiation and formation of spectral lines. Application to various astrophysical environments.

5362.* STELLAR ASTROPHYSICS. (4 cr; prereq 5321 or #; offered alt yrs)
Theory of stellar structure and evolution. Basic physics and equations of stellar structure. Application to stellar interiors and atmospheres. Nucleosynthesis.

5421.* HIGH ENERGY ASTROPHYSICS. (4 cr; prereq 3051, Phys 5024, 5101 or #; offered alt yrs)
Energetic phenomena in the universe. Supernovae, pulsars, radio and X-ray stars. Radio galaxies and quasars. Acceleration of high energy particles. Observational basis and current theoretical understanding.

5990. DIRECTED RESEARCH. (3 cr minimum; prereq #, Δ)
Independent research in observational and/or theoretical astrophysics under the direction of a faculty member. Intended for senior astrophysics majors.

8200.* SEMINAR. (1-3 cr)

8481,8482,8483.* TOPICS IN ASTROPHYSICS. (3 cr per qtr; prereq #)
Advanced discussions of important topics of current research interest. Recent topics include stellar spectroscopy, astrophysical fluid dynamics, signal processing, galactic dynamics, and modern instrumentation.

8990.* RESEARCH IN ASTRONOMY AND ASTROPHYSICS. (Cr ar; prereq #)

Other Courses of Interest

Phys 5051-5052-5053.* CLASSICAL PHYSICS

Phys 5151-5152-5153.* QUANTUM MECHANICS

Phys. 5162.* INTRODUCTION TO PLASMA PHYSICS

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Phys 5301.* INTRODUCTION TO NUCLEAR PHYSICS

Phys 5371.* INTRODUCTION TO ELEMENTARY PARTICLE PHYSICS

Phys 5401.* INTRODUCTION TO CONTEMPORARY PROBLEMS IN COSMIC RAY AND SPACE PHYSICS

Phys 8081-8082.* GENERAL RELATIVITY

Phys 8161.* ATOMIC AND MOLECULAR STRUCTURE

Phys 8163-8164.* PLASMA PHYSICS

Phys 8400.* SEMINAR: SPACE PHYSICS

Phys 8411.* COSMIC RAY AND SPACE PHYSICS

Phys 8421-8422.* SOLAR AND MAGNETOSPHERIC PHYSICS

Biochemistry, Molecular Biology and Biophysics

Professor: Norma M. Allewell, *head*, Department of Biochemistry¹; James W. Bodley, *interim head*, Department of Biochemistry²; Lester R. Drewes, *head*, Department of Biochemistry and Molecular Biology³, and *associate director of graduate studies*; John S. Anderson, *co-director of graduate studies* (biochemistry¹); Howard C. Towle, *co-director of graduate studies* (biochemistry²); Paul M. Anderson (biochemistry³); Leonard J. Banaszak (biochemistry²); Victor A. Bloomfield (biochemistry¹); Bianca M. Conti-Fine (biochemistry¹); Mary E. Dempsey (biochemistry²); Edward H. Egelman (cell biology and neuroanatomy); James A. Fuchs (biochemistry¹); Nelson D. Goldberg (biochemistry²); Ernest D. Gray (pediatrics); Gary R. Gray (chemistry); Harry P.C. Hogenkamp (biochemistry²); Alan B. Hooper (genetics and cell biology); James B. Howard (biochemistry²); James F. Koerner (biochemistry²); David C. LaPorte (biochemistry²); John D. Lipscomb (biochemistry²); Dennis M. Livingston (biochemistry²); Charles F. Louis (vet pathobiology); Rex E. Lovrien (biochemistry¹); Matthew F. Mescher (laboratory medicine and pathology); Gary L. Nelsestuen (biochemistry¹); Theodore R. Oegema (orthopedic surgery); Harry T. Orr (laboratory medicine and pathology); Joseph R. Prohaska (biochemistry³); Michael A. Raftery (biochemistry¹); Palmer Rogers (microbiology); Andreas Rosenberg

(laboratory medicine and pathology); Janet L. Schottel (biochemistry¹); David D. Thomas (biochemistry²); Tian Y. Tsong (biochemistry¹); Kamil Ugurbil (radiology); Brian G. Van Ness (biochemistry²); Clare K. Woodward (biochemistry¹)

Associate Professor: Kenneth W. Adolph (biochemistry²); Bridgette A. Barry (biochemistry¹); David A. Bernlohr (biochemistry¹); Anath Das (biochemistry¹); Michael C. Flickinger (biochemistry¹); Thomas E. Huntley (biochemistry³); Kevin H. Mayo (biochemistry²); Douglas H. Ohlendorf (biochemistry²); Robert J. Roon (biochemistry²); Wilmar L. Salo (biochemistry³); Michel M. Sanders (biochemistry²); Lawrence P. Wackett (biochemistry¹)

Assistant Professor: David J. Eide (biochemistry³); Gregg B. Fields (laboratory medicine and pathology); Ann E. Rougvie (genetics and cell biology); Paul G. Siliciano (biochemistry²); Jeffrey A. Simon (biochemistry¹)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A only) and Ph.D.

Curriculum—Biochemistry, molecular biology and biophysics is a joint graduate program offered by the two Departments of Biochemistry in the College of Biological Sciences and the Medical School. Training is offered in four designated areas: biochemistry, molecular biology, molecular biophysics, and physiological chemistry. Students may select a concentration in one area and take courses from other areas to fulfill a minor or supporting program. Graduate training in biochemistry, molecular biology and biophysics at the University of Minnesota, Duluth, is described in the *Duluth General Bulletin*.⁴

Prerequisites for Admission—The graduate program in biochemistry, molecular biology and biophysics is flexible enough to accommodate students with a wide variety of educational backgrounds. The program encourages application from students with undergraduate or master's degrees in the biological, chemical, or physical sciences. Recommended academic preparation includes one year each of calculus, organic chemistry, and physics and a background in basic biology, including biochemistry and genetics. Coursework in physical chemistry

¹ College of Biological Sciences, St. Paul campus

² Medical School, Minneapolis campus

³ University of Minnesota, Duluth

⁴ For information on the master's and doctoral degree programs offered in conjunction with the University of Minnesota, Duluth, please contact the associate director of graduate studies, Department of Biochemistry and Molecular Biology, 251 School of Medicine, University of Minnesota, 10 University Drive, Duluth, MN 55812 (218/726-7922).

is recommended for graduate-level biochemistry courses. For students of demonstrated ability, background deficiencies can be made up during the first year of graduate study.

Special Application Requirements— Applicants must submit three letters of recommendation from persons familiar with their academic and research capabilities. A statement of interests and goals, a complete set of transcripts, and official scores from the General Test of the Graduate Record Examination (GRE) are required. The GRE Subject Test in biochemistry, cell and molecular biology, biology, or chemistry is strongly recommended, but not required. The recommended date for receipt of completed applications is January 15. Completed files are reviewed between January and March. Graduate studies typically begin fall term. Information about an early start program involving participation in laboratory research beginning on August 1 may be obtained from the director of graduate studies.

Master's Degree Requirements— Students must satisfactorily complete one year of graduate biochemistry (8001-8002-8003), two laboratory rotations, and two special topics biochemistry courses and must participate in seminars. Written and oral examinations are required.

Doctoral Degree Requirements— Students must satisfactorily complete one year of graduate biochemistry (8001-8002-8003), two laboratory rotations, and two advanced topics courses in their area of concentration and must participate in seminars. One written and two oral examinations are required. For more information, contact the director of graduate studies.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Biochemistry (Medical School), University of Minnesota, 4-225 Millard Hall, 435 Delaware Street S.E., Minneapolis, MN 55455 (612/625-6100), or Department of Biochemistry (Biological Sciences), 140

Gortner Lab, University of Minnesota, 1479 Gortner Avenue, St. Paul, MN 55108 (612/624-7755). Information may also be requested through e-mail (bmbbgp@maroon.tc.umn.edu).

BioC 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

BioC 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

BioC 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

The courses directly below have both biochemistry designators, BioC and MdBc. Courses with only the BioC or MdBc designator follow this listing.

Biochemistry (BioC and MdBc)

(College of Biological Sciences and Medical School)

5525s. PHYSICAL BIOCHEMISTRY: SOLUTION STRUCTURE AND INTERACTIONS OF BIOLOGICAL MACROMOLECULES. (4 cr, §Chem 5525; prereq BioC 5331 or equiv, 2 qtrs physical chemistry) Allewell, Bloomfield, Tsong
Physical chemistry of equilibrium, transport and scattering phenomena in solution, with application to proteins and nucleic acids. Intermolecular forces, macromolecular dynamics, conformational transitions, binding thermodynamics, and methods for determining biopolymer size and shape, including sedimentation, diffusion, viscosity, electrophoresis, and scattering.

5526w. PHYSICAL BIOCHEMISTRY: SPECTROSCOPIC METHODS I. (4 cr, §Chem 5526; prereq 2 qtrs physical chem) Que, Ugurbil
Lectures on fundamental spectroscopic principles emphasizing development of magnetic resonance theory used in study of biological macromolecules.

5527f. PHYSICAL BIOCHEMISTRY: SPECTROSCOPIC METHODS II. (4 cr, §Chem 5527; prereq 2 qtrs physical chem) Barry, Thomas
Applications of optical and magnetic resonance techniques to study of structure and dynamics in proteins, lipids, nucleic acids, and synthetic analogs.

5528w. PHYSICAL BIOCHEMISTRY: ENZYME KINETICS. (4 cr; prereq 2 qtrs physical chem; BioC 5331 or BioC/MdBc 8001 or equiv desirable) Lipscomb
Theory and application of steady-state and transient kinetics for study of enzymes, enzyme systems, and cellular regulation.

5529s. PROTEIN STRUCTURE AND FOLDING. (4 cr, §Chem 5529; prereq BioC 5331 or equiv, 1 qtr physical chem or #) Banaszak, Woodward
Advanced course on protein structure, stability, folding, and molecular modeling. Results from X-ray crystallography, solution thermodynamics, NMR, computer graphics, and protein engineering.

Graduate Programs

8001f. ADVANCED BIOCHEMISTRY I: PROTEIN STRUCTURE AND FUNCTION. (4-5 cr, §BioC/MdBc 5751; prereq # or 3 qtrs organic chem, 2 qtrs physical chem, 1 qtr biochem) Banaszak, Wackett
Primary, secondary, tertiary, and quaternary structure of proteins. Methods to determine structure. Protein folding, forces stabilizing macromolecular structure; examples related to protein engineering and design. Interaction of proteins with ligands: structural change and reaction energetics. Dynamic properties of proteins and enzymes; enzyme substrate complexes and mechanism of enzyme catalysis.

8002w. ADVANCED BIOCHEMISTRY II: MOLECULAR BIOLOGY. (4-5 cr, §BioC/MdBc 5753; prereq BioC/MdBc 8001 or #) Das, Siliciano
Structure and stability of nucleic acids; organization of prokaryotic and eukaryotic genomes. Chromosome mechanics, including DNA replication, recombination, and transposable elements. Mechanism and regulation of gene expression, including transcription, processing, and translation in both prokaryotic and eukaryotic organisms.

8003s. ADVANCED BIOCHEMISTRY III: REGULATION OF METABOLISM AND BIOLOGICAL PROCESSES. (4-5 cr, §BioC/MdBc 5752; prereq BioC/MdBc 8002 or #) Bernlohr, LaPorte
Membrane structure and function; strategies for metabolic control. Important control points in key metabolic pathways. Transmembrane signalling and second messengers; their role in regulation. Coordination of genetic and enzymatic controls. Regulation of cell division, regulation of development, and integration of regulatory systems such as nerve transmission, muscle contraction, and vision.

8094. RESEARCH AND LITERATURE REPORTS. (1 cr) Staff
Current developments in biochemistry.

8206f. CELL SIGNALLING AND METABOLIC REGULATION. (3 cr, §MdBc 8206; prereq BioC/MdBc 8001-8002-8003 or equiv) Conti-Fine, staff
Mechanisms of regulation of signal receptors and second messengers, including cyclic nucleotides, calcium, and phosphoinositol derivatives; polypeptide and catecholamine hormone-mediated processes; molecular basis of neurotransmitter signalling and ion-channels.

8213f. ADVANCED MOLECULAR BIOLOGY I. (4 cr, §GCB 8213; prereq BioC/MdBc 8002 or GCB 8132 or #) Bodley, LaPorte, Ohlendorf, Siliciano, Towle
Lectures, readings, and discussions. Topics include DNA replication, recombination and gene conversion, regulation of gene expression in prokaryotes, regulation of gene expression in eucaryotes, chromatin structure and transcription, organellar gene expression.

8214w. ADVANCED MOLECULAR BIOLOGY II. (4 cr, §GCB 8214; prereq BioC/MdBc 8002 or GCB 8132 or #) Das, Livingston
Lectures, readings, and discussions. Topics include RNA splicing, RNA stability, initiation and control of translation, animal viruses, gene families, transposable elements, somatic recombination, yeast molecular biology, oncogenes.

8230w. MEMBRANE BIOCHEMISTRY. (3 cr; prereq BioC/MdBc 8001 or #) Thomas, staff
Lectures and readings on molecular structure, dynamics, and function of cell membranes. Fundamental principles and current research topics, with emphasis on systems and methods under investigation at University of Minnesota.

8290f,w,s,su. CURRENT RESEARCH TECHNIQUES. (1-3 cr; prereq grad major in biochemistry)
Research projects in biochemistry, each to be carried out in the research laboratory of an individual staff member. Satisfies all or part of the laboratory requirements for the Ph.D. degree.

Biochemistry (BioC)

(College of Biological Sciences)

5025f,w,s. LABORATORY IN BIOCHEMISTRY. (2 cr; prereq 3021 or ¶3021 or 5331 or ¶5331 or Biol 5001 or ¶Biol 5001) Barry, Conti-Fine, Lovrien
Discussions of techniques and problem-solving approaches illustrated with laboratory experiments and demonstrations.

5301w. ECOLOGICAL BIOCHEMISTRY. (3 cr; prereq 3021 or 5331 or #) Wackett
Biochemistry of environmental processes. Biochemistry of organismal interactions, biological responses to environmental stress, gene transfer in environment, and effects and fate of environmental toxins.

5331f. STRUCTURE, CATALYSIS, AND METABOLISM IN BIOLOGICAL SYSTEMS. (4 cr, §3021, §Biol 5001; prereq 2 qtrs organic chem, Biol 1202 or #) Flickinger, Nelsestuen
Structure and function of biological molecules. Protein structure, catalysis, and intermediary metabolism. Enzyme kinetics, thermodynamics, and role of cofactors in catalysis.

5332w. ENERGY AND SIGNAL TRANSDUCTION IN BIOLOGICAL SYSTEMS. (4 cr; prereq 5331 or #) Barry, Bernlohr
Biological membrane structure and membrane-associated proteins. Transport, oxidation/reduction photosynthesis, and electron transfer mechanisms. Membrane receptors, signal transduction, and specific regulatory systems.

5333s. MOLECULAR MECHANISM OF GENE ACTION. (4 cr; prereq 5332 or #) Fuchs, Schottel
Structure and function of nucleic acids and regulatory process involved in gene expression from biochemical point of view.

5401f. METABOLISM AND ITS REGULATION. (3 cr; prereq 3021 or 5331) Nelsestuen
Underlying principles determining metabolism of common and unusual compounds in plants, animals, and microbes. Regulation of carbon and energy flow in whole organisms.

5744w. ANALYTICAL BIOCHEMISTRY. (4 cr; prereq lab work in analytical and organic chemistry, #) Flickinger, Lovrien
Principal techniques of biochemistry experimental work; instrumentation and methods for isolation and characterization of proteins, lipids, and carbohydrates. Chromatography, electrophoresis, spectrophotometry, potentiometry, and fluorimetry.

5950. SPECIAL TOPICS. (1-5 cr; prereq #, Δ)

5970. DIRECTED STUDIES. (Cr ar; prereq #, Δ) Staff
Individual study of selected topics; selected readings and use of scientific literature.

5990. DIRECTED RESEARCH. (Cr ar; prereq #, Δ) Staff
Laboratory or field investigation of selected areas of research.

8990. GRADUATE RESEARCH. (1-7 cr; prereq #) Staff
Research problems in various fields in biochemistry represented by staff interests.

Biochemistry (MdBc)

(Medical School)

5053f.w,s,su. PROBLEMS IN BIOCHEMISTRY. (Cr and hrs ar [may be repeated 1 or more qtrs for cr]; prereq Δ; grad majors must regis S-N)

5100f.¹ BIOCHEMISTRY, MOLECULAR AND CELLULAR BIOLOGY. (9 cr; prereq regis med fr, ¶CBN 5104) Van Ness, staff
Integrated introduction to biochemistry, molecular biology, genetics, cell biology, and developmental biology.

5101w. HUMAN NUTRITION. (1 cr; prereq 5100, regis med fr or grad student) Staff
Principles of nutrition as foundation for understanding clinical nutrition.

5201f. BIOCHEMISTRY FOR DENTAL STUDENTS. (4 cr; prereq regis dental fr or grad student) Gray, Roon
Chemical properties, biosynthesis, catabolism, structure, and function of biomolecules. Fundamentals of molecular biology and metabolic regulation.

5202w. BIOCHEMISTRY FOR DENTAL STUDENTS. (3 cr; prereq regis dental fr or grad student) Oegema, Roon
Introduction to physiological chemistry emphasizing biological processes that occur in human tissues and fluid compartments.

5203f. TOPICS: DENTAL BIOCHEMISTRY. (Cr ar; prereq 5202) Oegema, Smith
Biochemical topics related to dentistry.

5300f. BIOCHEMISTRY. (4 cr; prereq organic chem or #; recommended for med tech majors) Roon, staff
Survey of chemical properties, biosynthesis, catabolism, and structural interaction of biomolecules. Metabolic regulation and molecular biology.

5301w. BIOCHEMISTRY. (3 cr; prereq 5300 or #; recommended for med tech majors) Oegema, Roon
Survey of physiological biochemistry emphasizing human processes.

5444s. MUSCLE CONTRACTION. (3 cr; prereq undergrad courses in biochemistry or physiology or #) Louis, Thomas, staff
Introduction to physiology, biochemical regulation, and physical chemistry of muscle contraction.

5460f. NEUROCHEMICAL COMMUNICATION. (4 cr, §NSc 5460, §VB 5460; prereq biochemistry) Koerner, staff
Electrophysiology and biochemistry of neuronal signaling and its manipulation of pharmacological agents, in context of historical findings and current research techniques. Information on most systems (e.g., autonomic and central nervous systems) in context of specific transmitter systems wherever practical. Two objective short answer examinations.

5531f. MACROMOLECULAR CRYSTALLOGRAPHY: FUNDAMENTALS. (1 cr; prereq 1 qtr organic chem, biochem or ¶biochem, 2 qtrs calculus, college physics) Ohlendorf
Basics of macromolecular crystallography as required for protein structure determination and engineering. Properties of X-rays, crystal growth and handling, space groups and symmetry, data collection and reduction, structure factors.

5532w. MACROMOLECULAR CRYSTALLOGRAPHY: TECHNIQUES. (1 cr; prereq 5531) Ohlendorf
Techniques for determining structure of macromolecule from its diffraction. Properties of Patterson function, heavy atoms techniques, molecular replacement, phase determination, generation and interpretation of electron density maps and refinement.

5533s. MACROMOLECULAR CRYSTALLOGRAPHY: APPLICATIONS. (1 cr; prereq 5532) Ohlendorf
Practical use of current software in macromolecular crystallography. Density modification, molecular dynamics refinement, computer graphics, modeling, computational aspects.

8300f.w,s,su. GRADUATE RESEARCH. (Cr ar; prereq #) Staff
Lab research projects, including study of scientific literature, planning of experimental strategy, performing research, and interpreting results.

Bioethics

Professor: Norman O. Dahl (philosophy); Jasper S. Hopkins (philosophy); Rosalie A. Kane (public health); H. E. Mason (philosophy); David J. Mayo (philosophy)²; Muriel B. Ryden (nursing); Naomi B. Scheman (philosophy)

Associate Professor: Mila A. Aroskar (health management and policy), *director of graduate studies;* Muriel J. Bebeau (preventive sciences—dentistry); Ronald E. Cranford (neurology); Patricia Crisham (nursing); John M. Dolan (philosophy); John M. Eyster (history of medicine); Steven H. Miles (medicine); Michael D. Root (philosophy); Susan M. Wolf (law)

Assistant Professor: Kathy Faber-Langendoen (medicine)

Instructor: Dianne M. Bartels (Center for Biomedical Ethics)

Course of Study—Minor in bioethics, applicable to master's (M.A. and M.S.) and doctoral programs.

¹ Offered on the Medical School calendar, which is different from the regular University calendar. Fall classes may start as much as one month ahead of other courses.

² University of Minnesota, Duluth

Graduate Programs

Curriculum—A structured graduate minor in bioethics is offered in conjunction with the Center for Biomedical Ethics. While recognizing that philosophy is the focal discipline for the field of bioethics, the program offers varied opportunities for multidisciplinary study, including coursework in history and philosophy of medicine, health law and public policy, health care economics, professional ethics, medical humanities, and moral development. In addition to a sequence of required courses in ethical theory and bioethics, the program consists of approximately 50 additional courses offered by a wide variety of departments within the University from which students make a selection in consultation with the director of graduate studies for bioethics.

Prerequisites for Admission—Admission to the bioethics graduate minor is contingent upon prior admission to a master's or doctoral degree-granting program within the Graduate School. Students are encouraged to have some previous exposure to philosophy or biomedicine or both. Graduate students in philosophy are expected to have successfully completed at least one graduate course in ethical theory.

Special Application Requirements—Contact the director of graduate studies in bioethics for an "Intent to Enroll" form, which students are encouraged to submit by the end of winter quarter the year before initiating coursework in the minor. Later submissions are considered as space permits. Fifteen students can be accepted per year. Although some priority is given to doctoral students, students familiar with philosophy, biomedicine, or both are admitted to the minor program on a first-come, first-served basis. Enrollment is contingent upon approval by the director of graduate studies for bioethics.

Minor Requirements—Students are encouraged to attend monthly faculty seminars sponsored by the Center for Biomedical Ethics, preferably during the year the student is completing coursework for the minor.

Master's students are required at a minimum to complete 12 graduate-level quarter credits in ethical theory and bioethics.

Doctoral students are required at a minimum to complete 20 graduate-level quarter credits in ethical theory and bioethics.

If mastery of the field of bioethics is desired, the student should consider coursework in addition to the minimum requirements for the minor program. Students also have the option of the related field(s) at the master's level or the supporting program at the doctoral level in the programs described further in this bulletin.

Language Requirement—None specific to the minor program.

For Further Information and Applications—Contact the Graduate Minor in Bioethics, Center for Biomedical Ethics, University of Minnesota, University Office Plaza, 2221 University Avenue S.E., Suite 110, Minneapolis, MN 55455 (612/626-9756; fax 612/626-9786).

Biological Sciences

The biological sciences at the University of Minnesota offer both traditional and custom-designed interdisciplinary graduate programs that allow students to obtain the combination of advisers and courses needed to support their research and career interests. A high degree of interdisciplinary cooperation allows graduate students access to state-of-the-art equipment, facilities, and the expertise of more than 1,000 members of the graduate faculties in biological sciences across the Twin Cities and Duluth campuses.

Graduate programs in the biological sciences are found in many colleges and departments. Most programs offer master's degrees under Plan A (involving a thesis) and Plan B (coursework only), and doctoral degrees, although some programs do not accept master's students (see listing of majors and degrees in the General Information section). All graduate programs follow general Graduate School requirements, but many programs have additional requirements unique to their own program. Brief information about each program's curriculum, prerequisites for admission, special application requirements, degree requirements for the master's and

doctoral degrees, and language requirements is listed under the appropriate graduate program heading.

Detailed and up-to-date information about a particular program can be obtained by writing to or calling the director of graduate studies of that program. Students who are undecided about a graduate field of study, or have general questions about the biological sciences, may contact Professor Sally Jorgensen, Coordinator for Life Sciences, College of Biological Sciences, University of Minnesota, 124 Snyder Hall, 1475 Gortner Avenue, St. Paul, MN 55108 (612/624-4240; e-mail sallyj@molbio.cbs.umn.edu), or the Graduate School, Biological Sciences Graduate Programs, University of Minnesota, 306 Johnston Hall, 101 Pleasant Street S.E., Minneapolis, MN 55455 (612/625-9364).

The table on the following page illustrates the inter-relatedness of major fields of study in the biological sciences at the University of Minnesota. The table shows that training and research opportunities in any particular discipline of the biological sciences are available to graduate students in a number of different programs. Undecided students, or students contemplating entering graduate school in a specific biological discipline, may find more than one program that offers graduate training and research in their chosen field of study. The table is divided into three parts: Basic Biological Sciences, Agricultural Sciences, and Natural Resource Sciences. Use the following codes to identify the graduate programs offering training in each discipline:

Graduate Programs and Codes:

Agro	.....	Agronomy
AnPh	.....	Animal Physiology ¹
AnSc	.....	Animal Science
BMBB	.....	Biochemistry, Molecular Biology and Biophysics ²
BMSc	.....	Biomedical Science ¹
CBio	.....	Conservation Biology ¹
DU	.....	Duluth Campus: Biology ³
EEB	.....	Ecology
Ent	.....	Entomology
FW	.....	Fisheries ⁴
FScN	.....	Food Science ⁵
Fors	.....	Forestry ⁶
Hort	.....	Horticulture
LA	.....	Landscape Architecture ⁷
MCDBG	.....	Molecular, Cellular, Developmental Biology and Genetics ⁸
MedC	.....	Medicinal Chemistry
MicB	.....	Microbiology
MicE	.....	Microbial Engineering ¹
NSc	.....	Neuroscience ¹
Nutr	.....	Nutrition ^{1,5}
Path	.....	PathoBiology ^{1,9}
PBio	.....	Plant Biological Sciences
Phcl	.....	Pharmacology
Phm	.....	Pharmaceutics
Phsl	.....	Physiology
PIBr	.....	Plant Breeding ^{1,10}
PIPa	.....	Plant Pathology ¹¹
Soil	.....	Soil Science
Txcl	.....	Toxicology ¹
VB	.....	Veterinary Biology ¹²
VP	.....	Veterinary Pathobiology ¹²
WC	.....	Wildlife Conservation ⁴
Zool	.....	Zoology ¹

Free-Standing Minors:

MiEc	.....	Microbial Ecology—applicable to master's (M.S. only) and doctoral programs.
PNI	.....	Psychoneuroimmunology (PNI)—applicable to doctoral programs only.
QP	.....	Quaternary Paleocology (QP)—applicable to master's (M.A. and M.S.) and doctoral programs.

¹ A non-departmental, interdisciplinary program.

² The graduate program in biochemistry, molecular biology and biophysics is jointly administered through the Departments of Biochemistry in the College of Biological Sciences (BioC) and the Medical School (MdBc).

³ Refer to Graduate Offerings, Duluth Campus, at the end of this Bulletin for more specific information about the opportunities for research and training on that campus.

⁴ The graduate programs in fisheries and in wildlife conservation are administered in the Department of Fisheries and Wildlife.

⁵ The graduate program in food science is administered in the Department of Food Science and Nutrition. The graduate program in nutrition is an intercollegiate program also administered in the Department of Food Science and Nutrition.

⁶ The graduate program in forestry is administered in the Department of Forest Products and the Department of Forest Resources.

⁷ The Master of Landscape Architecture (M.L.A.) is offered by this program.

⁸ An interdisciplinary program with most coursework offered through the Department of Genetics and Cell Biology.

⁹ The graduate program in pathobiology is administered in the Department of Laboratory Medicine and Pathology.

¹⁰ The graduate program in plant breeding is administered in the Department of Agronomy and Plant Genetics and the Department of Horticultural Science.

¹¹ The graduate program is plant pathology also offers the Ph.D. degree with a concentration in mycology.

¹² The graduate programs in veterinary biology and veterinary pathobiology are administered in the Department of Veterinary PathoBiology.

Fields of Study

Graduate Programs Offering Training in This Area

Basic Biological Sciences

Animal and Human Anatomy
Biochemistry/Chemistry

DU, MCDBG, NSc, Phsl, VB, Zool
AnPh, AnSc, BMBB, BMSc, Ent, Fors, FScN, FW, Hort, MCDBG, MedC, MicB, MicE, NSc, Nutr, Path, PBio, Phcl, Phm, Phsl, PIbR, PIPa, PNI, Soil, Txcl, VB, VP, Zool

Biomedical Sciences
Biotechnology

BMSc (as part of the M.D./Ph.D. program in the Medical School)
AnPh, AnSc, BMBB, Ent, FScN, Hort, MedC, MicB, MicE, NSc, Nutr, Path, PBio, Phm, Phsl, PIbR, PIPa, Soil, Txcl, VB, VP, Zool

Cell/Developmental Biology

AnPh, AnSc, BMBB, BMSc, DU, Ent, Fors, Hort, MCDBG, MicB, NSc, Path, PBio, Phsl, PIPa, Txcl, VB, VP, Zool

Ecology/Environmental Biology

CBio, DU, EEB, Ent, Fors, FW, Hort, LA, MiEc, NSc, PBio, QP, Soil, WC, Zool

Entomology

CBio, DU, EEB, Ent, NSc, PIPa, Zool

Evolutionary/Systematic Biology

CBio, EEB, Ent, Fors, FW, Hort, MCDBG, MicB, PBio, PIPa, QP, Zool

Genetics

AnSc, BioC, BMSc, CBio, EEB, Ent, Fors, Hort, MCDBG, MicB, MicE, NSc, Path, PBio, Phsl, PIbR, PIPa, VB, VP, WC, Zool

Immunology

AnPh, BMBB, BMSc, MicB, Path, PNI, VP

Microbiology

BMSc, FScN, MicB, MicE, MiEc, PIPa, Soil, VP

Molecular Biology

The techniques of molecular biology are used in nearly all fields, but are important components of biological research in the following programs:
AnPh, AnSc, BMBB, BMSc, DU, Ent, Fors, Hort, MCDBG, MedC, MicB, MicE, MiEc, NSc, Nutr, Path, PBio, Phcl, Phsl, PIbR, PIPa, PNI, VB, VP
AnPh, BMSc, DU, Ent, FW, MCDBG, NSc, Phcl, Phsl, PNI, VB
AnSc, FScN, Nutr

Neurobiology

Nutrition

Parasitology

Pharmacokinetics/Drug Delivery

Pharmacology

Physiology, animal and plant

Plant Biology

Plant Pathology

Toxicology

Virology

Zoology

Ent, VP
Phcl, Phm, Txcl, VB
BMSc, NSc, Phcl, Phsl, VB
Agro, AnPh, DU, Ent, Fors, Hort, MCDBG, MicB, NSc, Nutr, PBio, Phcl, Phsl, PIbR, PIPa, Txcl, VB, VP, WC, Zool
Agro, BioC, CBio, DU, EEB, Fors, Hort, PBio, PIbR, PIPa, QP, Soil, WC
PIPa
BMSc, CBio, FW, MedC, Phcl, Phm, Txcl, VB
BMSc, Hort, MicB, PIPa
CBio, DU, EEB, Zool

Agricultural Sciences

Agronomy and Plant Breeding

Animal Sciences

Food Sciences/Nutrition

Horticulture

Landscape Architecture

Soil Science

Veterinary Sciences

Agro, Hort, PIbR, Soil
AnPh, AnSc, VB, VP, WC, Zool
AnSc, FScN, MicB, Nutr
Hort, LA, PBio, PIbR
LA
Agro, Fors, Hort, PIPa, Soil
NSc, VB, VP

Natural Resource Sciences

Conservation

Environmental Sciences

Fish/Wildlife

Forestry

Limnology

CBio, DU, EEB, Fors, FW, LA, Soil, WC
See Ecology/Environmental Biology above
AnPh, CBio, DU, EEB, FW, WC
CBio, Fors, Soil
DU, EEB, Fors

Biomedical Engineering (BME)

Professor: Matthew V. Tirrell (chemical engineering and materials science), *director of graduate studies;* Robert J. Bache (medicine); David G. Benditt (medicine); Perry L. Blackshear, Jr. (*emeritus:* mechanical engineering); Victor A. Bloomfield (biochemistry); Henry Buchwald (surgery); Dennis D. Caywood (small animal clinical sciences); Frank B. Cerra (surgery); Jay N. Cohn (medicine); Max Donath (mechanical engineering); Arthur G. Erdman (mechanical engineering); Stanley M. Finkelstein (laboratory medicine and pathology); John E. Foker (surgery); Leo T. Furcht (laboratory medicine and pathology); James R. Gage (orthopedic surgery); Robert P. Heibel (medicine); Russell K. Hobbie (physics); Mostafa Kaveh (electrical engineering); Maurice M. Kreevoy (chemistry); Tarald O. Kvalseth (mechanical engineering); David G. Levitt (physiology); Jack L. Lewis (orthopaedic surgery); Rex E. Lovrien (biochemistry); Wilmer G. Miller (chemistry); Suhas V. Patankar (mechanical engineering); Richard E. Poppele (physiology); Gundu H. R. Rao (laboratory medicine and pathology); Donald R. Riley (mechanical engineering); Otto H. Schmitt (*emeritus:* electrical engineering); John F. Soechting (physiology); Ephraim M. Sparrow (mechanical engineering); Neal F. Viemeister (psychology); Theodore A. Wilson (aerospace engineering and mechanics)

Associate Professor: James E. Holte (electrical engineering); Wei-Shou Hu (chemical engineering and materials science); Robert P. Patterson (physical medicine and rehabilitation); Clark M. Smith, II (pediatrics)

Assistant Professor: Joan E. Bechtold (orthopaedic surgery); Gregg B. Fields (laboratory medicine and pathology); William B. Gleason (laboratory medicine and pathology); Xiaoping Hu (radiology); Allison Hubel (laboratory medicine and pathology); Paul A. Iaizzo (anesthesiology); Daniel L. Mooradian (laboratory medicine and pathology); Lisa M. Schutte (orthopaedic surgery); Robert T. Tranquillo (chemical engineering and materials science)

Clinical Instructor: Carl S. Smith (surgery)

Other: Arthur J. Coury (vice president in biomaterials and pharmaceutical research, Focal Interventional Therapeutics); Prakash Keshaviah (corporate research fellow, Baxter Clinical Laboratories)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Biomedical engineering is an interdisciplinary program designed to provide familiarity with the interactions among the engineering, biological, and medical sciences. Thesis research topics might include the following areas of biomedical engineering research: blood fluid mechanics;

hemodynamics of cardiovascular function, structure, and instrumentation; design of artificial internal organs; biomaterials and biointerfacial science; tissue engineering; biomedical imaging; organ preservation; chemotaxis; modeling of lung dynamics and study of pathological pulmonary conditions; bone and joint mechanics and design of bone and joint prostheses; microbial population dynamics; membranes and mass transfer; development of instrumentation and control devices to correct neurological defects; human factors engineering; health effects of design of tools and workplace; application of computer science to a wide variety of problems in physiological simulation, diagnosis, and medical data recording. Further information on current research areas is available from the director of graduate studies.

Prerequisites for Admission—A baccalaureate degree in engineering or in a physical or biological science is required. Successful applicants without an engineering degree are required to complete appropriate coursework to provide preparation for graduate-level engineering courses before being admitted as a candidate for the degree. In most cases, this coursework is not considered part of the degree program.

Special Application Requirements—Three letters of recommendation are required. In evaluating applications, consideration is given to whether or not an appropriate focus exists within the program to match the candidate's interests. The Graduate Record Examination is required of all students. For international students requiring the Test of English as a Foreign Language (TOEFL), the minimum score is 575.

Master's Degree Requirements—For the M.S. degree, students are required to complete 53 credits, including 3 credits of graduate seminars and a 12-credit minor program in a *traditional engineering field* (approved by that department). Plan B students are required to complete an internship and Plan B paper. Plan A students are required to complete a research thesis. A final oral examination is required for the M.S. degree.

Graduate Programs

Doctoral Degree Requirements—Ph.D. programs are planned with the aid of an adviser and a committee selected jointly by the candidate and the director of graduate studies from the above list of department faculty and approved by the Biomedical Engineering Graduate Program Review Committee. The committee decides on the suitability of the program and thesis topic and is responsible for the appointment of examination committees, subject to Graduate School approval.

The major program provides students with comprehensive training in both the engineering and life sciences aspects of at least one area of biomedical engineering. Students normally complete a broad but cohesive program consisting of coursework from a variety of departments. Students are required to take six credits of graduate seminar. In addition, students are required to complete *a minor program in a traditional engineering field. That engineering department must approve the minor program.*

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—For the M.S. degree, students are required to complete 12 credits in two departments other than that of their major. For the Ph.D. degree, 18 credits outside the major are required. For both degrees, courses are approved by the director of graduate studies based on consultation with the student. Students must also register for three quarters of an approved biomedical engineering seminar series.

For Further Information and Applications—

Contact the Biomedical Engineering Program, University of Minnesota, Box 107 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/626-3446). Program office is located at 7-101 Health Sciences Unit F, 308 Harvard Street S.E., Minneapolis campus.

BMEEn 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

BMEEn 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

BMEEn 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5001. BIOMATERIALS I. (3-4 cr, §MatS 5481, §MatS 5482; prereq IT upper div or grad student or med student or #)

Physical and chemical aspects of biomaterials.

5002. BIOMATERIALS II. (3 cr, §MatS 5483; prereq IT upper div or grad student or med student or #)

Biological aspects of biomaterials.

5003. ARTIFICIAL INTERNAL ORGAN DESIGN. (4 cr, §ChEn 5757; prereq IT upper div or grad student or med student or #)

Principles of design and development.

5701. BIOMEDICAL APPLICATIONS OF HEAT TRANSFER IN HUMANS. (3-4 cr; prereq Phsl 3053, Phsl 3056, Phsl 5441) Iaizzo, Sparrow

Overview of physiology underlying thermoregulation in humans, clinical applications of heat transfer in humans, and framework for a design project.

5950. BIOELECTRIC MEASUREMENTS. (3 cr; prereq Phsl 5441, calculus, college physics)

Electrodes, instrumentation, and processing requirements for endogenously generated electric potentials and electrical impedance of tissue. Electrode characteristics, signal processing, and interpretation of physiological events by ECG, EEG, EMG, and EOG. Measurement of respiration, blood flow and volume, and other physiological events by electrical impedance.

5951. BIOELECTRIC STIMULATION. (3 cr; prereq Phsl 5441, engineering-level calculus and physics)

Theory and application of electrical stimulation in areas of therapeutic and functional neuromuscular stimulation and pain control, cardiac pacing, and defibrillation, tissue healing, and electrotherapy. Efficiency, safety, and environmental electrical fields.

8002. INTERNSHIP IN BIOMEDICAL ENGINEERING. (3 cr; prereq BMEEn grad major or Δ)

Supervised lab experience unrelated to student's normal employment. Report required.

8100-8200-8300. BIOMEDICAL ENGINEERING SEMINAR. (1 cr per qtr)

Lectures, demonstrations, and individual research that introduces graduate students and faculty to techniques and goals of biomedical engineering and surgery.

8702. ADVANCED TOPICS IN BIOMATERIALS. (2 cr; prereq 5001, 5002, 5003 or #)

Surgical implantation of materials, hybrid artificial organs, inflammation and infection caused by implants; collagen and biopolymers; biocompatibility; blood-surface interactions; biodegradation; mineralization; antimicrobial treatments; drug delivery; wound healing; Society of Biomaterials conference report.

8770. PLAN B PROJECT. (4 cr, no cr toward PhD; prereq #)

May be taken to satisfy Plan B master's project requirement. May appear on master's program, but does not count toward 20-credit minimum in major. Project topic arranged between student and instructor. Written report required.

8970. INDEPENDENT STUDY. (1-4 cr; prereq #)

Topic determined by interests of student in consultation with instructor; requires approval by consenting faculty member and director of graduate studies.

8990. DIRECTED RESEARCH. (1-4 cr; prereq #)

Content determined by interests of student in consultation with instructor.

Biomedical Science (BMSc)

Regents' Professor: Alfred Michael (pediatrics); James G. White (laboratory medicine and pathology)

Professor: Theodore R. Oegema (orthopedic surgery), *director of graduate studies;* Norma M. Allewell (biochemistry); Dwight L. Anderson (microbiology); Robert J. Bache (medicine); Leonard J. Banaszak (biochemistry); James W. Bodley (biochemistry); Frank B. Cerra (surgery); P. Patrick Cleary (microbiology); Bianca M. Conti-Fine (biochemistry); Mary E. Dempsey (biochemistry); David L. Dunn (surgery); Martin Dworkin (microbiology); Timothy J. Ebner (neurosurgery); Edward H. Egelman (cell biology and neuroanatomy); Robert P. Elde (cell biology and neuroanatomy); Esam E. El-Fakahany (psychiatry); Stanley L. Erlandsen (cell biology and neuroanatomy); David P. Fan (genetics and cell biology); Anthony J. Faras (microbiology); Stanley M. Finkelstein (laboratory medicine and pathology); Leo T. Furcht (laboratory medicine and pathology); Apostolos P. Georgopoulos (physiology); Glenn J. Giesler (cell biology and neuroanatomy); Gordon D. Ginder (medicine); Nelson D. Goldberg (biochemistry); Gary R. Gray (chemistry); Ashley T. Haase (microbiology); Perry B. Hackett (genetics and cell biology); David W. Hamilton (cell biology and neuroanatomy); Robert K. Herman (genetics and cell biology); Harry P. C. Hogenkamp (biochemistry); Jordan L. Holtzman (medicine); Margaret K. Hostetter (pediatrics); Thomas H. Hostetter (medicine); James B. Howard (biochemistry); Harry S. Jacob (medicine); Ronald R. W. Jemmerson (microbiology); Marc K. Jenkins (microbiology); Ross G. Johnson (genetics and cell biology); Russell C. Johnson (microbiology); M. Colin Jordan (medicine); John Kersey (laboratory medicine and pathology); James F. Koerner (biochemistry); Ryoko Kuriyama (cell biology and neuroanatomy); David C. LaPorte (biochemistry); Alice A. Larson (veterinary pathobiology); Tucker W. LeBien (laboratory medicine and pathology); Hon Cheung Lee (physiology); Nancy M. Lee (pharmacology); Paul C. Letourneau (cell biology and neuroanatomy); Jack L. Lewis (orthopedic surgery); Richard W. Linck (cell biology and neuroanatomy); John D. Lipscomb (biochemistry); Horace H. Loh (pharmacology); Walter C. Low (neurosurgery); Steven C. McLoon (cell biology and neuroanatomy); Matthew F. Mescher (laboratory medicine and pathology); Eric A.

Newman (physiology); Jack H. Oppenheimer (medicine); Harry T. Orr (laboratory medicine and pathology); Peter G. W. Plagemann (microbiology); Richard E. Popple (physiology); R. Paul Robertson (medicine); Palmer Rogers (microbiology); Andreas Rosenberg (laboratory medicine and pathology); Irwin Rubenstein (genetics and cell biology); Patrick Schlievert (microbiology); Virginia S. Seybold (cell biology and neuroanatomy); Norman E. Sladek (pharmacology); John F. Soechting (physiology); Chang W. Song (therapeutic radiology); Robert L. Sorenson (cell biology and neuroanatomy); Sheldon B. Sparber (pharmacology); David D. Thomas (biochemistry); Matthew V. Tirrell (chemical engineering and materials science); Howard C. Towle (biochemistry); Tian Y. Tsong (biochemistry); Kamil Ugurbil (biochemistry); Daniel Vallera (laboratory medicine and pathology); Brian G. Van Ness (biochemistry); Theodore A. Wilson (aerospace engineering and mechanics); Ben G. Zimmerman (pharmacology)

Adjunct Professor: Stephen J. Riederer (Mayo Clinic/diagnostic radiology)

Associate Professor: Bruce R. Blazar (pediatrics); Aristidis S. Charonis (laboratory medicine and pathology); Kathleen F. Conklin (microbiology); Robert A. Gross (neurology); Victoria Iwanij (genetics and cell biology); James B. McCarthy (laboratory medicine and pathology); R. Scott McIvor (laboratory medicine and pathology); Robert F. O'Dea (pediatrics); Peter Southern (microbiology); Effie C. Tsilibary (laboratory medicine and pathology); Susan M. Wick (plant biology)

Assistant Professor: David K. Ann (pharmacology); Christopher M. Gomez (neurology); Louise M. Nutter (pharmacology); Mary E. Porter (cell biology and neuroanatomy); Sundaram Ramakrishnan (pharmacology); Paul G. Siliciano (biochemistry); Amy P. Skubitz (laboratory medicine and pathology); Stanley A. Thayer (pharmacology); H. Joseph Yost (cell biology and neuroanatomy)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—Ph.D.

Curriculum—In consultation with their faculty advisers and the Committee on Graduate Studies, students custom-design interdisciplinary programs at the interfaces of biology, medicine, engineering, and physical sciences.

Prerequisites for Admission—Admission is limited to students who have been accepted by the Medical School's M.D./Ph.D. program.

Language Requirements—None.

Graduate Programs

For Further Information and

Applications—Contact the director of the M.D./Ph.D. Program, Medical School, University of Minnesota, Box 293 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/625-3680; fax 612/626-6800; e-mail mdphd@lenti.med.umn.edu).

BMSc 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

BMSc 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

BMSc 8990. RESEARCH: BIOMEDICAL SCIENCE. (Cr ar; prereq enrollment in MD/PhD program)

Biophysical Sciences and Medical Physics (BPhy)

Professor: Dean E. Abrahamson (public affairs); Eugene Ackerman (*emeritus*; laboratory medicine and pathology); Dwight L. Anderson (oral sciences); Victor A. Bloomfield (biochemistry/biological sciences); Bianca M. Conti-Fine (biochemistry/biological sciences); William H. Douglas (operative dentistry); Stanley M. Finkelstein (laboratory medicine and pathology); John E. Foker (surgery); Russell K. Hobbie (physics); Faiz M. Khan (therapeutic radiology); Rex E. Lovrien (biochemistry/biological sciences); Richard Popple (physiology); Andreas Rosenberg (laboratory medicine and pathology); Chang W. Song (therapeutic radiology); David D. Thomas (biochemistry/medical school); Fatih M. Uckun (therapeutic radiology); Warren J. Warwick (pediatrics); Clare K. Woodward (biochemistry/biological sciences)

Associate Professor: Michael G. Garwood (radiology); Bruce J. Gerbi (therapeutic radiology); Xiaoping Hu (radiology); Scott M. O'Grady (veterinary biology); E. Russell Ritenour (radiology)

Assistant Professor: Vincent A. Barnett (physiology); F. Christopher Deibel, Jr. (therapeutic radiology); Ralph DeLong (operative dentistry); Richard A. Geise (radiology); Bruce E. Hammer (radiology); Bruce E. Hasselquist (radiology); Arthur E. Stillman (radiology)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Degree programs include concentration in one or more of the four areas: experimental biophysics, applied biophysics, theoretical biophysics, and medical biophysics. A list of more than 50

courses offered by a variety of departments and accepted for credit in the biophysical sciences major is available on request from the director of graduate studies. Other pertinent courses may also be used as part of the program.

Prerequisites for Admission—All students should have some familiarity with physical chemistry, intermediate physics, intermediate mathematics, biostatistics, computer programming, biology, physiology, and biochemistry. This may be demonstrated by coursework completed at the undergraduate level or as part of the graduate program; by reading or practical experience; or by informal competency examinations.

Special Application Requirements—Three letters of recommendation and scores from the General Test of the Graduate Record Examination are required. Applicants are considered for admission in all quarters.

Master's Degree Requirements—Three core courses—Phys 5551, 5552, and 5553—are normally required. A special three-person committee, chaired by the adviser, is responsible for assuring that the student's program includes broad training in the biophysical sciences. This committee is usually recommended to the Graduate School to administer the oral examination. A final oral examination is required.

Doctoral Degree Requirements—The core curriculum consists of Phys 5551, 5552, and 5553. A significant portion of the coursework should be relevant to the area of thesis research. Programs should also include an area of specialization outside the thesis area. Students are required to take a written preliminary examination at the end of one year of postbaccalaureate study, or as soon as possible after completing Phys 5551, 5552, and 5553. This examination is prepared by a committee and is given at the start of the fall quarter. A special committee is recommended to the Graduate School to administer the Ph.D. oral preliminary examination, which should be taken by

October of the third year of full-time registration or its equivalent. The oral examining committee is also expected to review the student's course program.

Language Requirements—For the M.S. degree, none. For the Ph.D. degree, candidates must demonstrate competence in reading scientific literature in at least one foreign language. International students may submit evidence of competence in their native language if significant, relevant publications exist in that language. All other students must meet Graduate School requirements for the language selected.

Minor Requirements for Students

Majoring in Other Fields—Programs are arranged on an individual basis and must consist of courses that represent broad coverage of the biophysical sciences. Eight-credit minors are not acceptable.

For Further Information and Applications

Contact the Biophysical Sciences and Medical Physics Program, Laboratory Medicine and Pathology, University of Minnesota, Box 292 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/626-6638).

Note—The following courses are offered in biophysical sciences. Those numbered 5170 through 5174 are taught concurrently with courses in radiology and/or in therapeutic radiology that bear the same course numbers.

BPhy 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

BPhy 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

BPhy 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5138. SEMINAR: BIOPHYSICAL SCIENCES. (Cr ar)

5155, 5156, 5157. BIOPHYSICS. (3 cr per qtr; prereq basic preparation in biological sciences, physical sciences, mathematics, #) Schmitt
Selected topics in theoretical, experimental, and technical areas of biophysical science where quantitative methods of the physical sciences are especially applicable. *5155:* Basic principles of biophysical analysis and experimentation. Biostatics; structure of biological systems, especially as revealed by electronic, optical, and ionizing radiation imaging techniques; hypermicroscopy, birefringence, colloidal and micellar systems. *5156:* Biophysical function; dynamics of biophysical systems, excitatory state in nerve and muscle, contractility, secretion, synthesis, sensory and motor transducers. *5157:* Organization of biological systems for communication and control; stability of feedback and feed-ahead systems; biocommunication theory, computer aspects of living systems, biomimetics.

5170. BASIC RADIOLOGICAL PHYSICS. (3 cr, §Rad 5170, §TRad 5170; prereq #) Khan
Theoretical and experimental aspects of radiological physics. Physical properties of various ionizing radiations; interactions of ionizing radiations with matter; methods of radiation dose measurement.

5171. PHYSICS OF NUCLEAR MEDICINE. (3 cr, §Rad 5171, §TRad 5171; prereq 5170, #) Geise, Hasselquist, Ritenour
Theoretical and experimental applications of radionuclides in medicine and biology. Imaging devices and techniques; dynamic tracer analysis; internal emitter dosimetry. Radioimmunoassay and statistics of counting.

5172. RADIATION BIOLOGY. (3 cr, §Rad 5172, §TRad 5172; prereq 5170, #) Song
Effects of ionizing radiation on cells, tissues, and organisms; biochemical and physiological bases of radiation effects; biological rationale for radiation therapy practices.

5173. PHYSICS OF RADIATION THERAPY. (3 cr, §Rad 5173, §TRad 5173; prereq 5170 or #) Khan
High energy and teletherapy machines. Measurements of radiation quality, output, and depth dose distributions for clinical use. Calculation of treatment parameters. Beam modification and shaping. Treatment planning for fixed field and rotational therapy. Physics of intracavitary and interstitial therapy. Computer applications in treatment planning. Principles and criteria for radiation protection.

5174. PHYSICS OF DIAGNOSTIC RADIOLOGY. (3 cr, §Rad 5174, §TRad 5174; prereq 5170 or #) Ritenour
Physics of diagnostic imaging; includes CAT scanning and ultrasound. X-ray production, image receptors, radiation exposure and protection. Special imaging modes including computerized tomographic scanning and electron radiography.

5181. PHYSICS OF NUCLEAR MEDICINE LABORATORY. (1 cr; prereq 5171 or #) Hasselquist
Supplements 5171. Basic counting devices, gamma counters, gamma cameras, quality control techniques, hot lab techniques, and radiation safety.

Graduate Programs

5184. DIAGNOSTIC RADIOLOGICAL PHYSICS LABORATORY. (2 cr; prereq 5174 or #) Geise
Introduction to techniques of performance testing and calibration of radiological imaging equipment and related radiation safety survey methods.

8204. RESEARCH IN BIOPHYSICS AND RADIATION BIOLOGY. (Cr ar) Staff

8221, 8222, 8223. RESEARCH IN BIOPHYSICS.
(Cr ar) Staff

See also Phys 5551, 5552, 5553.

Biophysics

See Biochemistry, Molecular Biology and Biophysics.

Biostatistics (PubH)¹

Professor: Thomas A. Louis, *head*; Chap T. Le, *director of graduate studies*; James R. Boen; Anne I. Goldman; David R. Jacobs; Marcus O. Kjelsberg; Vernon E. Weckwerth

Associate Professor: Kathryn M. Chaloner; John E. Connett; Patricia M. Grambsch; Kathleen M. Keenan; James D. Neaton; Stephen S. Rich; J. William Thomas; Daniel Zelterman

Assistant Professor: Bradley P. Carlin; Lance A. Waller

Senior Research Associate: Dorothee P. Aepli; Timothy R. Church; James S. Hodges; John P. Matts

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—The field of biostatistics combines statistics, computing, and biomedical science to further research in human health. Biostatisticians design, direct, and analyze clinical trials; plan and carry out health surveys; develop new statistical methods; and analyze data from observational studies, laboratory experiments, follow-up studies, and surveys. The program is designed to develop methodologically sound and applications-oriented biostatisticians. The research program couples collaboration on projects in human health with development of

biostatistical methods to meet the challenges of these applications.

Prerequisites for Admission—Program-specific admission requirements are as follows: mathematics through multivariable calculus (four quarters or three semesters) and linear algebra (one quarter or semester); at least one (quarter or semester) course in applied statistics; and at least one (quarter or semester) course in computer programming using a standard procedural language, such as FORTRAN or C. Additional for Ph.D. students: three advanced mathematics courses, which may be taken after admission.

Admission preference is given to those who have a demonstrated background and interest in health sciences and public health. Applicants should have a strong academic record (this usually means an overall grade point average of 3.1 or above on a 4 point scale; 3.4 or above for quantitative courses). The Graduate Record Examination is required, with expected scores of at least 400 for the verbal area and at least 550 for the quantitative and analytical areas. If the applicant's native language is not English, the student is expected to have a score of at least 600 on the Test of English as a Foreign Language (TOEFL). Three letters of recommendation are also required from all applicants.

Special Application Requirements—Fall quarter entry is recommended.

Master's Degree Requirements—Biostatistical inference, theory of statistics, clinical trials, statistical computing, analysis of categorical data, survival analysis, statistics, biostatistics, and health sciences electives. The master's degree usually requires two years of full-time study.

Doctoral Degree Requirements—The doctoral program is open to students who have completed the requirements for the M.S., have shown proficiency in statistics and computing, and have adequate background in mathematics and health sciences. The Ph.D. degree usually requires one or two years of coursework beyond the M.S., plus the dissertation. Additional course

¹ A master of public health degree (M.P.H.) with an emphasis in biostatistics is offered by the School of Public Health. Consult the School of Public Health Bulletin for further information.

topics for the Ph.D. include general linear models, analysis of longitudinal data, sequential analysis, advanced survival analysis, bioassay and screening, Bayes and empirical Bayes methods, current topics in categorical data, spatial biostatistics, and modern nonparametric methods. Consult the director of graduate studies for more details.

Language Requirements—None.

For Further Information and Applications—Contact the Student Services Center, School of Public Health, University of Minnesota, Box 819 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (612/626-3500 or 1/800/774-8636; fax 612/626-6931; e-mail sph-uofm@greg2.sph.umn.edu).

Note—Biostatistics courses are listed and described in the Public Health section of this bulletin. See PubH 5404 to 5470 and 8420 to 8450.

PubH 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

PubH 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

PubH 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Building Science (Bldg)

Professor: James L. Bowyer (forest products); Thomas H. Kuehn (mechanical engineering); Lance LaVine (architecture); James W. Ramsey (mechanical engineering)

Associate Professor: Kevin A. Janni (agricultural engineering); Elmer L. Schmidt (forest products); Raymond L. Sterling (civil and mineral engineering)

Assistant Professor: Becky Yust (design, housing, and apparel)

Research Fellow: Mary Vogel (landscape architecture)

Other: David T. Grimsrud (program director, Minnesota Building Research Center)

Course of Study—Minor in building science, applicable to master's (M.A. and M.S.) and doctoral programs.

Curriculum—A graduate minor in building science is offered in conjunction with the Minnesota Building Research Center. The minor offers varied opportunities for multidisciplinary study, including relevant coursework in agricultural engineering,

architecture, civil engineering, computer science, electrical engineering, forest products, housing, landscape architecture, mechanical engineering, public affairs, and public health.

In addition to a required seminar in building science, the program consists of courses offered by a wide variety of departments within the University from which students make a selection in consultation with the director of graduate studies in building science.

Prerequisites for Admission—Admission to the building science graduate minor is contingent upon prior admission to a master's or doctoral degree-granting program within the Graduate School.

Special Application Requirements—Contact the director of graduate studies in building science for an Intent to Enroll form, which students are encouraged to submit by April 1 in the academic year before beginning coursework in the minor. Later submissions are considered as space permits. A maximum of 15 students are accepted each year. Enrollment is contingent upon approval by the director of graduate studies in building science.

Minor Requirements—The required seminar must be taken before the elective courses.

Master's students are required to complete at least 12 graduate credits outside their major, which include 3 credits for Seminar: Building Science and 9 credits for elective courses.

Doctoral students are required to complete at least 21 graduate credits outside their major, which include 3 credits for Seminar: Building Science and 18 credits for elective courses from two departments.

Language Requirements—None specific to the minor program.

For Further Information and Applications—Contact the Graduate Minor in Building Science, Minnesota Building Research Center, University of Minnesota, 1425 University Avenue S.E., Room 220, Minneapolis, MN 55455 (612/626-7419).

Graduate Programs

Bldg 8000. TOPICS IN BUILDING SCIENCE. (3 cr; prereq admission to bldg sci minor or #)
Major topics and research methods used in different disciplines to investigate research questions about buildings.

Arch 5381. COMPUTER-AIDED ARCHITECTURAL DESIGN

Arch 5539. DAYLIGHTING AND ARCHITECTURAL DESIGN

CE 5301. FOUNDATION ENGINEERING

CE 8605. THE FINITE ELEMENT METHOD IN CIVIL ENGINEERING

CE 8606. ADVANCED TOPICS IN FINITE ELEMENT ANALYSIS

CSci 5121. ALGORITHMS AND DATA STRUCTURES II

CSci 5280. COMPUTER-AIDED DESIGN I

CSci 5511. ARTIFICIAL INTELLIGENCE I

EE 5255. DIGITAL CONTROL SYSTEMS

ForP 5303. WOOD DETERIORATION

ForP 5355. MECHANICS AND STRUCTURAL DESIGN WITH WOOD PRODUCTS

LA 5228. SEMINAR: TOPICS IN CAMPUS PLANNING

ME 5342. HEAT TRANSFER

ME 5603. THERMAL ENVIRONMENTAL ENGINEERING

ME 5604. HEATING AND COOLING LOADS IN BUILDINGS

ME 5605. REFRIGERATION AND AIR CONDITIONING SYSTEMS

ME 5712. SOLAR ENERGY UTILIZATION

ME 8600. PSYCHROMETRICS AND AIR CONDITIONING

PA 5711. ENERGY POLICY I

PA 5721. ENVIRONMENTAL POLICY I

PubH 5181. AIR POLLUTION

Business Administration

Professor: Paul E. Johnson, director of graduate studies, Ph.D. program; Carl R. Adams; Gordon J. Alexander; Beth E. Allen; Amin H. Amershi; Richard D. Arvey; Rajiv D. Banker; Frederick J. Beier; R. Glen Berryman; Mario F. Bognanno; Norman E. Bowie; John H. Boyd; Richard N. Cardozo; Balaji S. Chakravarthy; Norman L. Chervany; Terry L. Childers; Larry L. Cummings; Gordon B. Davis; Gerardine DeSanctis; John W. Dickhaut; Gary W. Dickson; Michael U. Dothan; W.

Bruce Erickson; John A. Fossum; Joseph Galaskiewicz; John F. Geweke; Edward J. Green; Donald V. Harper; Arthur V. Hill; Thomas R. Hoffmann; Michael J. Houston; John S. Hughes; Ravi K. Jagannathan; Deborah Roedder John; George John; James S. Jordan; Chandra S. Kanodia; John H. Kareken; W. David Kelton; Stephen F. LeRoy; Barbara J. Loken; Salvatore T. March; Alfred A. Marcus; Christopher J. Nachtsheim; Timothy J. Nantell; Edward C. Prescott; Kenneth J. Roering; Ivan Ross; William Rudelius; Roger G. Schroeder; James G. Scoville; Allan D. Shocker; Andrew H. Van de Ven; Orville C. Walker, Jr.; James C. Wetherbe; Andrew F. Whitman; Raymond E. Willis; Mahmood A. Zaidi

Associate Professor: Dennis A. Ahlburg; Stuart Albert; John C. Anderson; Ross E. Azevedo; Srinivasan Balakrishnan; P. George Benson; Philip Bromiley; John M. Bryson; Shawn P. Curley; Fred D. Davis, Jr.; George P. D'Elia; Gordon L. Duke; Gordon C. Everest; James M. Gahlon; Robert A. Hansen; Patrick J. Hess; Laurent L. Jacque; Edward J. Joyce; Stefanie A. Lenway; Ian H. Maitland; John J. Mauriel; Kevin A. McCabe; J. David Naumann; Mary Lippitt Nichols; Akshay R. Rao; Judy D. Rayburn; Peter Rosko; Robert Ruckert; Michael J. Stutzer; Michael R. Taaffe; Jan Werner

Assistant Professor: Evelyn F. Carroll; Gary W. Carter; Chun Chang; Dale L. Goodhue; Ellie G. Harris; Christina M. L. Kelton; Inder S. Khosla; Abbas A. Kurawarwala; Bong-Soo Lee; Arijit Mukherji; P. Jane Saly; Linda G. Schneider; Kingshuk K. Sinha; Gerald F. Smith; Kathleen M. Sutcliffe; Akbar Zaheer; Srilata Zaheer

Other: Donald R. Bell, assistant dean and director of graduate studies, M.B.A. program; Frederick R. Jacobs, director of graduate studies, business taxation; Erhard Bruderer; Paul G. Gutterman; Howard Strauss; Terry L. Tranter

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.B.A., M.B.T. (Plan B only), and Ph.D.

Master of Business Administration (M.B.A.)

Curriculum—The M.B.A. program offers a comprehensive curriculum that combines a broad core of disciplines—intended to develop a common foundation of knowledge from the functional areas of management—with the flexibility to specialize in a specific concentration. Students may build their own program during the latter half of their studies or follow a prescribed concentration recommended by one of the six departments. The curriculum connects theory and sound business practice. A variety of classroom techniques is used, including case study,

lecture, class discussion, and group work. In addition, day students participate in a unique corporate consulting experience during the final phase of their program.

Prerequisites for Admission—Applicants must have completed an undergraduate degree in any field and the equivalent of at least a first-level college course in microeconomics and in finite mathematics or calculus.

Special Application Requirements—Results of the Graduate Management Admission Test (GMAT) are required.

Degree Requirements—Three programs are offered. The regular program of 90 credits is for students without prior education in business administration. An advanced placement program of 64 credits is for students who have excelled in a broadly based undergraduate degree program in business administration. (Students seeking admission to the advanced placement program should have completed all their coursework within the past seven years, earning grades of A or B.) These two programs are offered in the evening as well. The evening regular program is 78 credits; the evening advanced placement program is 54 credits.

The Carlson Executive M.B.A. (CEMBA) program (74 credits) is for individuals with eight or more years of full-time professional or managerial experience and an undergraduate degree in any field. The curriculum focuses on strategic management, emphasizes interactive learning, and includes two week-long residencies each year at a northern Minnesota resort and a nine-day residency abroad in the second year of the program. CEMBA is a two-year program that meets all day (on campus) Friday and Saturday, every other week. The program provides a full range of customer services, such as book purchases, registration, meals, and parking.

For Further Information and Applications—Contact the M.B.A. or CEMBA program, Carlson School of Management, University of Minnesota, 295 Humphrey Center, 271 19th Avenue South, Minneapolis, MN 55455 (612/625-5555; or 612/624-1385 for the Carlson Executive M.B.A.).

Master of Business Taxation (M.B.T.)

Curriculum—This degree program is designed to help students acquire a conceptual understanding of taxation and to develop technical competence in the practical application of the rules of taxation in business and personal decision making. The program is offered only in the evening through Continuing Education and Extension. It is designed to accommodate the nontraditional student who is employed during the day and enrolled in the program on a part-time basis during the evening. Students enrolled part time can expect to complete the program in approximately two to three years. Students enrolled full-time can complete the program in a shorter period.

Special Application Requirements—Results of the Graduate Management Admissions Test (GMAT) or the Law School Admission Test (LSAT) are required. Applicants are considered for admission for fall, winter, spring, and first summer term.

Degree Requirements—Students are required to have gained, through coursework, a common body of knowledge in the various areas of business. When the appropriate coursework is lacking, students must make up the deficiencies. These courses may be taken after admission; graduate credit is not granted in most cases.

Students must complete 46 credits, including 16 credits in business, economics, and accounting; 14 credits in tax methods and periods, tax research, tax procedure, and corporate tax; and 16 credits of elective tax courses. At least 4 credits of the coursework serve as a basis for the Plan B project(s). Students must maintain a 3.0 grade point average. The final examination is oral.

Graduate Programs

For Further Information and

Applications—Contact Business Taxation, Department of Accounting, University of Minnesota, 645 Management and Economics Building, 271 19th Avenue South, Minneapolis, MN 55455 (612/624-7511).

Doctor of Philosophy

Curriculum—The doctoral program in business administration offers advanced graduate education for students seeking academic positions at leading universities and research-oriented positions in business and government. The study program is designed for individuals who have the intellectual capacity for advanced study, enjoy independent research and analytical thinking, and wish to master a discipline within business administration and contribute to its future development. The following areas of specialization are offered: accounting, finance, information and decision sciences, marketing and logistics management, operations and management science, and strategic management and organization.

Special Application Requirements—Scores from the Graduate Management Admission Test (GMAT) taken within the last five years are required unless the applicant has already taken the Graduate Record Examination (GRE), in which case GRE scores may substitute for GMAT scores.

Degree Requirements—The program includes a field of specialization within the Carlson School of Management, research methodology, supporting fields of study, preliminary written and oral examinations, and a doctoral dissertation. If a student does not have a bachelor's or master's degree in business administration, certain basic courses may also be required. Three to four years of full-time study are usually required to complete the Ph.D.

Minor Requirements for Students

Majoring in Other Fields—For a Ph.D. minor in business administration, students must complete a cohesive program of 24 credits of graduate work in the field,

developed in consultation with an adviser who is a full member of the graduate faculty in business administration.

For Further Information and

Applications—Contact the Ph.D. program, Carlson School of Management, University of Minnesota, 295 Humphrey Center, 271 19th Avenue South, Minneapolis, MN 55455 (612/624-0875; fax 612/626-7785).

BA 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

BA 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Accounting (Acct)

5101. CORPORATE FINANCIAL REPORTING. (4 cr; prereq 1050 or MBA 8030, MBA student or Sch Mgmt approval)

Preparation and interpretation of corporate financial reports. Income determinations, revenue recognition, income tax allocation, inventories, fixed assets, long-term debt, and leases.

5102. ADVANCED FINANCIAL REPORTING I. (4 cr; prereq 3101 or 5101, mgmt or grad mgmt student or Sch Mgmt approval)

Relationship between complex events such as defined benefit pension plans, leases, and intercorporate investments and their reflection in financial statements. Introduction to business combinations and consolidated financial reporting.

5125. AUDITING PRINCIPLES AND PROCEDURES. (4 cr; prereq 3101 or 5101, accounting major or Sch Mgmt approval)

The auditor's role and function. Includes audit standards, ethics, procedures, legal responsibilities.

5126. INTERNAL AUDITING. (4 cr; prereq 3201 or 5201, 5102, accounting major or Sch Mgmt approval) Financial and operational auditing. Standards. Management of the function.

5135. INCOME TAX ACCOUNTING. (4 cr; prereq 1025 or 1050, accounting major or Sch Mgmt approval) Introduction to principles of federal income taxation of various taxpaying entities.

5160. FINANCIAL STATEMENT ANALYSIS. (4 cr; prereq 1050 or MBA 8030, accounting major or Sch Mgmt approval) Interpretation and analysis of financial statements and schedules for investors and other users.

5180. ADVANCED ACCOUNTING II. (4 cr; prereq 5102, mgmt or MBA student or Sch Mgmt approval) Consolidated financial reporting with focus on international business organizations. Introduction to reporting issues in governmental and not-for-profit entities.

5201. ADVANCED MANAGEMENT

ACCOUNTING. (4 cr; prereq 3201 or MBA 8035, accounting major or MBA student or Sch Mgmt approval)

Design of internal control systems in decentralized organizations, focusing on strategic interactions between internal control system, market share, and pricing strategies. Performance evaluation, transfer pricing, and cost allocations.

5230. CORPORATE TAXATION. (4 cr; prereq 5135 or equiv, MBT program approval)

Tax consequences of formation, operation, and liquidation of a business corporation.

5236. TAXATION II. (4 cr; prereq 5135, accounting major or Sch Mgmt approval)

Income taxation of corporations. Partnerships. Tax research.

5271. ACCOUNTING SYSTEMS. (4 cr; prereq 3201 or 5201, 5102, accounting major or Sch Mgmt approval)

Applications of electronic data processing systems in accounting, including modeling, financial planning, auditing, and data security. Analysis and design of accounting information systems.

5300. CURRENT TOPICS IN MANAGERIAL

ACCOUNTING. (4 cr [may be repeated for cr]; prereq 3201 or 5201, accounting major or Sch Mgmt approval)
Topics vary quarterly.

5310. CURRENT TOPICS IN FINANCIAL

ACCOUNTING. (4 cr [may be repeated for cr]; prereq 5102, accounting major or Sch Mgmt approval)
Topics vary quarterly.

5340. PARTNERSHIP TAXATION. (4 cr; prereq 5135 or equiv, MBT program approval)

Tax consequences of formation, operation, and dissolution of a partnership.

5390. CURRENT TOPICS IN TAXATION. (Cr ar; prereq 5135 or equiv, MBT program approval)

Current tax legislation problems. Topics vary quarterly.

8100. TAX ACCOUNTING METHODS AND

PERIODS. (4 cr; prereq 5135 or equiv, MBT program approval)

Rules affecting timing of income and deductions for tax purposes. Cash and accrual accounting methods examined overall and with respect to individual items of income and deductions. Rules for changing accounting methods and accounting periods.

8150. FINANCIAL ACCOUNTING ISSUES. (4 cr; prereq 1050, 3001, MBT program approval)

Accounting principles and practices underlying preparation of financial statements and additional disclosures. Includes recent pronouncements on financial accounting.

8220. TAX RESEARCH. (2 cr; prereq 5135 or equiv, MBT program approval)

In-depth treatment of tax research methodology including tax questions, locating potential authority, assessing potential authority, and communicating research results.

8225. TAX PROCEDURE AND PRACTICE. (4 cr; prereq 5135 or equiv, MBT program approval)

Procedure dealing with the IRS including sources of IRS policy; processing returns; auditing returns; rulings and determination letters; closing agreements; assessments and collections.

8230. TAXATION OF CORPORATIONS I. (4 cr; prereq 5135 or equiv, MBT program approval)

Federal income taxation of corporations and shareholders. Organization of a corporation; establishment of its capital structure; determination of its tax liability; dividends and other nonliquidating distributions, stock redemptions, and liquidations.

8330. TAXATION OF CORPORATIONS II. (4 cr; prereq 8230 or equiv, MBT program approval)

Corporate readjustments related to multiple corporations and consolidated returns.

8340. TAXATION OF PARTNERS AND PARTNERSHIPS. (4 cr; prereq 5135 or equiv, MBT program approval)

Reviews tax consequences associated with formation, operation, and dissolution of a partnership.

8350. TAXATION OF ESTATES, GIFTS, AND TRUSTS. (4 cr; 5135 or equiv, MBT program approval)

Taxation of transfers under federal estate and gift tax laws. Includes property owned by the decedent; retained life estates; transfers taking effect at death; revocable transfers; joint interest; powers of appointment; valuation problems; expenses, debts, and taxes; charitable requests; marital deduction; taxable inter vivos gifts, gift splitting and credits.

8356. TAXATION OF DEFERRED COMPENSATION AND FRINGE BENEFITS. (4 cr; prereq 8230 or equiv, MBT program approval)

Federal income taxation of corporate deferred compensation and fringe benefits with emphasis on pension plans, profit sharing plans, stock options plans, individual retirement accounts, annuities and insurance, medical related compensation benefits, and reporting requirements.

8360. STATE AND LOCAL TAXATION. (4 cr; prereq 5135 or equiv, MBT program approval)

Minnesota individual and corporate income, property, sales, and excise taxes. Tax problems of businesses with multistate operations.

8380. TAX ASPECTS OF INTERNATIONAL

BUSINESS. (4 cr; prereq 8230 or equiv, MBT program approval)

Multinational business operations and transactions involving foreign income. Tax consequences of transactions with foreign organizations and by related foreign companies.

8390. CURRENT TOPICS IN TAXATION. (Cr ar; prereq 5135 or equiv, MBT program approval)

Current tax legislation and problems. Topics may vary quarterly.

8805. SEMINAR I. (4 cr; prereq PhD student or Grad Sch Mgmt approval)

Economics modeling applied to accounting issues.

Graduate Programs

8810. SEMINAR II. (4 cr; prereq PhD student or Grad Sch Mgmt approval)
Empirical financial accounting research.

8820. SEMINAR III. (4 cr; prereq PhD student or Grad Sch Mgmt approval)
Behavioral accounting research.

8990. READINGS IN ACCOUNTING. (Cr ar; prereq #, Grad Sch Mgmt approval)
Readings not available in regular courses.

8995. RESEARCH IN ACCOUNTING. (Cr ar; prereq PhD student, Grad Sch Mgmt approval)

Business, Government, and Society (BGS)

8017. ORGANIZATIONAL POLITICS AND MANAGEMENT. (4 cr; prereq grad mgmt student or Grad Sch Mgmt approval)
Political aspects of managing a large corporation. Political considerations examined both in terms of the political process within an organization and in terms of the organization's political relationships with other institutions.

8019. TOPICS IN BUSINESS, GOVERNMENT, AND SOCIETY. (4 cr; prereq grad mgmt student)
Selected topics and problems of current interest and of a varied nature considered in depth. Class discussion and course projects. Content varies quarterly depending on the instructor.

Business Law (BLaw)

8158. INTRODUCTION TO LAW, THE LAW OF CONTRACTS AND SALES CONTRACTS. (4 cr, §3058; prereq Econ 1002, grad mgmt student or Grad Sch Mgmt approval)
Origin of law, its place in and effect upon society; history and development of law; system of courts, legal procedure. Extensive study of the law of contracts as the basic law affecting business transactions; law affecting sales of goods contracts.

8278. AGENCY, PARTNERSHIPS, CORPORATIONS, AND COMMERCIAL PAPER. (4 cr, §3078; prereq 8158, grad mgmt student or Grad Sch Mgmt approval; offered when feasible)

8288. LAW OF PERSONAL PROPERTY, REAL PROPERTY, WILLS AND ESTATES. (4 cr, §3088; prereq 8158, grad mgmt student or Grad Sch Mgmt approval; offered when feasible)

Entrepreneurship (Entr)

8082. ENTREPRENEURSHIP. (4 cr, §Mgmt 8082, §Mktg 8082; prereq MBA core courses)
Analysis of entrepreneurial activities, including identifying opportunities, creating value, developing business concept and plan, attracting resources, building an organization, handling risks, managing growth, coping with failure, restructuring and redirecting an organization. Role of entrepreneurship in organization, economy, society. Integrates concepts and materials from all business functions. Extensive use of case studies.

Finance (BFin)

8100. CASES IN FINANCIAL MANAGEMENT. (4 cr; prereq MBA 8040 or #, grad mgmt student or Grad Sch Mgmt approval)
Introduction to corporate project analysis and financial planning and to corporate financial decision making. Cases used to illustrate what modern finance theory implies for evaluation of operating, e.g., marketing, production, strategic, and capital structure decisions. Intended primarily for students not specializing in finance.

8150. THEORY OF FINANCE. (4 cr; prereq MBA 8040 or #, grad mgmt/IR student or Grad Sch Mgmt approval)
Rigorous introduction to modern theory of finance. Discussion of, *inter alia*, capital budgeting, capital structure, dividend policy, asset pricing, application of option pricing to corporate finance, and efficiency of financial markets.

8200. FINANCIAL MARKETS AND INTEREST RATES. (4 cr; prereq MBA 8040 or #, grad mgmt student or Grad Sch Mgmt approval)
Survey of financial markets of modern economies and introduction to theory of how interest rates in the various markets are related. Discussion of, *inter alia*, interest rate term structure, relationship between interest rate and exchange rate, inflation and interest rates, and use of financial futures.

8300. INVESTMENTS AND PORTFOLIO MANAGEMENT. (4 cr; prereq 8150 or #, grad mgmt student or Grad Sch Mgmt approval)
Introduction to investment decision-making procedures and environment for individuals and institutions. Analytical methods for evaluating securities and how these methods relate to modern portfolio theory. Focus on common stocks.

8400. INTERNATIONAL FINANCIAL MANAGEMENT. (4 cr; prereq 8150 or #, grad mgmt student or Grad Sch Mgmt approval)
Implications of modern finance theory for multinational corporation. Discussion, for background, of alternative exchange rate regimes and risks each regime imposes on the multinational and how different international risks influence basic corporate financial decisions.

8601. CORPORATE INVESTMENT AND FINANCIAL STRATEGY. (4 cr; prereq 8150 or #, grad mgmt student or Grad Sch Mgmt approval)
In-depth theoretical analysis of long-term financial decisions, using case studies. Discussion of, *inter alia*, Modigliani-Miller results for capital structure and dividend policy, and use of capital asset pricing models in capital budgeting.

8602. FINANCIAL MANAGEMENT OF FINANCIAL INSTITUTIONS. (4 cr; prereq 8150 or #, grad mgmt student or Grad Sch Mgmt approval; Econ 3101 or Econ 3105 recommended)
Introduction to decision making in commercial banks and other depository institutions, with emphasis on lending and funding decisions. Interest rate risk and, *inter alia*, influence of technological change on banking business.

8603. FUTURES MARKETS. (4 cr; prereq 8150 or #, grad mgmt student or Grad Sch Mgmt approval)
Markets and uses for financial futures and options on these futures. Rational pricing of these instruments and their application by financial and portfolio managers.

8604. OPTIONS MARKETS. (4 cr; prereq 8150 or #, grad mgmt student or Grad Sch Mgmt approval)
Basic features and uses of options. Stock, stock index, bond, currency, and futures options. Use of options in management of portfolio risk, interest rate risk, and foreign currency risk.

8606. INVESTMENT BANKING. (4 cr, §8605; prereq 8150 or #, grad mgmt student or Grad Sch Mgmt approval)

How investment bankers serve corporate clients (and themselves), optimal contracts, pricing of new issues, mergers and acquisitions, and legal framework of investment banking.

8801. INTRODUCTION TO FINANCE. (4 cr; prereq Math 1261 or equiv, Math 3251 or equiv or ¶Math 3251, Math 3261 or equiv or ¶Math 3261, Econ 8101 or ¶Econ 8101 or #, PhD student)

Expected utility theory, measures of risk, portfolio choice, aggregation and separation, linear pricing models.

8810. CORPORATE FINANCE. (4 cr, §8821; prereq 8801, PhD student)

Separation and unanimity, investment strategies, valuation of corporate liabilities, financing strategies, dividend policy.

8811. MATHEMATICAL METHODS IN FINANCE. (4 cr, §8802; prereq 8801, Stat 5121 or equiv or #, PhD student)

Discrete theory: information structures, Radner equilibria, spanning. Continuous theory: information structures, Ito calculus, integral representation of martingales, Radner equilibria, arbitrage pricing.

8812. ECONOMETRIC METHODS IN FINANCE. (4 cr, §8831; prereq 8801, Stat 5121-5122 or Stat 5131-5132 or #, PhD student)

Econometric tests of linear pricing models, tests of market efficiency, event studies.

8813. THEORY OF FINANCIAL CONTRACTS. (4 cr; prereq 8801, PhD student)

Risk sharing contracts, incentive contracts, agency, signalling, self-selection, incentive compatibility, financial intermediation.

8814. ADVANCED THEORY OF CAPITAL MARKETS. (4 cr, §8803; prereq 8801, 8811, Econ 8102 or equiv or #, PhD student)

Intertemporal portfolio choice, intertemporal general equilibrium models, options, futures, theory of the term structure, rational expectations.

8850. INDEPENDENT STUDY IN FINANCE. (Cr ar [may be repeated for cr]; prereq #, grad mgmt student, Grad Sch Mgmt approval)

Problems or developments of special interest in finance.

8900. DIRECTED RESEARCH IN FINANCE. (Cr ar [may be repeated for cr, max 24 cr]; prereq PhD finance student, completion of required coursework for PhD, #) Individualized directed research. Project approved and advised by faculty member.

Information and Decision Sciences (IDSc)

5102. INTRODUCTION TO INFORMATION SYSTEMS ANALYSIS. (4 cr; prereq 3001 or 3002 or 3030; offered when feasible)

5103. DATABASE DESIGN, MANIPULATION, AND MANAGEMENT. (4 cr; prereq 3001 or 3002 or 3030; offered when feasible)

5410. DECISION SUPPORT AND EXPERT SYSTEMS. (4 cr; prereq 3030 or MBA 8025 or equiv or #)

Overview of technical and organizational aspects of decision support systems (DSS), including individual and group DSS, expert systems, and executive information systems. Management of DSS within end-use computing environments. Conceptual foundations of DSS, DSS software reviews, and case examples.

5998. SPECIAL RESEARCH TOPICS. (4 cr; prereq Δ; offered when feasible)

8110. INDIVIDUAL PRODUCTIVITY WITH INFORMATION TECHNOLOGY. (4 cr, §8103)

Davis, Naumann

Analysis design, development, and use of information technology and systems in support of productivity by a knowledge worker or work group. Information resources for individual knowledge worker tasks and activities. Analyzing individual information requirements and defining an appropriate information technology infrastructure. Defining data needs plus access and retention of records, text, and multimedia data. Tailoring and extending capabilities and utility of common tools and software packages. Applying application development tools to specify, design, and implement individual information system applications. Defining work-group information access and connectivity needs. Differentiating role of knowledge worker in building and maintaining individual systems from role of IS specialist in departmental and corporate application development and maintenance.

8120. ORGANIZATIONAL PRODUCTIVITY WITH INFORMATION TECHNOLOGY. (4 cr, §8102)

DeSanctis, Dickson

Conceptual foundations and trends in hardware, software, databases, and telecommunications. Program architecture, information architectures, systems development, programming languages and tools, operations, re-engineering, data management, systems planning, IT industry, data security, disaster recovery, and legal issues in management of computing. Conceptual foundations, alternative corporate approaches, and case examples. Perspectives of information systems manager and user manager.

Graduate Programs

8130. INFORMATION SYSTEMS ANALYSIS, DESIGN, AND DEVELOPMENT. (4 cr; §8103; prereq 8110 or #) March

Development of large-scale applications systems, including abstraction, design, and construction. Theoretical and methodological perspectives. Basic systems concepts; information requirements determination; data flow, data structure, behavior, and object-oriented modeling; relational database concepts. Use of CASE tools in storing and analyzing data flow diagrams.

8140. MANAGING INFORMATION SERVICES. (4 cr; §8101; prereq 8120, 8130 or #) DeSanctis, Dickson
Issues, strategies, and tactics for managing delivery of information technology and related services to organizations. Major topics in the managing of information systems at corporate and business-unit level. Case examples, role-playing, and outside speakers. Alternative corporate approaches. Students prepare briefing reports on corporate MIS approaches.

8430. ADVANCED DATABASE DESIGN AND ADMINISTRATION. (4 cr; prereq grad mgmt student, 8130 or equiv or #) Everst

Perspective of data administrator serving users of information and DBMS. Role, organization, functions, and tools of data administration. Data planning and information architectures. Advanced logical database design. Advanced database manipulation with high-level and natural languages. Object-oriented DBMS and support for graphics and CAD/CAM applications. Data security, maintaining database integrity, and managing data in a shared, networking, or distributed environment. Strategies for using advanced DBMS tools in systems development and operations.

8440. ADVANCED INFORMATION SYSTEMS DEVELOPMENT. (4 cr; prereq 8130 or equiv or #)
Emerging technologies affecting information systems development process and information systems. Computer-aided software engineering tools, distributed systems, and electronic data interchange. Field study of new technology or new technique required.

8450. TELECOMMUNICATIONS. (4 cr; prereq MBA 8025 or equiv or #) Naumann

Introduction to concepts and terminology of electronic communications. Data communications hardware, software, and facilities. Public and private, local and wide area networks. Communications industry, telecommunications regulations, standards, and standards development process. Data communications systems, including network planning, implementation and maintenance, systems development in telecommunications environment, and planning and management of telecommunications systems in organizations.

8500. CONCEPTUAL AND RESEARCH INTRODUCTION TO INFORMATION AND DECISION SCIENCES. (4 cr; prereq PhD student or #) Davis, staff

Relationships to underlying disciplines. Major research streams. Seminal articles, survey literature, and major researchers. Framework for organizing knowledge about information and decision sciences.

8502. ORGANIZATION THEORY AND RESEARCH IN THE INFORMATION AND DECISION SCIENCES. (4 cr; prereq PhD student or #) Goodhue

Review of organization theory and research from economics, organization studies, and sociology relevant to study of information and decision sciences.

8503. COGNITIVE SCIENCE RESEARCH AND THEORY IN THE INFORMATION AND DECISION SCIENCES. (4 cr; prereq PhD student or #) Johnson

Empirically based concepts of knowledge and reason. Mental representation and conceptual systems that guide problem solving and decision making. Computational metaphor of mind drawn from psychology, computer science, linguistics, anthropology, and philosophy. Implications for understanding of knowledge work.

8599. SEMINAR IN INFORMATION AND DECISION SCIENCES TOPICS. (4 cr [may be repeated for cr]; prereq PhD student or #)
Topic selected from new areas of research, research methods, and significant issues.

8601. SYSTEM DEVELOPMENT SEMINAR. (4 cr; prereq PhD student or #; offered when feasible)

8702. BEHAVIORAL DECISION THEORY. (4 cr; prereq PhD student or #; offered alt yrs) Curley
Choice and related judgments from behavioral perspective. Models of choice, including decisions under certainty and uncertainty. Processes involved in deriving major underlying judgments, including likelihood, covariation, and causation. Judgment learning and effectiveness of training. Metachoice: selecting among choice strategies.

8710. HEURISTIC DECISION MAKING. (4 cr; prereq PhD student or #) Johnson
Cognitive basis for human decision making; theory and methodology for study of the knowledge individuals use to meet demands of tasks in work settings and everyday life.

8990. READINGS IN INFORMATION AND DECISION SCIENCES. (Cr ar; prereq PhD student, #)

8995. GRADUATE RESEARCH IN INFORMATION AND DECISION SCIENCES. (Cr ar; prereq PhD student, #)

Insurance (Ins)

5100. RISK MANAGEMENT AND INSURANCE.

(4 cr; prereq grad mgmt student or Grad Sch Mgmt approval)
Recognizing and evaluating the property, liability, and personal risks facing businesses, nonprofit organizations, government units, individuals, or families. Tools of risk management—retention, loss control, and insurance—and conditions under which they should be used. Selecting and dealing with an insurer. Public policy issues—government regulation, social insurance, health insurance and pension legislation, and automobile insurance problems.

5230. LIFE CONTINGENCIES I. (4 cr, §Math 5057; prereq Math 1211, Math 1221, Math 1231 or Math 1131 or #)

Calculation of net premiums, gross premiums, reserves, and nonforfeiture values for major life insurance contracts. Impact of assumed mortality, interest, and expense assumptions on these items.

5231. LIFE CONTINGENCIES II. (4 cr, §Math 5058; prereq 5230 or #)

Advanced topics such as compound interest and annuities certain, the measurement of mortality, life insurance and annuity premiums and reserves. Multilife functions. Population problems and multiple-decrement theory.

Logistics Management (LM)

5010. TOPICS IN LOGISTICS MANAGEMENT.

(4 cr; prereq 3000 or 5030 or 5020, #, mgmt or grad mgmt student, Sch Mgmt approval) Beier, Harper
Specialized topics in field of logistics; topics change quarterly.

5020. ADVANCED LOGISTICS MANAGEMENT.

(4 cr; prereq 3000 or 5030 or equiv, mgmt or grad mgmt student, Sch Mgmt approval) Beier, Harper
Management of flow of physical products (supply and distribution) of an organization. Transportation alternatives, customer service, inventory management, location decisions, warehousing, logistics information systems, international logistics, and logistics system design. Primarily case problems. Includes simulation exercise.

5030. PRINCIPLES OF TRANSPORTATION. (4 cr;

prereq Econ 1101 or equiv, mgmt or grad mgmt student, Sch Mgmt approval) Beier, Harper
Organizational, economic, and service aspects of U.S. transportation system, including rail, highway, water, pipeline, and air transportation. Decision making in transportation companies. Government promotional and regulatory policy.

8030. SEMINAR IN LOGISTICS MANAGEMENT.

(4 cr; prereq 3000 or 3010 or 5030; offered when feasible)

8990. READINGS IN LOGISTICS MANAGEMENT.

(Cr ar; prereq consent of adviser, #, Grad Sch Mgmt approval)

8995. GRADUATE RESEARCH IN LOGISTICS

MANAGEMENT. (Cr ar; prereq Grad Sch Mgmt approval)

Management (Mgmt)

5101. ADVANCED TOPICS IN MANAGEMENT. (Cr

ar [may be repeated for cr]; prereq sr or grad student, #) Specialized topics; content varies quarterly.

5175. STRATEGIC FORECASTING FOR

MANAGERS. (4 cr; prereq 3001 or MBA student or #) Methods of economic, social, and technological forecasting and applications to problems of managerial decision making and planning.

8004. ADVANCED TOPICS IN MANAGEMENT.

(4 cr [may be repeated for cr]; prereq 3001 or 8001 or MBA 8010, grad mgmt student or Grad Sch Mgmt approval)

Topics of special interest; content varies quarterly.

8006. PSYCHOLOGY IN MANAGEMENT. (4 cr,

§3002; prereq grad mgmt student or Grad Sch Mgmt approval)

Development and application of behavioral principles, methods, and skills fundamental to managerial competence in preventing and solving problems within and between individuals and groups and that aid in effective use of human resources. Various lab procedures used to study these concepts, methods, and skills and furnish practice in applying them to management problems.

8012. ORGANIZATIONAL BEHAVIOR AND

MANAGEMENT ANALYSIS. (4 cr; prereq grad mgmt student or Grad Sch Mgmt approval)

Concepts, theories, and empirical research relevant to diagnosis, prediction, and control of human behavior in complex organizations. Models and techniques for analyzing group processes, leadership styles, and organizational structure, change, and environment. Students prepare papers based on their own research or on secondary analysis of existing literature.

8021. ORGANIZATION DESIGN AND

DEVELOPMENT. (4 cr; prereq grad mgmt student or Grad Sch Mgmt approval)

Design and implementation of organizational change. An information processing point of view used to examine design of communication, decision making, and task systems. Theories and techniques of change at both the organization-wide and individual levels. Emphasis on developing skills for managing change and conflict.

8031. INDUSTRY AND COMPETITIVE ANALYSIS.

(4 cr; prereq MBA 8060)

Formulating competitive strategies at business unit level. Students acquire skills necessary to analyze an industry and competition within it.

8032. INTERNATIONAL AND COOPERATIVE

STRATEGIES. (4 cr; prereq MBA 8060)

International corporate strategies and cooperative strategies between organizations, such as licensing, franchising, joint ventures, and other strategic alliances.

8033. MANAGING THE STRATEGY PROCESS.

(4 cr; prereq MBA 8060)

Process through which strategy is formed and implemented in large diversified organizations. Structuring the organization, strategic planning and control systems, incentives systems, strategic human resource management, and top management style.

8050. THE MANAGEMENT OF INNOVATION AND

CHANGE. (4 cr, §5050; prereq grad mgmt student or Grad Sch Mgmt approval)

Application of theories and research on development and implementation of new organizational programs, products, and technologies, and which paths lead to success, which to failure. Builds diagnostic skills and principles for managing organizational innovation and change.

Graduate Programs

8082. ENTREPRENEURSHIP. (4 cr, §Entr 8082, §Mktg 8082; prereq MBA core courses)
Analysis of entrepreneurial activities, including identifying opportunities, creating value, developing business concept and plan, attracting resources, building an organization, handling risks, managing growth, coping with failure, restructuring and redirecting an organization. Role of entrepreneurship in organization, economy, society. Integrates concepts and materials from all business functions. Extensive use of case studies.

8101. SEMINAR IN STRATEGIC MANAGEMENT. (4 cr; prereq PhD student or Grad Sch Mgmt approval)
Research and theory on strategic management, including policy formulation and implementation, long-range corporate planning, internal organizational design, administrative behavior, management of external environment, interactions between business, government, and society, and interorganizational relations.

8102. HISTORY OF MANAGEMENT THOUGHT. (4 cr; prereq PhD student or #, Grad Sch Mgmt approval)
History and philosophy of management thought as it emerged from economics, sociology, psychology, industrial engineering, and management perspectives.

8201. FOUNDATIONS OF BUSINESS-GOVERNMENT-SOCIETY. (4 cr; prereq PhD student or #, Grad Sch Mgmt approval)
Original works in political philosophy, legal philosophy, social theory, and economics. Understanding of history of thought in this area, critical awareness of competing contemporary approaches to public policy decisions.

8202. EXTERNAL AFFAIRS MANAGEMENT. (4 cr; prereq PhD student or Grad Sch Mgmt approval)
How organizations adapt to external pressures and manage their external affairs. Topics include environmental uncertainties, government regulation, collective action, and public opinion. Proactive and reactive organizational strategies, major ethical issues.

8203. RESEARCH TOPICS AND METHODS IN BUSINESS-GOVERNMENT-SOCIETY. (4 cr [may be repeated for cr]; prereq PhD student or Grad Sch Mgmt approval)
Helps students understand current research area, identify research topics, formulate researchable problems, and choose appropriate methods. Critique of methods used in outstanding current research required.

8301. SEMINAR IN ORGANIZATION BEHAVIOR. (4 cr; prereq PhD student or Grad Sch Mgmt approval; offered alt yrs)
Major theories and current research on individual and group processes in organizations from a micro perspective.

8302. SEMINAR IN ORGANIZATION THEORY. (4 cr; prereq PhD student or Grad Sch Mgmt approval; offered alt yrs)
Major theories and current research on organizational and interorganizational topics from a macro perspective.

8303. ORGANIZATIONAL RESEARCH SEMINAR. (4 cr; prereq PhD student, #)
Advanced topics and research problems related to specific organizational issues. Development of focused research problems, theory building, hypotheses formulation, research design, and observation.

8401. SEMINAR IN STRATEGY FORMULATION. (4 cr; prereq PhD student or Grad Sch Mgmt approval)
Theories and current research on processes by which organizations develop goals, objectives, strategic policies, long-range plans, and programs. Theories and research across functions of marketing, finance, accounting, operations research, and other disciplines.

8402. SEMINAR IN STRATEGY IMPLEMENTATION. (4 cr; prereq PhD student or #, Grad Sch Mgmt approval)
Process through which strategy is formed/implemented in multibusiness firms. Introduces important theoretical and empirical literature on how senior managers can effectively establish premises that guide subordinate managers in making/implementing strategic decisions.

8403. STRATEGIC MANAGEMENT RESEARCH SEMINAR. (4 cr [may be repeated for cr]; prereq PhD student or Grad Sch Mgmt approval)
Special, advanced theories and research in strategic management. Helps students formulate strategic problems, create theories and hypotheses, design research, collect and analyze data, and critique current theories and methods used to examine strategic managerial problems.

8990. READINGS IN MANAGEMENT THEORY AND ADMINISTRATION. (Cr ar; prereq 2nd-yr grad student, requisite intro courses, adviser consent, #, Grad Sch Mgmt approval)
Intensive research in a particular subject; preparation of a major term paper normally required.

8995. GRADUATE RESEARCH IN MANAGEMENT THEORY AND ADMINISTRATION. (Cr ar; prereq 2nd-yr grad student, requisite intro courses, adviser consent, #, Grad Sch Mgmt approval)
Special research projects on a specific problem completed in cooperation with a business firm.

Marketing (Mktg)

8051. MARKETING RESEARCH. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad Sch Mgmt approval) Childers, D John, Loken, Schneider
Methods for collecting and analyzing data to solve marketing problems. Survey research techniques. Research design, secondary and primary data collection, sample design, and data analysis. Application of these techniques to marketing problems.

8053. MARKETING RESEARCH: ADVANCED TOPICS AND FIELDWORK. (4 cr; prereq 8051, grad mgmt student or Grad Sch Mgmt approval)
Application of marketing research in a study with an actual client. Advanced topics such as single source data and computer-assisted interviewing. Advanced techniques for sampling and data analysis.

8055. CONSUMER BEHAVIOR. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad Sch Mgmt approval) Loken, Ross
Applications of behavioral sciences to understanding customer behavior in the marketplace. Perception, learning, persuasion, motivation, personality, decision-making strategies, and family, social, and cultural influences. Managerial implications and applications.

8060. DISTRIBUTION SYSTEMS. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad Sch Mgmt approval) Beier, G John, Walker
Analysis of interrelationships between marketing institutions and their formation into channels of distribution. Interorganizational problems, including design and management of distribution channels.

8072. INTERNATIONAL MARKETING. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad Sch Mgmt approval) Tavassoli
Managing international marketing function. Identifying marketing-based international business opportunities; constructing and evaluating culturally adjusted marketing strategies.

8074. PRODUCT POLICY. (4 cr, §8084; prereq MBA 8045 or equiv or Δ, grad mgmt student or Grad Sch Mgmt approval) Ruekert, Shocker
New product development process. Modification of existing product lines and managing product portfolio.

8075. PRICING STRATEGY. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad School Mgmt approval) Rao, Ruekert
Analysis of cost, customer, and competition issues in formulation of pricing strategy. Pricing new and existing products, product lines, and services through channels of distribution for industrial and consumer markets.

8076. SALES MANAGEMENT. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad Sch Mgmt approval) Rao, Walker
Management of personal selling function of promotional mix. Problems of performance evaluation, sales force selection, compensation, and territorial design.

8078. MARKETING COMMUNICATIONS. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad Sch Mgmt approval) Ross, Ruekert, Schneider
Managing communication aspect of marketing strategy. Advertising and sales promotion. Setting advertising objectives and budgets, media selection, creative strategy, and sales promotion techniques.

8080. BUSINESS-TO-BUSINESS MARKETING. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad Sch Mgmt approval) G John, Roering
Marketing issues facing firms that buy/sell products and services to other firms. Combining tools and analytic techniques. Buying behavior of organizational clients, trade marketing programs, vertical integration, and alliances between firms.

8082. ENTREPRENEURSHIP. (4 cr, §Entr 8082, §Mgmt 8082; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad School Mgmt approval) Cardozo
Analysis of entrepreneurial activities, including identifying opportunities, creating value, developing business concept and plan, attracting resources, building an organization, handling risks, managing growth, coping with failure, restructuring and redirecting an organization. Role of entrepreneurship in organization, economy, society.

8084. MARKETING PLANS FOR NEW PRODUCTS AND BUSINESSES. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad Sch Mgmt approval) Rudelius
Key elements of marketing and business plans. Issues and strategies for marketing and financing new products and businesses using individual and team projects. Interaction with business practitioners.

8088. STRATEGIC MARKETING. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad Sch Mgmt approval) G John, Kelton, Walker
Determination of product-markets where organization should compete; sustainable competitive advantage to be developed. Matching marketing strategy with environment. Coordination between marketing and other business functions. Organization of marketing function and management of marketing process.

8090. MARKETING TOPICS. (4 cr [may be repeated for cr]; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad Sch Mgmt approval)
Selected topics and problems of current interest and of a varied nature considered in depth. Class discussion and course projects. Content varies quarterly.

8800. SEMINAR: MARKETING THEORY. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad Sch Mgmt approval) Rao, Ruekert

8810. SEMINAR: CONSUMER BEHAVIOR. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad Sch Mgmt approval) D John, Loken

8830. SEMINAR: INTER-ORGANIZATIONAL RELATIONS. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad School Mgmt approval) G John

8840. SEMINAR: THEORY AND METHODS OF MEASUREMENT. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad School Mgmt approval) Childers

8850. SEMINAR: DESIGN AND IMPLEMENTATION OF MARKETING STRATEGIES. (4 cr; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad School Mgmt approval) Ruekert, Walker

8890. SEMINAR: MARKETING TOPICS. (4 cr [may be repeated for cr]; prereq MBA 8045 or MBA 8210 or equiv or Δ, grad mgmt student or Grad School Mgmt approval)

Graduate Programs

8990. READINGS IN MARKETING. (Cr ar [may be repeated for cr]; prereq MBA 8045 or MBA 8210 or equiv or Δ, consent of adviser, #, grad mgmt student or Grad Sch Mgmt approval)

Readings useful to student's individual program and objectives that are not available in regular course offerings.

8995. GRADUATE RESEARCH IN MARKETING. (Cr ar [may be repeated for cr]; prereq MBA 8045 or MBA 8210 or equiv or Δ, consent of adviser, #, grad mgmt student or Grad Sch Mgmt approval)

Individual research on an approved topic appropriate to the student's program and objectives.

Master of Business Administration (MBA)

5100. MANAGEMENT TOPICS. (Cr ar; prereq #)

8005. COMPUTER ACCESS AND PROGRAMMING FOR BUSINESS ANALYSIS. (1 cr; prereq MBA student; evening program)

Computer access and use information necessary for MBA courses. Introduction to computer terminology and computing at Minnesota, plus programming in BASIC.

8010. MANAGEMENT AND ORGANIZATION BEHAVIOR. (4 cr; prereq MBA student; evening program)

The process of planning, organizing, directing, and controlling. Theories of organization performance, structure, and design. Interpersonal and leadership skills. Emphasis on applications of theory to business situations faced by the practicing manager and on development of interpersonal skills. Case studies and in-class simulations used.

8015. HUMAN RESOURCES MANAGEMENT. (4 cr; prereq MBA student; evening program)

Systematic approach to major phases of human resource management in organizations, including knowledge bases and theories; problems; constraints; opportunities; program controls, evaluations, and costs; and results of effective and efficient human resource management. Point of view is that of the generalist, not that of the specialist personnel or industrial relations professional.

8020. BUSINESS STATISTICS: DATA SOURCES, PRESENTATION, AND ANALYSIS. (4 cr; prereq MBA student; evening program)

Descriptive and inferential statistics for managerial problem solving. Analysis of primary and secondary data; regression analysis; use of statistical packages.

8025. DECISION SCIENCES AND INFORMATION SYSTEMS. (4 cr; prereq MBA student; evening program)

Systems analysis, probability and decision analysis applied to managerial problems under conditions of uncertainty. Formulation and interpretation of mathematical models. Role of information systems in decision making. Principles of implementation of decision science models and information systems.

8030. FINANCIAL ACCOUNTING. (4 cr; prereq MBA student; evening program)

Understanding, interpreting, and analyzing financial statements of business enterprises.

8035. MANAGERIAL ACCOUNTING. (4 cr; prereq MBA student; evening program)

Use of accounting data in management decisions; accounting systems to generate accounting data, including study of planning and control; transfer pricing, performance evaluation, cost behavior, cost allocation, and standard costs.

8040. FINANCIAL MANAGEMENT. (4 cr; prereq MBA student; evening program)

Analytical introduction to the theory and practice of finance. Application of basic financial concepts of risk, return, and valuation to decisions that a person engaged in a small business or a corporate financial officer must make about sources and uses of funds during conditions of changing financial markets.

8045. MARKETING MANAGEMENT. (4 cr; prereq MBA student; evening program) Hansen, Rao, Roering
Managing the marketing function; understanding foundational marketing concepts and marketing strategy and planning. Diagnosis of marketing problems and opportunities at operational and strategic levels.

8050. OPERATIONS MANAGEMENT. (4 cr; prereq MBA student; evening program)

Operations function in different types of organizations and relations of operations to business decisions. Operations strategy, process management, Just-In-Time, scheduling, inventory control, and quality improvement.

8055. BUSINESS, GOVERNMENT, AND MACROECONOMICS. (4 cr; prereq MBA student; evening program)

Roles of government and business in society; alternative systems of economic and political values; social, political, economic, and cultural conflicts affecting the business sector.

8060. STRATEGY AND POLICY. (4 cr; prereq MBA student; evening program)

Emphasis on development of skills necessary for effective oral presentation, written presentation, and oral attack and defense of alternative positions. Focuses on strategy, planning, and control systems. Topics include problem location or identification and determination of priorities, problem analysis, development of alternative solutions, choice among alternatives, and implementation.

8070. PROBLEM FORMULATION AND DECISION MAKING. (5 cr; prereq MBA student; evening program)

Formulation and analysis of managerial problems in unstructured situations.

8110. BEHAVIORAL SCIENCE FOR BUSINESS.

(4 cr; prereq MBA student) John, Loken, Ostroff
Basic knowledge from various disciplines about human, collective, and institutional behavior, and methods for learning this knowledge. Fundamental behavioral science theories and evidence; ability to diagnose situations and critique applications presented in subsequent courses.

8120. DATA ANALYSIS AND STATISTICS FOR MANAGERS. (4 cr; prereq MBA student) Benson, Nachtsheim

Application of exploratory data analysis, basic inferential procedures, statistical process control, and regression analysis; methods selected for relevance to managerial decision making and problem solving. Improvement of "statistical thinking" abilities.

8130. FINANCIAL ACCOUNTING. (3 cr; prereq MBA student) Hughes, Rayburn

Basic principles of financial accounting underlying construction, interpretation, and use of corporate financial reports.

8140. MANAGERIAL ECONOMICS. (4 cr; prereq MBA student) Leroy, McCabe

How markets work, how positive economic rents (profits) are made, and how strategic behavior affects profits. Market micro-structure, industrial structure, uncertainty, and incentives and firm governance.

8210. MARKETING MANAGEMENT. (4 cr; prereq MBA student) Beier, John

Managing the marketing function; understanding foundational marketing concepts, marketing strategy and planning. Diagnosis of marketing problems and opportunities at operational and strategic levels. Part of integrated functional core.

8215. HUMAN RESOURCE MANAGEMENT. (2 cr; prereq MBA student) Arvey, Noe

Theory, research, and practice of managing human resources. Acquiring, developing, and compensating employees, designing work, assessing outcomes. Influence of business strategy, legislation, labor markets, and unions. Part of integrated functional core.

8220. OPERATIONS MANAGEMENT. (4 cr; prereq MBA student) Hill, Schroeder

Management of operations function in manufacturing and service organizations. Managerial perspective; impact of operations decisions related to cost, quality, flexibility, and service. Part of integrated functional core.

8225. INTEGRATED INFORMATION MANAGEMENT. (2 cr; prereq MBA student)

Chervany, Davis
Managing information resources and providing support services for users. Information resources include internally and externally developed information and associated hardware and software technology, personnel and users, and operational and management systems. Part of integrated functional core.

8230. FINANCIAL MANAGEMENT. (4 cr; prereq MBA student) Gahlon, Nantell

Tools and concepts of financial management and their use by financial and non-financial managers to measure creation of value within organizations. Valuation of businesses and business opportunities; identification of financial requirements and financing sources. Part of integrated functional core.

8235. MANAGERIAL ACCOUNTING. (3 cr; prereq MBA student) Joyce, Kanodia

Cost systems as potential sources of sustainable competitive advantage. Designing cost systems to provide manager with accurate, relevant, and timely information. Part of integrated functional core.

8300. STRATEGIC MANAGEMENT. (4 cr; prereq MBA student) Balakrishnan, Bromiley

Introduction to concepts and techniques of strategic analysis and management used to create and implement a coherent concept of overall corporate direction. Strategy formulation and implementation at business unit and corporate levels. Takes international orientation.

8305. THE INTERNATIONAL ENVIRONMENT OF BUSINESS. (2 cr; prereq MBA student) Jacque, Lenway

Dynamics of international business environment (institutions, markets, and socio-cultural systems) and its impact on competitiveness of firms. Roles of and relationships with governments and socio-political systems, trade theories and policies, international monetary and financial systems.

8315. THE ETHICAL ENVIRONMENT OF BUSINESS. (2 cr; prereq MBA student) Bowie, Maitland

Relationship of ethical management and the law. Implications for corporate profitability. Managing to maximize profits of shareholders vs. managing to harmonize interests of various stakeholders. Workplace safety, product liability, the environment, regulation, and fiduciary obligations to shareholders.

8325. ORGANIZATIONS AND THE MANAGEMENT OF CHANGE. (2 cr; prereq MBA student) Sutcliffe, Van de Ven

Structure and functioning of complex organizations and of organizational change processes. Development of managerial ability to effectively influence organizational situations.

8335. MANAGING FOR QUALITY AND CONTINUOUS IMPROVEMENT. (2 cr; prereq MBA student) Anderson, Schroeder

Theory and practice of quality management and continuous improvement. Incorporation of issues of quality improvement in business strategy, customer requirements, organizational design, process and product design and control, and management of products and services in the field.

8500. FIELD CONSULTING PROJECT. (6 cr; prereq MBA student; offered in day MBA program only)

Interdisciplinary team approach to formulation and execution of a study of an actual business problem. Teams work on problems currently faced by business, nonprofit, and government organizations in the Twin Cities metropolitan area.

8600. TOP MANAGEMENT PERSPECTIVES. (2 cr; prereq MBA student)

Brings students face-to-face with leading executives and entrepreneurs from throughout the nation. Values, attitudes, and skills for leadership. How personal characteristics and beliefs of leaders shape situations.

Graduate Programs

Operations and Management Science (OMS)

5100. MANUFACTURING FOR COMPETITIVE ADVANTAGE. (4 cr; prereq 3000 or IEOR 3000 or MBA 8050 or #, mgmt or grad mgmt or IT student) Overview of manufacturing, particularly as it contributes to firm's competitiveness. Primarily for students in engineering. Manufacturing strategy, technology and quality issues, and integration of work force into manufacturing effort.

5150. MANAGERIAL STATISTICS. (4 cr, §DSci 5050; prereq 1020 or MBA 8020 or #, mgmt or grad mgmt student) Simple linear and multiple regression analysis; residual analysis, model building, and use of transformation; time series forecasting, exponential smoothing, and autoregressive models; use of factorial and response surface designs in product development and testing; business applications.

5155. METHODS FOR QUALITY AND PRODUCTIVITY IMPROVEMENT. (4 cr, §DSci 5055; prereq 1020 or MBA 8020 or #, mgmt or grad mgmt student) Statistical methods for on-line and off-line quality control. Quality management philosophy, Pareto analysis, control charts, experimental design, and sampling inspection. Applications to administrative, service, and production operations.

5160. DETERMINISTIC MODELING AND OPTIMIZATION. (4 cr; prereq MBA student, Grad Sch Mgmt approval) Survey of deterministic optimization problems, techniques, and applications. Classical optimization, linear programming, transportation and assignment problems, integer programming, networks, PERT/CPM, and dynamic programming. Applications in pricing, vehicle routing, capital budgeting, portfolio selection, production scheduling, and marketing strategy. Computer packages for solving optimization problems.

5170. SIMULATION MODELING. (4 cr; prereq MBA student, Grad Sch Mgmt approval) Survey of probabilistic modeling, with emphasis on computer simulation of complex systems. Event-scheduling simulation models, process-interaction simulations using high-level simulation language, structural and quantitative simulation modeling, overview of simulation methodological issues, animation. Use of computers and various languages to carry out actual simulation studies. Business applications.

5180. RELIABILITY DESIGN AND ANALYSIS. (4 cr; prereq MBA student, Grad Sch Mgmt approval) Fundamental aspects of reliability theory and practice. Designing reliability into products or systems via probabilistic modeling and analysis, and development of cost-efficient, life-testing procedures for analysis of lifetime data.

5850. TOPICS IN OPERATIONS AND MANAGEMENT SCIENCE. (4 cr; prereq 1020, 3000 or #, MBA student, Grad Sch Mgmt approval) Topics may vary quarterly.

8041. PROJECT MANAGEMENT. (4 cr, §OM 8041; prereq 3000 or MBA 8050 or #, grad mgmt student or Grad Sch Mgmt approval) Planning and executing projects; product and system development. Creating development strategy and project plans, tools, and methods for effective cross-functional integration such as QFD and DFM. Project scheduling techniques such as PERT/CPM, effective prototyping, organizing and leading project teams. Examples from manufacturing, software, and service industries.

8051. MANAGEMENT OF SERVICE OPERATIONS. (4 cr; prereq 3000 or MBA 8050 or #, grad mgmt student or Grad Sch Mgmt approval) Decision making for producing services and improving service firm productivity and quality. Service output measurement, defining customer contact, service classification, designing service delivery systems, capacity management in service firms, service automation, and service quality improvement. Lectures and case studies.

8056. PRODUCTION AND INVENTORY MANAGEMENT. (4 cr, §OM 8056; prereq 3000 or MBA 8050 or #, grad mgmt student or Grad Sch Mgmt approval) Inventory planning, production planning, Materials Requirement Planning (MRP), Just-In-Time concepts, finite loading systems, distribution systems, forecasting, master scheduling, capacity management, production activity control, and purchasing. Taught from planning and control systems viewpoint with managerial orientation.

8057. PROCESS, TECHNOLOGY, AND INNOVATION IN THE OPERATIONS FUNCTION. (4 cr, §OM 8057; prereq 3000 or MBA 8050 or #, grad mgmt student or Grad Sch Mgmt approval) Comparison of different operations process types; fundamental management problems in each type, including importance of process technology choice, innovation, and future technological advances. Case studies used in conjunction with lectures.

8058. OPERATIONS STRATEGY. (4 cr, §OM 8058; prereq 3000 or MBA 8050 or #, grad mgmt student or Grad Sch Mgmt approval) Integrated view of operations function within an organization, with focus on decision making and policy from chief operations manager perspective. Structural and infrastructure decisions. Managing operations for competitive advantage. Cases and lectures.

8059. QUALITY MANAGEMENT. (4 cr, §OM 8059; prereq 3000 or MBA 8050 or #, grad mgmt student or Grad Sch Mgmt approval) Managing quality improvement within service and manufacturing organizations, including establishing culture and strategy for quality, quality costs, process analysis, statistical process control, customer/supplier management, quality control, and organization for quality. Taught from managerial perspective. Lectures, demonstrations, and cases.

8650. REGRESSION ANALYSIS. (4 cr, §DSci 8650; prereq MBA 8020 or equiv or #)

Regression and correlation models, inferences in simple and multiple regression, multicollinearity, indicator variables, variable selection techniques, assumption violation treatment, applications to management problems, introduction to logistic regression and other advanced topics.

8651. EXPERIMENTAL DESIGN. (4 cr, §DSci 8651; prereq 8650 or #; offered alt yrs)

Variance analysis for one-way, two-way, and multi-way data. Basic statistical design concepts and result analysis. Randomized block, latin square, cross-over, factorial designs, confounding; estimation and effect comparison; response surfaces; applications to management.

8652. MULTIVARIATE METHODS. (4 cr; prereq 8650 or #; offered alt yrs)

Introduction to multivariate statistical analysis; one and two sample tests on means; linear discriminant analysis; canonical correlation; multivariate analysis; applications to management problems with use of packaged statistical routines.

8662. COMBINATORIAL OPTIMIZATION. (4 cr; prereq 8660 or #; offered alt yrs)

Solution techniques for class of optimization problems characterized by an optimal solution drawn from a finite or countably infinite set of feasible solutions. Such problems can be formulated in general as integer programs. Specialized solution techniques, such as for network flow, matching, and matroid problems, and more general solution techniques, such as cutting plane methods and enumeration methods (e.g., dynamic programming and branch-and-bound). Theory of NP-Completeness as classification scheme for computational complexity of such problems.

8670. STOCHASTIC MODELING AND ANALYSIS. (4 cr, §DSci 8670; prereq Stat 5122 or #; offered alt yrs)

Probabilistic modeling of dynamic process, including Markov chains; Poisson, renewal, and continuous-time Markov processes; queuing models. Statistical estimation of selected models; applications to managerial problems, such as brand shift, industrial migration, manufacturing, and computer/communications networks.

8671. SIMULATION ANALYSIS. (4 cr, §DSci 8671; offered alt yrs)

Treatment of underlying probabilistic and statistical aspects of computer simulation. Random number generators, variate and process generation, statistical analysis of simulation output, ranking and selection of simulation models, and variance reduction techniques.

8680. QUEUEING THEORY: A COMPUTATIONAL APPROACH. (4 cr; prereq 8670; offered alt yrs)

Theory of Stochastic Service Systems (theory of queues) from an algorithmic point of view. Prepares students to model and analyze complex stochastic service systems via classical methods and algorithmic methods and approximations.

8710. RESEARCH IN OPERATIONS STRATEGY. (4 cr; prereq PhD student or #; offered alt yrs)

Operations performance, competitive advantage, focused factory, product and process innovation, operations strategy implementation. Research results and methods.

8720. MANAGEMENT OF TECHNOLOGICAL OPERATIONS. (4 cr; prereq PhD student or #; offered alt yrs)

Theories and models used to address problems of managing technological operations and operations in manufacturing and service firms. Technology strategy, economic/organizational perspectives on technology, productivity analysis, technology evaluation, project selection and evaluation, learning, etc.

8730. RESEARCH ON SCHEDULING. (4 cr; prereq 5160, PhD student or #; offered alt yrs)

Literature and research methods in aggregate planning, scheduling, routing, sequencing, and dispatching in manufacturing and service industries. Advanced research papers and methods discussed.

8735. OPERATIONS FORECASTING AND INVENTORY RESEARCH. (4 cr; prereq PhD student or #; offered alt yrs)

Research on forecasting, inventory control, Materials Requirement Planning (MRP), Just-In-Time manufacturing, and related subjects. Research studies and methods discussed.

8745. RESEARCH ON QUALITY MANAGEMENT. (4 cr; prereq PhD student or #; offered alt yrs)

Examination of research literature, methods, and results. Research on quality strategy, economics of quality, statistical process control, vendor management, statistical process control, off-line quality, and quality practice.

8799. SEMINAR: OPERATIONS AND MANAGEMENT SCIENCE. (4 cr)

Examination of current literature and research methods. Topics vary according to faculty and student interest.

8850. TOPICS IN OPERATIONS AND MANAGEMENT SCIENCE. (4 cr, §OM 8850; prereq MBA 8050, MBA 8020 or #, grad mgmt student or Grad Sch Mgmt approval)

Seminar providing broad range of state-of-the-art topics.

8990. READINGS IN OPERATIONS AND MANAGEMENT SCIENCE. (Cr ar, §OM 8990; prereq #, Grad Sch Mgmt approval)

8995. GRADUATE RESEARCH IN OPERATIONS AND MANAGEMENT SCIENCE. (Cr ar; prereq #, Grad Sch Mgmt approval)

Business and Marketing Education

See Vocational and Technical Education.

Business Taxation

See Business Administration.

Cell and Developmental Biology

See Molecular, Cellular, Developmental Biology and Genetics.

Cellular and Integrative Physiology (Phsl)

Professor: Robert F. Miller, *head:* Dwight A. Burkhardt; Joseph DiSalvo¹; Sue Donaldson; Timothy J. Ebner; Esther M. Gallant; Apostolos P. Georgopoulos; Lois J. Heller¹; Hon Cheung Lee; Arthur S. Leon; David G. Levitt; Walter C. Low; Eric A. Newman; Richard E. Poppele; Richard L. Purple; John F. Soechting

Associate Professor: O. Douglas Wangenstein, *director of graduate studies;* Edwin W. Haller¹, *associate director of graduate studies;* W. Dale Branton; Martha Flanders; Jurgen Fohlmeister; Stephen A. Katz; David Mohrman¹; Scott M. O'Grady; John W. Osborn; Winfried A. Raabe; Edward K. Stauffer¹; Lorentz E. Wittmers, Jr.¹

Assistant Professor: Kevin D. Fox; Paul A. Iaizzo

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Physiology is the application of mathematics, physics, and chemistry to the study of structure and function in living systems. This interdisciplinary program emphasizes a quantitative approach to understanding normal and abnormal functions of cells, organs, and organ systems in humans and other animals. Twin Cities faculty members are from the Department of Physiology, other basic science departments in the Medical School and College of Veterinary Medicine, and clinical departments in the Medical School. Duluth faculty members are from the Department of Medical and Molecular Physiology of the Duluth School of Medicine. Research possibilities for students range from molecular to organ system studies, with opportunities for learning and applying modern techniques of organ, cell, and molecular physiology.

The Ph.D. program typically requires four to five years. In the first two years, students take core courses that provide a broad

background in molecular, cell, and organ physiology. Supporting work may be from any of several disciplines, including but not limited to, biochemistry, cell and molecular biology, computer science, engineering, mathematics, and physics. Individualized programs are structured so each student can build a core of commonly required knowledge as well as strengths for particular areas of research. By the start of the second year, students must choose an adviser and begin laboratory work. A preliminary oral examination is taken after the second year when coursework has been completed and a plan for thesis research has been formulated. Specialty areas of this program include membrane and epithelial transport, ion channels, signal transduction, contractile processes, cardiovascular integration, and neurophysiology, with emphasis on motor systems, vision, and computational neuroscience.

Prerequisites for Admission—For the major, an undergraduate degree with at least one year (three quarters or two semesters) of calculus, one year of physics, one year of biology, and two years of chemistry. For the minor, a background in mathematics, physics, chemistry, and biology acceptable to the graduate faculty.

Special Application Requirements—For the Ph.D., applicants must take either the General Test of the Graduate Record Examination or the Medical College Admission Test. For all applicants, three letters of recommendation must be submitted. Admission is generally in fall quarter.

Master's Degree Requirements—A one-year core academic program is offered in cellular and human physiology. Programs are thereafter individualized to meet the needs of each student.

Doctoral Degree Requirements—The two-year core sequence consists of courses in cell and molecular biology, cell physiology, medical physiology, and medical neuroscience. Substitution or waiver of these requirements is possible upon petition to and

¹ University of Minnesota, Duluth

concurrency by the graduate program executive committee. Supporting work is individualized to meet the needs of each student.

Language Requirements—None, although all students are expected to gain a solid background in the use of computers and in a computer language.

For Further Information and Applications—Contact the Department of Physiology, University of Minnesota, 6-255 Millard Hall, 435 Delaware Street S.E., Minneapolis, MN 55455 (612/625-5902). Additional information concerning the master's program is available by contacting the associate director of graduate studies, Department of Medical and Molecular Physiology, School of Medicine, University of Minnesota, 10 University Drive, Duluth, MN 55812 (218/726-8551).

Phsl 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Phsl 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5100w. SYSTEMS PHYSIOLOGY. (5 cr; prereq biochem and human anatomy; primarily for dental, pharmacy, med tech, nurse anesthetist students; not recommended for students who have taken 3051 or 3052 or 3053 or 3055 or 3056 or 5440 or 5441) Katz, staff
Cell, general, endocrine, cardiovascular, respiratory, gastrointestinal, energy metabolism, and renal physiology.

5101s. NEUROSCIENCE FOR DENTAL STUDENTS. (1.5 cr; prereq courses in biochemistry and human anatomy, ¶CBN 5110 [1.5 cr] required; 3 lect and 3 lab hrs per wk) Staff

Basic principles of nervous function examined through study of neuroanatomy and neurophysiology.

5110-5111. HUMAN PHYSIOLOGY. (3 cr for 5110, 4 cr for 5111; primarily for 1st-yr med students and grad students) Wangenstein, staff

5112. HUMAN NEUROSCIENCE B. (3 cr; prereq 1st-yr med or grad student; Anat 5111-Phsl 5112†) Ebner, staff

5130-5131†. INTERMEDIATE SYSTEMS PHYSIOLOGY. (4 cr for 5130, 5 cr for 5131; prereq phsl grad student or #, physics, calculus, cell biol) Wangenstein, staff
Survey of systems physiology. Lectures and labs same as *Phsl 5110-5111*. Weekly discussion sessions.

5201. COMPUTATIONAL NEUROSCIENCE I: MEMBRANES AND CHANNELS. (5 cr; prereq 5112 or equiv; 3 lect and 4 lab hrs per wk) Fohlmeister
Comprehensive examination of membrane and ion channels using UNIX work stations to simulate their properties. Includes Hodgkin-Huxley model, non-linear dynamic systems, voltage and ligand gated ion channels, and impulse propagation.

5202. COMPUTATIONAL NEUROSCIENCE II: CELLS AND CIRCUITS. (5 cr; prereq understanding of UNIX, 5201 or equiv) Miller, staff
Comprehensive investigation of computational properties of single neurons and locally connected cell networks. Linear cable theory, compartmental modeling of single neuron properties, spatio-temporal interactions between synaptic inputs in neuronal dendritic trees, computational properties of passive and active dendritic spines and spine clusters, quantitative interpretation of whole-cell voltage-clamp data, and dynamics of locally connected cell networks.

5203. COMPUTATIONAL NEUROSCIENCE III: NEURAL SYSTEMS AND INFORMATION PROCESSING. (5 cr; prereq 5202) Soechting
Quantitative examination of information processing by networks of neurons based on experimental data and theoretical models. Neural codes, neural network models and information processing, neural control systems, and computational maps.

5440f-5441w. QUANTITATIVE PHYSIOLOGY. (3 cr; prereq 1 yr each of college chem, physics, math through integral calculus) Levitt, staff
Diffusion, surface tension, and mechanics of respiration, circulation, digestion, and locomotion. Chemical aspects of blood, respiration, renal function, nutrition, and metabolism. Endocrine, sensory, neuromuscular, and central neural functioning.

5444s. MUSCLE CONTRACTION. (3 cr, §MdBc 5444; prereq undergrad biochemistry or physiology courses, #) Donaldson
Introduction to physiology, biochemical regulation, and physical chemistry of muscle contraction.

5568f. PHYSIOLOGY OF VISUAL SYSTEMS. (3 cr; prereq #; offered alt yrs) Purple
Material emphasis on vertebrate visual system: receptor transduction, retinal structure and physiology, and central visual processes. Conceptual emphasis on visual system as information-reception and information-processing system.

8113f,w,s,su. PROBLEMS IN PHYSIOLOGY. (Cr and hrs ar; prereq #) Staff
Topics assigned for readings or lab study; conferences.

8202.* READINGS IN PHYSIOLOGY. (Cr and hrs ar) Staff
Topics selected for each student; written reviews prepared and discussed.

8203.* RESEARCH IN PHYSIOLOGY. (Cr and hrs ar)

Graduate Programs

8205. BIOMEDICAL IMAGE PROCESSING. (4 cr; prereq calculus, Fourier transforms)
Theory and applications of image processing to biomedical research, including topics in hardware, software, image processing algorithms, and three-dimensional reconstruction techniques. Lab includes use of image processing systems on UNIX workstations.

8211.¹ SELECTED TOPICS IN HEART AND CIRCULATION. (2-4 cr; prereq 5130-5131 or equiv or #) Heller, Mohrman, staff
One or more seminars in advanced physiology of heart and circulation.

8216f,w,s.¹ SELECTED TOPICS IN NEUROPHYSIOLOGY. (2-4 cr; prereq CBN 5111, Phs1 5112) Poppele, Soechting, staff
Advanced seminar.

8300. CELLULAR AND MOLECULAR PHYSIOLOGY. (4 cr; prereq GCB 5035, GCB 8148, GCB 8149 or equiv or #) Branton, Lee, Levitt, Miller, Newman, O'Grady
Contemporary concepts and developments in mechanisms of signal transduction, ion channel, and transport processes. Cellular and molecular approaches. Lectures, readings, and discussion.

For additional graduate course listings, please consult the *Duluth General Bulletin*.

Chemical Engineering and Materials Science and Engineering

CHEMICAL ENGINEERING

Regents' Professor: Rutherford Aris; L. Edward Scriven
Professor: H. Ted Davis, *head*; Lanny D. Schmidt, *director of graduate studies*; Frank S. Bates; Robert W. Carr, Jr.; Barry C. Carter; James R. Chelikowsky; Edward L. Cussler; John S. Dahler; D. Fennell Evans; Arnold G. Fredrickson; Christie J. Geankoplis; William W. Gerberich; Wayne L. Gladfelter (chemistry); Wei-Shou Hu; Christopher W. Macosko; Wilmer G. Miller (chemistry); Richard A. Oriani (*emeritus*); David A. Shores; William H. Smyrl; Matthew V. Tirrell; Michael D. Ward; John H. Weaver

Associate Professor: Jeffrey J. Derby; Michael C. Flickinger (biochemistry); Alon V. McCormick; Christopher J. Palmstrom; John M. Sivertsen; Friedrich Srien; Robert T. Tranquillo

Assistant Professor: Prodomos Daoutidis; Lorraine F. Francis; C. Daniel Frisbie; Timothy P. Lodge (chemistry); J. Ilja Siepmann (chemistry); Renata M. M. Wentzcovitch

MATERIALS SCIENCE AND ENGINEERING

Regents' Professor: Rutherford Aris; L. Edward Scriven
Professor: William W. Gerberich, *associate head*; Michael D. Ward; *director of graduate studies*; Frank S.

Bates; Robert W. Carr, Jr.; Barry C. Carter; James R. Chelikowsky; Philip I. Cohen (electrical engineering); Edward L. Cussler; E. Dan Dahlberg (physics); John S. Dahler; H. Ted Davis; D. Fennell Evans; Arnold G. Fredrickson; Wayne L. Gladfelter (chemistry); Allen M. Goldman (physics); J. Woods Halley (physics); David L. Kohlstedt (geology and geophysics); Christopher W. Macosko; Marshall I. Nathan (electrical engineering); Richard A. Oriani (*emeritus*); Emil Pfender (mechanical engineering); Lanny D. Schmidt; David A. Shores; William H. Smyrl; James H. Stout (geology and geophysics); Matthew V. Tirrell; John H. Weaver

Associate Professor: Jeffrey J. Derby; Alfonso Franciosi; Alon V. McCormick; Christopher J. Palmstrom; John M. Sivertsen; Robert T. Tranquillo

Assistant Professor: Prodomos Daoutidis; Lorraine F. Francis; C. Daniel Frisbie; Timothy P. Lodge (chemistry); Renata M. M. Wentzcovitch

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—Chemical Engineering: M.S.Ch.E. (Plan A only), M.Ch.E., and Ph.D.; Materials Science and Engineering: M.S. (Plan A only), M.S.Mat.S.E. (Plan A only), M.Mat.S.E., and Ph.D.

Curriculum—Emphases are available in colloids, interfaces, microelectronic materials, ceramics, polymers, molecular materials, nanostructures and nanocomposites, organic solid state chemistry, catalysis, surface chemistry and physics, chemical kinetics, molecular theory of rate processes, thermodynamics, chemical reactor analysis, control and optimization, fluid and interfacial mechanics, crystal growth, bioengineering, molecular interfaces, interface chemistry and physics, physical and chemical metallurgy, metal physics, electronic properties of materials, electronic structure theory, superconductivity, electrochemistry, corrosion, rheology, structure-property relationships, electron microscopy, scanning tunneling microscopy, and atomic force microscopy.

Prerequisites for Admission—A bachelor's degree in chemical engineering, materials science, metallurgy, polymer engineering, chemistry, physics, or electrical engineering is required. Applicants may be accepted without this prerequisite, but may be required to complete additional preparatory studies

¹ Students should consult the department for offerings during any specific quarter.

prescribed by their adviser or the director of graduate studies after admission.

Special Application Requirements—Three letters of recommendation are required.

Graduate Record Examination scores are required for students with degrees in other disciplines and are strongly recommended for all applicants. Deadline for application is February 1; late applications are considered if space is available.

Master's Degree Requirements—For the M.S. degree, see the General Information section of this bulletin. For the M.Ch.E. and M.Mat.S.E. degrees, 28 credits, of which 20 must be in the major field, plus a work-related project, are required. A final oral examination is required for all master's degrees.

Doctoral Degree Requirements—The Ph.D. program requires 45 credits in the major (including up to 9 seminar credits) and 21 to 23 credits in the minor or supporting program. If a minor is chosen instead of a supporting program, the field is generally mathematics, physics, chemistry, or electrical engineering.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Chemical Engineering and Materials Science, University of Minnesota, 151 Amundson Hall, 421 Washington Avenue S.E., Minneapolis, MN 55455 (612/625-0382).

ChEn 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

ChEn 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

ChEn 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

MatS 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

MatS 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

MatS 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Chemical Engineering (ChEn)

5001. COMPUTATIONAL METHODS IN CHEMICAL ENGINEERING AND MATERIALS SCIENCE. (4 cr; §MatS 5001; prereq ChEn or MatS major; 3 lect and 1 computer lab hrs per wk) Introduction to analysis of representative chemical engineering problems by computer and mathematical methods.

5101. PRINCIPLES OF CHEMICAL ENGINEERING I. (4 cr; prereq 5001 or §5001, IT student; 3 lect and 2 rec hrs per wk) Staff Energy and material balances applied to chemical engineering systems.

5102. PRINCIPLES OF CHEMICAL ENGINEERING II. (4 cr; prereq 5001, 5101; 3 lect and 2 rec hrs per wk) Staff Fluid dynamics and its application to chemical engineering unit operations.

5103. PRINCIPLES OF CHEMICAL ENGINEERING III. (4 cr; prereq 5102, upper div ChEn or MatS major; 3 lect and 2 rec hrs per wk) Staff Heat and mass transfer and their application to chemical engineering unit operations.

5104. UNIT OPERATIONS AND SEPARATION PROCESSES. (4 cr; prereq 5101, upper div ChEn or MatS major; 3 lect and 2 rec hrs per wk) Absorption, extraction, distillation, stagewise and continuous separations.

5105. SCIENTIFIC MODELS FOR CHEMICAL ENGINEERING PROCESSES. (4 cr; prereq sr ChEn or MatS major or IT honors or grad student or #; 3 lect hrs per wk) Physical-chemical validation; time and space scale-up and scale-down of experiments and models; role of pilot plants and theory in understanding present and future processes over a sufficient range of space and time scales; generalization and resolution of quantitative models, illustrated by old and new examples.

5201. THERMODYNAMICS AND MATERIALS STATES. (4 cr; prereq 5001, 5101, Chem 5534, upper div ChEn or MatS major; 3 lect and 2 rec hrs per wk) Staff Principles of thermodynamics applied to closed and open systems and to equilibrium states of homogeneous and heterogeneous substances, gases, liquids, and solids.

5202. CHEMICAL ENGINEERING THERMODYNAMICS AND KINETICS. (4 cr; prereq 5201, upper div ChEn or MatS major; 3 lect and 2 rec hrs per wk) Staff Chemical equilibrium and chemical kinetics applied to chemical engineering systems.

5301. CHEMICAL REACTOR ANALYSIS. (4 cr; prereq 5202, upper div ChEn or MatS major; 3 lect and 2 rec hrs per wk) Staff Principles of reactor design for homogeneous and heterogeneous reactions. Analysis of reactors from a kinetic and thermodynamic point of view.

Graduate Programs

5302. APPLIED REACTOR ANALYSIS. (4 cr; prereq 5301 or equiv)

Treatment of practical chemical reaction systems and the reactors for them. Catalysis and its role in chemical industry. Analysis of functioning chemical reaction systems such as ammonia synthesis, polymerization reactors, combustion, sulfur dioxide removal systems.

5401. CHEMICAL ENGINEERING LABORATORY.

(2 cr; prereq 5102, ¶5103, upper div ChEn or MatS major; 4 lab and 1 conf hrs per wk)

Applications of unit operations; principles of fluid flow, heat and mass transfer; experiments with reports.

5402. CHEMICAL ENGINEERING LABORATORY.

(4 cr; prereq 5103, upper div ChEn or MatS major; 4 lab, 1 lect, and 1 conf hrs per wk)
Continuation of 5401.

5501. PROCESS EVALUATION AND DESIGN. (4 cr; prereq 4th yr or #, upper div ChEn or MatS major; 3 lect and 3 design lab hrs per wk)

Dynamics of chemical engineering industries, economics of process evaluation, bases for cost estimations. Plant designs prepared and compared with actual installation. Special applications of unit operations, reaction kinetics, and thermodynamics.

5502. PROCESS EVALUATION AND DESIGN. (4 cr; prereq 5501 or #, upper div ChEn or MatS major; 3 lect and 2 lab hrs per wk)

Computer-aided design of unit operations, chemical reactors and integrated plants; operability characteristics of chemical processes; design for optimum operability (safety, reliability, control).

5601. PROCESS CONTROL. (4 cr; prereq 4th yr or #, upper div ChEn or MatS major; 3 lect and 2 rec hrs per wk)

Elementary theory of control and its application to chemical processes. Synthesis of feedback control loops for linear systems.

5603. PROCESS CONTROL. (3 cr; prereq 5601 or #; 3 lect hrs per wk)

Advanced topics in chemical process control; synthesis.

5604. PROCESS CONTROL LABORATORY. (2 cr; prereq 5601)

Experiments that illustrate and apply control theory. Measurement techniques, calibration, tuning of controls, characterization of sensors and control circuits.

5640. POLYMERIZATION REACTOR ENGINEERING.

(4 cr [available to grads for 3 cr]; prereq chemical engineering reactor design course or #; 3 lect hrs and 1 lab hr ar per wk)

Introduction to analysis and design of polymerization reactors. Topics include mathematical modeling techniques, chain-growth and step-growth polymerization, copolymerization, molecular weight distributions, composition and sequence distributions. Emphasis on application of results.

5751. BIOCHEMICAL ENGINEERING I. (3 cr; prereq grad student or sr in ChEng or #; 3 lect hrs per wk)

Applications of material and energy balances and concepts from thermodynamics, kinetics, and transport phenomena to cellular and enzyme systems.

5752. BIOCHEMICAL ENGINEERING II. (3 cr; prereq Biol 5001, grad student or sr in ChEng or #; 3 lect hrs per wk)

Engineering analysis and design of cellular and enzyme systems for production of chemical commodities.

5753. BIOCHEMICAL ENGINEERING III. (3 cr; prereq Biol 5001, grad student or sr in ChEng or #; 3 lect hrs per wk)

Description and analysis of methods for separation of biochemical products of cellular and enzyme activity; applications to process synthesis.

5754. FOOD PROCESSING TECHNOLOGY. (4 cr; prereq 5103 or #; 3 lect hrs per wk)

Heat transfer in food processing; protein processing; financial evaluation of projects; case studies; discussions of marketing, government regulation, nutrition.

5756. BIOCHEMICAL ENGINEERING LABORATORY. (2 cr; prereq 5751 or 5752; 4 lab hrs per wk)

Microbial growth, biochemical product formation, isolation, purification, and medium sterilization.

5757. PRINCIPLES OF ARTIFICIAL INTERNAL ORGAN DESIGN. (3 cr; prereq #; 3 lect hrs per wk)

Survey of artificial internal organs important in the maintenance of homeostasis; emphasis on general principles and particular problems of design including blood compatibility, access, and alternative approaches to replacing natural organ function.

5761. SCIENCE AND TECHNOLOGY OF POROUS MEDIA. (3 cr; 3 lect hrs per wk)

Fundamentals of porous media structures and of flow, transport, and deformation in them. Relations of macroscopic properties and behavior to underlying microscopic structures and mechanisms. Examples from nature and technology, with reference to in situ processing and enhanced recovery.

5771. COLLOIDS AND DISPERSIONS. (3 cr; prereq physical chem; 3 lect hrs per wk)

Preparation, stability, and coagulation kinetics of colloidal solutions. DLVO theory, electrokinetic phenomena, and properties of micelles and other microstructures.

5774. INTERFACIAL PHENOMENA OF LIQUIDS. (3 cr; prereq physical chem, 5012 or equiv)

Surface tension, surface geometry and capillarity, thin-films and disjoining pressure, contact angle; capillarity-driven and surface tension gradient-driven flows; wetting, spreading, dewetting, retraction; surfactant effects; fluid displacement, detergency, flotation, dynamic wetting, entrainment, adhesion. Examples from science and technology.

5780. PRINCIPLES OF MASS TRANSFER IN ENGINEERING AND BIOLOGICAL ENGINEERING.

(3 cr; prereq upper div engineering or science student; 3 lect hrs per wk)

Mass transfer in gases, liquids, biological and macromolecular solutions, gels, solids, membranes, capillaries, and porous solids. Interaction between mass transfer and chemical reaction. Applications in biological, environmental, mineral, chemical engineering systems.

5810. PROCESSING OF ELECTRONIC MATERIALS. (3 cr; prereq MatS 5011 or #; 3 lect hrs per wk)

Materials science and chemical engineering aspects of processing of materials for microelectronic devices (e.g., semiconductor memories and microprocessors) and optical devices (e.g., semiconductor lasers and optical waveguides).

5902, 5903, 5904, 5905. SPECIAL PROBLEMS.

(Cr ar)

Investigations in chemical engineering. Library or lab research.

8004, 8005. PHYSICAL RATE PROCESSES. (3 cr per qtr; prereq 5103, #)

Heat and mass transfer. Mechanisms of heat and mass transport. Derivations of equations of change for energy and individual chemical species. Application to selected problems in unsteady state heat and mass transport, forced and free convection, coupled transport, and conic diffusion.

8101. INTERMEDIATE FLUID MECHANICS. (3 cr; prereq 5103, #)

Derivation of equations of change; analysis of statics, kinematics, and dynamics of viscous fluids; survey of rectilinear, boundary-layer, creeping, inviscid, irrotational, and other flow approximations; representative problems with emphasis on chemical engineering applications.

8102. PROBLEMS IN FLUID MECHANICS. (3 cr; prereq 8101)

Application of principles to prototypal cases of flow and transfer. Problem solving and critical analysis of literature of physicochemical fluid mechanics.

8104. INTERFACES AND INTERFACIAL PHENOMENA. (3 cr; prereq 8101; offered alt yrs)

Theory of boundary conditions. Equilibrium and dynamics of fluid interfaces. Analysis of surface tension-driven motions and other interfacial phenomena.

8105. PRINCIPLES AND APPLICATIONS OF RHEOLOGY. (3 cr; prereq 8101, 8103; offered alt yrs)

Deformation and flow of non-Newtonian and viscoelastic fluids, plastic materials, and perfectly elastic solids. Phenomenological and molecular interpretation of rheology of elastomers, polymer melts and polymer solutions, application of rheology to polymer processing.

8201-8202-8203. ADVANCED MATHEMATICS FOR CHEMICAL ENGINEERS. (3 cr per qtr; prereq #)

Elements and applications of linear algebra. Intermediate level treatment of linear ordinary and partial differential equations. Eigenvalue problems and generation of finite Fourier transforms of general type. Elementary functional analysis. First order partial differential equations and sometime perturbation methods.

8301-8302. PHYSICAL AND CHEMICAL THERMODYNAMICS. (3 cr per qtr; prereq 5202 or #)

Principles of thermodynamics and applications to phase equilibria and chemical equilibria, especially in flow systems, with examples drawn from applied chemistry, chemical engineering, and materials science.

8401. CHEMICAL REACTION KINETICS—KINETICS OF HOMOGENEOUS REACTIONS.

(3 cr; prereq #)

Description and characterization of reacting systems. Theory of elementary reactions. Energy transfer and relaxation in gases. Methods of elucidating the reactions of highly reactive transient intermediates.

8402. CHEMICAL REACTION KINETICS—SURFACE CHEMISTRY. (3 cr; prereq #)

Atomistics of adsorption and reaction on solid surfaces. Discussion of modern techniques for characterization of surfaces such as AES, LEED, UPS, XPS, SEM, and TEM. Principles of heterogeneous catalysis and survey of important existing and developing catalytic processes.

8403. CHEMICAL REACTION KINETICS—ADVANCED TOPICS. (3 cr; prereq #)

8500. INTERMEDIATE CHEMICAL REACTOR ANALYSIS. (3 cr)

Survey of the analysis of chemical reactions and reactors. Steady state design and optimality. Transient behavior and stability problems.

8601-8602-8603. MOLECULAR THEORY OF EQUILIBRIUM AND NONEQUILIBRIUM PROCESSES. (3 cr per qtr)

Theory and interpretation in terms of molecular scale processes of (a) structure and thermodynamic properties of homogeneous and inhomogeneous systems at equilibrium (8601-8602) and (b) transport phenomena and theory of irreversible processes (8602-8603). Major emphasis on fluids.

8701. ANALYSIS OF CHEMICAL ENGINEERING PROBLEMS. (3 cr; prereq 8203)

Critical analysis of current chemical engineering literature.

8702. ADVANCED TOPICS IN CHEMICAL ENGINEERING. (1-3 cr per qtr)

8703. PROCESS CONTROL. (3 cr; prereq 5601 or #; 3 lect hrs per wk)

Advanced topics in chemical process control; synthesis of control structures; multivariable control schemes; optimal control and estimation; computer-aided real-time process control.

8774. INTERFACIAL PHENOMENA OF LIQUIDS.

(3 cr; prereq physical chem, 8101 or equiv) Scriven Surface tension, surface geometry and capillarity, thin-films and disjoining pressure, contact angle; capillarity-driven and surface tension gradient-driven flows; wetting, spreading, dewetting, retraction; surfactant effects; fluid displacement, detergency, flotation, dynamic wetting, entrainment, and adhesion. Examples from science and technology.

8801, 8802, 8803. SEMINAR. (1 cr per qtr)

Presentation and discussion of papers concerning the newer developments in chemical engineering.

Graduate Programs

8810. PROCESSING OF ELECTRONIC MATERIALS. (3 cr; prereq MatS 5011 or #; 3 lect hrs per wk)

Materials science and chemical engineering aspects of processing of materials for microelectronic devices (semiconductor memories, microprocessors) and optical devices (semiconductor lasers, optical wave guides).

8850. GENERAL SURVEY OF CHEMICAL ENGINEERING. (1 cr)

Independent reading under staff guidance.

8901, 8902, 8903. RESEARCH IN CHEMICAL ENGINEERING. (Cr ar)

Heat and mass transfer, fluid dynamics, chemical kinetics, chemical reactor theory, thermodynamics, process control, bioengineering, applied mathematics.

Materials Science and Engineering (MatS)

5001. COMPUTATIONAL METHODS IN CHEMICAL ENGINEERING AND MATERIALS SCIENCE. (4 cr. \$ChEn 5001; prereq ChEn or MatS major; 3 lect and 1 computer lab hrs per wk)

Introduction to analysis of representative chemical engineering and materials science problems by computer and mathematical methods.

5011. INTRODUCTION TO THE SCIENCE OF MATERIALS. (4 cr; prereq upper div ChEn or MatS major; 3 lect and 2 rec hrs per wk)

Introduction to materials. Metals, polymers, ceramics, glasses, composites, electronic and magnetic materials.

5012. INTRODUCTION TO DISLOCATIONS AND PHYSICAL METALLURGY. (4 cr; prereq upper div IT standing, 5011 or #; 3 lect and 1 rec hrs per wk)

Basis of work hardening, solid solution strengthening, precipitation hardening and heat treatment of alloys.

5013. INTRODUCTION TO ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS. (4 cr; prereq upper div IT standing, 5011 or #; 3 lect and 1 rec hrs per wk)

Introduction to quantum mechanics and semi-quantitative theories of electrical and magnetic properties of solids.

5101. THERMODYNAMICS OF SOLIDS. (4 cr; prereq Chem 5534 or #; 3 lect and 1 rec hrs per wk)

Fundamental concepts, 1st and 2nd laws, free energy, equilibrium constant, fugacity and activity relationships, solution models, order-disorder.

5102. DIFFUSION AND SOLID STATE KINETICS. (4 cr; prereq 5101 or #, upper div IT standing; 3 lect and 1 rec hr per wk)

Kinetics: quantitative relationship between rate of reaction and reactant concentration. Diffusion: interstitial and substitution diffusion, steady-state and transient systems.

5112. CERAMICS. (4 cr; prereq 5102 or #; 3 lect and 1 rec hrs per wk)

Introduction to ceramics, including glasses. Crystalline and non-crystalline structures; phase relations; ternary phase diagrams; mechanical, thermal, electrical, magnetic, and optical properties of ceramics.

5200. OPTICAL AND ELECTRON MICROSCOPY OF SOLIDS. (4 cr; prereq upper div IT standing, 3400 or #; 2 lect and 3 lab hrs per wk)

Practical experience in materials and techniques of evaluation. Investigation of microstructure using optical metallography. Use of transmission electron microscopy, scanning electron microscopy, and elemental microanalysis for metallurgical systems.

5202. X-RAY STRUCTURAL ANALYSIS. (4 cr; prereq upper div IT standing; 1 lect, 1 rec and 5 lab hrs per wk)

Geometry of crystals; properties and diffraction of X-rays; single crystal Laue methods and powder techniques; crystal structure determination; structure of polycrystals; single crystal orientation; crystal texture; precision lattice parameter measurements; chemical analysis; stress measurements; radiography.

5304. FAILURE ANALYSIS. (4 cr; prereq 3400, 5013, 5411 or #; 2 lect and 4 lab hrs per wk)

Embrittlement, wear, corrosion, integrated circuit breakdown, vibration, and fatigue. Analysis of failure using metallographic, electron microscopy, and microanalytic techniques.

5411. MATERIALS DESIGN. (4 cr; prereq sr MatS major; 3 lect and 1 rec hrs per wk)

Mechanical and thermal processing with applications to forging, extrusion, rolling; advanced topics on heat treatment of steel, titanium and aluminum alloys, and materials for microelectronic applications. Materials selection based on cost and design function.

5450. CORROSION AND ELECTROCHEMISTRY OF CORROSION. (4 cr; prereq IT upper div, 5101 or #; 3 lect and 2 lab hrs per wk)

Electrochemical thermodynamics, Butler-Volmer equation, electrochemical kinetics, theory of corrosion, passivation, inhibition, forms of corrosion, environmental degradation of mechanical properties, cathodic and anodic protection.

5455. ELECTROCHEMICAL ENGINEERING. (4 cr; prereq upper div IT, grad student or #; 4 lect hrs per wk)

Fundamentals of electrochemical engineering. Topics include electrokinetics, thermodynamics of cells, batteries, fuel cells, electrosynthesis, and modern sensors.

5460. OXIDATION OF METALS. (4 cr; prereq 5102 and upper div IT standing; 3 lect and 1 rec hrs per wk)

Theory of high temperature oxidation of metals and alloys; oxidation in complex environments; practical applications and design criteria.

5470. CORROSION AND ELECTROCHEMISTRY OF HOMOGENEOUS AND HETEROGENEOUS SURFACES. (4 cr; prereq 5450 or 5460 or #; 3 lect and 1 rec hrs per wk)

Transport and kinetic phenomena in corrosion processes. Wagner-Traud coupling of oxidation and reduction reactions on homogeneous and heterogeneous surfaces. Principles of current, potential, and concentration distribution modeling in general and localized corrosion.

5481-5482-5483. SPECIAL PROBLEMS IN PHYSICAL METALLURGY AND MATERIALS SCIENCE. (Cr and hrs ar; prereq sr)

Library or lab studies of scientific or engineering problems in physical metallurgy and materials science.

5610. POLYMER CHEMISTRY I. (4 cr; prereq upper div IT student, ChEn 3301 or ChEn 3331 or #; 3 lect and 3 lab hrs per wk)

Polymer synthesis and physical chemistry: polymerization kinetics and reactors, molecular weight distribution, network formation, macromolecules in solution and their characterization, glassy and crystalline state, rubber elasticity, flow and viscoelasticity, environmental degradation.

5613. POLYMER LABORATORY. (2 cr; prereq 5610 or 5630 or #5630 or Chem 8611)

Synthesis and characterization of molecular structure and properties of several polymers. Experiments include free radical copolymerization, copolymer ratio by IR, molecular size by SEC, crosslinking polymerization, solubility, swelling, crystallization kinetics, thermal transitions by DSC, viscoelasticity, rubber elasticity, tensile properties.

5620. PROCESSING OF POLYMERS AND THEIR COMPOSITES. (4 cr [3 cr w/o lab by dept permission]; prereq heat transfer, fluid mechanics or #; 3 lect and 1 lab-rec hrs per wk)

Polymer processing principles and applications: rheology of long chain molecules, flow in simple geometries, die design, mixing, thermal properties, heat transfer and phase change; thermoplastic operations—extrusion, forming, and molding; thermoset operations—fiber and particulate reinforced composite molding, pultrusion, and filament winding.

5630. POLYMER PHYSICAL PROPERTIES. (4 cr; prereq 3400 or 5011, MatS/Chem 5610 or #; 3 lect and 1 open lab hrs per wk)

Polymer structure-property relations: structure and morphology of the crystalline and amorphous state. Crystallization kinetics, vitrification and the glass transition, mechanical properties, failure, permeability, optical and electrical properties, polymer composites, effect of processing on properties.

5820. THIN FILMS AND INTERFACES OF MICROELECTRONIC MATERIALS. (3 cr; prereq 5013 or #; 3 lect hrs per wk)

Oxidation of Si; formation of interfaces, silicides, and multilayers; interface growth and morphology; thermodynamic and kinetic parameters of evolving interfaces; distribution of reaction products; fabrication of diffusion barriers; epitaxial overlayers; electrical and analytical techniques for characterization.

8110. FUNDAMENTALS OF MATERIALS SCIENCE. (3 cr)

Chemical bonding; perfect and imperfect crystals; defects; thermodynamics and kinetics; phase diagrams and phase transformation; diffusion; electronic structure of solids and electrical properties; semiconductor statistics.

8112. SOLID STATE REACTIONS. (3 cr; prereq #)

The kinetics of phase transformations and processes such as oxidation and epitaxial layer formation are considered in the framework of modern concepts of nucleation and growth theory such as the theory of spinodal decomposition.

8114. SYMMETRY AND SCATTERING IN SOFT MATERIALS. (3 cr; 3 lect hrs per wk)

Theory and concepts of symmetry and structure in polymers and organic crystals. Role of symmetry in x-ray and neutron scattering. Point group and space group symmetries. Molecular origins for ordering in solids.

8210. STRUCTURE-PROPERTY RELATIONSHIPS: MECHANICAL AND MICROELECTRONIC. (3 cr; prereq #)

Geometry and properties of metal crystals; electrical and thermal conductivity; Hall effect; optical properties; elastic and plastic behavior of metals; principles of microelectronic materials and devices.

8213, 8214. ELECTRONIC PROPERTIES OF MATERIALS. (3 cr per qtr; prereq #)

Basic physical theory of bonding in metals, alloys, and semiconductors. Crystal structures related to fundamental parameters. Band theory using free electron, tight binding, APW, KKR, pseudopotential, and other techniques. Experimental techniques for measuring electronic properties, including photoemission, Auger spectroscopy, and optical spectroscopy. Transport properties, microelectronic materials, metal-semiconductor interface phenomena, and other topics.

8311. THEORIES OF MECHANICAL BEHAVIOR OF SOLIDS. (3 cr)

The theoretical analysis of the mechanical behavior of solids. Included are theories of work-hardening, recovery, creep, fatigue, and fracture. Fracture mechanics theories examined in lab exercises associated with compliance, strain-energy release rate, and J-integral techniques.

8401. TRANSFORMATIONS IN ALLOYS AND ORIGINS OF MICROSTRUCTURE. (3 cr; prereq #)

Factors governing polycrystalline microstructures, including topology of two-dimensional and three-dimensional cellular arrays, nature of grain boundaries and interfaces, recovery, recrystallization and grain growth, allotropic transformation, eutectoid decomposition, martensitic transformations, precipitation reactions.

8460. OXIDATION OF METALS. (4 cr; prereq 5102 or #; 3 lect and 1 rec hrs per wk)

Theory of high temperature oxidation of metals and alloys; oxidation in complex environments; practical applications and design criteria.

8470-8471-8472. SEMINAR: MATERIALS SCIENCE AND ENGINEERING. (Cr ar)

8480-8481-8482. SELECTED TOPICS IN MATERIALS SCIENCE AND ENGINEERING. (Cr ar)

Graduate Programs

8520. ELECTRON DIFFRACTION AND ELECTRON MICROSCOPY. (3 cr)

Scattering of electrons by solids, mass thickness, and diffraction contrast. Kinematic theory of diffraction and image interpretation. Chemical and structural analysis by electron diffraction. X-ray energy microanalysis and secondary electron topography. Instruction in use of the TEM and SEM. Five lab exercises.

8521. TOPICS IN ELECTRON MICROSCOPY. (3 cr)
(Continuation of 8520) Research projects using either scanning or transmission electron microscopy. Lectures on specimen preparation techniques, and special applications of the microscope.

8522. ADVANCED X-RAY DIFFRACTION OF METALS. (3 cr; prereq 5403 or #)

Reciprocal lattice, structure factor, Fourier analysis, diffuse and low angle scattering.

Chemical Physics (ChPh)

Professor: Donald G. Truhlar (chemistry), *director of graduate studies;* Norma M. Allewell (biochemistry); Jan Almlöf (chemistry); Paul F. Barbara (chemistry); Victor A. Bloomfield (biochemistry); Charles E. Campbell (physics and astronomy); James R. Chelikowsky (chemical engineering and materials science); John S. Dahler (chemistry); H. Ted Davis (chemical engineering and materials science); W. Ronald Gentry (chemistry); Clayton F. Giese (physics and astronomy); Allen M. Goldman (physics and astronomy); J. Woods Halley (physics and astronomy); Cheng-Cher Huang (physics and astronomy); Sanford Lipsky (chemistry); Wilmer G. Miller (chemistry); Albert J. Moscovitz (chemistry); Lanny D. Schmidt (chemical engineering and materials science); David D. Thomas (biochemistry); John H. Weaver (chemical engineering and materials science); Walter Weyhmann (physics and astronomy)

Associate Professor: Kenneth R. Leopold (chemistry)

Assistant Professor: Christopher J. Cramer (chemistry); David M. Ferguson (medicinal chemistry); Doreen G. Leopold (chemistry); Karin Musier-Forsyth (chemistry); Jeffrey T. Roberts (chemistry)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A) and Ph.D.

Curriculum—Focus is on areas where the techniques of chemistry and physics are brought together for the study of atoms and molecules, their interactions in gases, liquids, and solids, and the detailed structure and dynamics of material changes. Areas of research and specialization include spectroscopy, optical properties, laser applications, molecular collisions, chemical

dynamics, quantum mechanics, statistical mechanics, thermodynamics, low-temperature behavior, polymers or macromolecules, surface science, biochemistry, computational chemistry, and biochemical and heterogeneous catalysis.

Prerequisites for Admission—Applicants should have adequate preparation in mathematics, physics, and chemistry. For financial support, applicants should apply either to the Department of Chemistry or the Department of Physics. Applicants not requiring financial support have their academic qualifications reviewed by the director of graduate studies in chemical physics.

Special Application Requirements—Three letters of recommendation are required.

Master's Degree Requirements—At least 8 credits of coursework must be in chemistry and must include statistical or chemical thermodynamics or both; at least 8 credits must be in appropriate physics courses; and at least 8 credits must be in quantum mechanics, which may be taken in either the chemistry or physics department.

Doctoral Degree Requirements—A proficiency examination in physical chemistry is required. Programs ordinarily include at least 36 graduate credits, which include coursework in chemistry and/or physics with options for coursework in quantum mechanics, thermodynamics, statistical physics, and/or chemical dynamics. There is no minor or supporting field requirement. A graduate student handbook that provides complete requirements is available from the address below.

Language Requirement—None.

For Further Information and Applications—Contact the Chemical Physics Program, Department of Chemistry, University of Minnesota, 137 Smith Hall, 207 Pleasant Street S.E., Minneapolis, MN 55455 (612/626-7444).

ChPh 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

ChPh 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

ChPh 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

8101. CHEMICAL PHYSICS SEMINAR. (1 cr; prereq ChPh grad student)
Seminar by student on his or her research.

Chemistry (Chem)

Professor: W. Ronald Gentry, *chair*; Wilmer G. Miller, *vice chair*; Harold S. Swofford, Jr., *director of graduate studies*; Norma M. Allewell; Jan Almlöf; George Barany; Paul F. Barbara; Victor A. Bloomfield; J. Doyle Britton; Peter W. Carr; John S. Dahler; H. Ted Davis; John E. Ellis; John F. Evans; Wayne L. Gladfelder; Gary R. Gray; Thomas R. Hoyer; Essie Kariv-Miller; John D. Lipscomb; Sanford Lipsky; Hung-wen Liu; Timothy P. Lodge; Kent R. Mann; Larry L. Miller; Albert J. Moscowitz; Wayland E. Noland; Louis H. Pignolet; Stephen Prager (*emeritus*); Lawrence Que; Michael A. Raftery; Donald G. Truhlar

Associate Professor: Frank S. Bates; Steven R. Kass; Doreen G. Leopold; Kenneth R. Leopold; Scott D. Rychnovsky; Marian Stankovich; William B. Tolman; Michael D. Ward

Assistant Professor: Christopher J. Cramer; Mark D. Distefano; Craig J. Forsyth; Eric J. Munson; Karin Musier-Forsyth; Jeffrey T. Roberts; J. Ilja Siepmann; Andreas Stein; Li Sun;

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.¹

Curriculum—Graduate work in the Department of Chemistry is organized into six specialty areas: analytical chemistry, biological chemistry, inorganic chemistry, materials chemistry, organic chemistry, and physical chemistry. Interdisciplinary work is also an option.

Prerequisites for Admission—Applicants must offer the substantial equivalent of the courses in analytical, inorganic, organic, and physical chemistry required of undergraduate

majors in the Minnesota chemistry curriculum. They must also have at least one year of college physics plus college mathematics through calculus.

Special Application Requirements—Three letters of recommendation are required for all applications. Scores from General (Aptitude) and Subject (Advanced) Tests of the Graduate Record Examination (GRE) are required for fellowship consideration. International applicants are expected to provide scores of at least 580 on the Test of English as a Foreign Language (TOEFL), as well as GRE scores.

Proficiency Examination—Students working toward the M.S. or Ph.D. in chemistry are required to take a set of four proficiency examinations, one each in analytical, inorganic, organic, and physical chemistry. These examinations are taken on entrance; the results are used for guidance. Ph.D. students are expected to satisfy the proficiency requirements in all four fields during their first academic year in residence. M.S. students are expected to pass the proficiency examination in their specialty area during their first academic year in residence.

General Degree Requirements—A list of required and recommended courses, including courses from outside the field of chemistry, can be obtained from the director of graduate studies. Procedures are available for satisfying course requirements through special examination rather than course registration.

Master's Degree Requirements—One to three 4-credit project papers are required for Plan B. A final oral examination is required for both Plan A and Plan B.

Doctoral Degree Requirements—Ph.D. candidates must complete 36 credits of work in approved graduate courses (30 credits for students in organic chemistry). Analytical, biological, inorganic, materials, and organic chemistry specialty areas require a written research dossier. For students specializing in physical chemistry, this examination consists

¹ For information on the doctoral degree program offered in conjunction with the University of Minnesota, Duluth, please contact the director of graduate studies on the Twin Cities campus, or the program director or Graduate School office on the Duluth campus.

Graduate Programs

of two papers. A student needs to pass the written preliminary examination in only one of the five specialty areas. When the written examination has been passed, the student may proceed to the preliminary oral examination.

Language Requirements—None.

For Further Information and Applications—Contact the assistant to the director of graduate studies, Department of Chemistry, University of Minnesota, 137 Smith Hall, 207 Pleasant Street S.E., Minneapolis, MN 55455 (612/626-7444 or 1-800-777-2431; fax 612/626-7541).

Chem 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Chem 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Chem 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5122. ADVANCED ANALYTICAL CHEMISTRY. (4 cr; prereq 1 yr organic chem and one thermodynamics course)
Equilibria in aqueous and nonaqueous systems.

5126. MODERN ANALYTICAL CHEMISTRY. (4 cr; prereq 3332 and 3335, IT chemical engineering major or Δ ; 2 lect hrs and two 3-hr labs per wk)
Strategies and techniques for solving modern analytical problems. The use of modern instruments in analysis.

5127. ANALOG INSTRUMENTATION. (5 cr; prereq Phys 1253, Math 1262 or equiv or #, chem major or grad student)

Basic principles of electronic design and circuitry, servo systems, operational amplifiers, feedback control, oscillators, digital gates, converters for signal processing and control of measurement systems.

5128. THE SMALL COMPUTER IN THE CHEMICAL LABORATORY. (5 cr; prereq 5127 or #; 3 lect hrs and two 4-hr labs per wk)
Applications of the lab computer to control of chemical instrumentation and acquisition of data. Hardware (interfacing) and software (assembly language programming) aspects of automating the chemical experiment.

5130. ANALYTICAL CHEMISTRY. (3 cr; prereq 1 yr organic chem with lab, CLA or IT chem major; 3 lect hrs and 1 rec hr per wk)
Methods and concepts of measurement by chemical and instrumental analysis, including titrimetry, quantitative spectrophotometric analysis, chromatographic separations, and equilibrium and rate methods of analysis emphasizing applications to organic and biochemical systems.

5131. ANALYTICAL CHEMISTRY LABORATORY. (2 cr; prereq 5130 or \S 5130; two 4-hr labs per wk)
High-precision methods, acidimetry and complexometry, single- and multi-component analysis by spectrophotometry, analysis of mixtures by ion exchange and gas chromatography, enzymatic and rate methods of analysis.

5133. CHEMICAL INSTRUMENTATION AND ANALYSIS LECTURE. (3 cr; prereq 5130, 5131, 5534, 5535 or #)
Methodology and practices for solving analytical problems. Application of modern instrumental techniques to analysis.

5139. CHROMATOGRAPHY AND SEPARATION SCIENCE. (4 cr; prereq 5133, 5140 or equiv or #, chem major or grad student)
Fundamental and practical aspects of gas liquid chromatography, modern liquid chromatography, electrophoresis, and other techniques used for analyses and separations.

5140. CHEMICAL INSTRUMENTATION AND ANALYSIS LABORATORY. (3 cr; prereq 5133, chem major)
Instrumental techniques including spectroscopic methods of analysis, electrochemical methods of analysis, and analyses based on separation. Emphasis on use of computers in data collection and reduction.

5301. SPECTRAL METHODS OF ORGANIC QUALITATIVE ANALYSIS. (4 cr, §8302; prereq 3303 or 3333 or equiv; 3 lect and 1 conf hrs per wk)
Practical application of nuclear magnetic resonance, mass, ultraviolet infrared spectral analysis to solution of organic problems.

5302. ORGANIC SYNTHESIS. (4 cr; prereq 3303 or 3333 or equiv, #)
Reactions of typical functional groups and introduction to modern lab methods of organic synthesis.

5331, 5332. ADVANCED ORGANIC CHEMISTRY I, II. (4 cr per qtr, §8331, §8332; prereq 3303, #)
Depending on year and instructor, emphasizes heterocyclic chemistry, natural products chemistry, organic electrochemistry, synthetic applications of organometallic chemistry, solid-state chemistry, polymer chemistry and/or stereochemistry.

5342. CHEMISTRY OF NATURAL PRODUCTS. (3 cr; prereq 3303 or 3333 or equiv; offered alt yrs)
Biosynthesis of secondary natural products with emphasis on alkaloids, terpenes, and acetogenins.

5344. HETEROCYCLIC COMPOUNDS. (3 cr; prereq 3303 or 3333 or equiv; offered alt yrs)
Typical classes of heterocyclic compounds, their chemical and physical properties and uses, synthesis.

5520-5521. ELEMENTARY PHYSICAL CHEMISTRY. (3 cr per qtr; prereq 1 yr college chem, Phys 1291 or \S Phys 1291 or Phys 1106, Math 3211)
Brief general survey. 5520: Thermodynamics and applications to chemistry. 5521: Elementary statistical mechanics, kinetics, and structure.

5525. PHYSICAL BIOCHEMISTRY: SOLUTION STRUCTURE AND INTERACTIONS OF BIOLOGICAL MACROMOLECULES. (4 cr, §BioC 5525, §MdBc 5525; prereq 2 qtrs physical chem, Biol 5001 or equiv)

Physical chemistry of equilibrium, transport, and scattering phenomena in solution, with application to proteins and nucleic acids. Intermolecular forces, macromolecules dynamics, conformational transitions, binding thermodynamics, methods for determining biopolymer size and shape, including sedimentation, diffusion, viscosity, electrophoresis, and scattering.

5526. PHYSICAL BIOCHEMISTRY: SPECTROSCOPIC METHODS I. (4 cr, §BioC 5526, §MdBc 5526; prereq 2 qtrs physical chem)

Lectures on fundamental spectroscopic principles with emphasis on development of magnetic resonance theory used in study of biological macromolecules.

5527. PHYSICAL BIOCHEMISTRY: SPECTROSCOPIC METHODS II. (4 cr, §BioC 5527, §MdBc 5527; prereq 2 qtrs physical chem, BioC/Chem/MdBc 5526 or #)

Application of optical and magnetic resonance techniques to study of structure and dynamics in proteins, lipids, nucleic acids, and synthetic analogs.

5528. PHYSICAL BIOCHEMISTRY: ENZYME KINETICS. (4 cr, §BioC/MdBc 5528; prereq 2 qtrs physical chem, BioC/MdBc 5751; BioC 5002 or equiv recommended)

Theory and application of steady-state and transient kinetics to study of enzymes, enzyme systems, and cellular regulation.

5529. PROTEIN STRUCTURE AND FOLDING. (4 cr, §BioC/MdBc 5529; prereq Biol 5001 or equiv, 1 qtr physical chem or #)

Advanced course on protein structure, stability, folding, and molecular modeling. Results from X-ray crystallography, solution thermodynamics, NMR, computer graphics, and protein engineering.

5533. QUANTUM CHEMISTRY. (4 cr; prereq 1 yr college chem, Phys 1291 or ¶Phys 1291 or 1106 with #, Math 3211)

Principles of quantum mechanics with applications to atomic and molecular structure and to spectroscopy.

5534. CHEMICAL THERMODYNAMICS. (4 cr; prereq IT upper div or CLA chem major or Δ, Phys 1291 or ¶Phys 1291 or 1106 with #, Math 3211)

Principles of thermodynamics with applications to chemical systems.

5535. STATISTICAL MECHANICS AND REACTION KINETICS. (4 cr; prereq 5534)

(Continuation of 5534) Developing statistical thermodynamics and the kinetic theory of gases with applications to reaction rate theory. Phenomenological kinetics and experimental methods.

5538. PHYSICAL CHEMISTRY LABORATORY.

(1 cr; prereq 5535 or ¶5535; not open to chem majors) Experiments in thermodynamics and reaction kinetics.

5540. PHYSICAL CHEMISTRY LABORATORY.

(3 cr; prereq chem major, 5533, 5535 or ¶5535; 1 lect and 8 lab hrs per wk)

Experiments illustrating principles and methods of thermodynamics, reaction kinetics, and quantum mechanics.

5610. POLYMER SCIENCE. (4 cr, §MatS 5610; prereq physical chem or MatS 5011 or #; 3 lect hrs and one 3-hr lab per wk)

Polymer synthesis and physical chemistry: polymerization kinetics and reactors, molecular weight distribution, network formation, macromolecules in solution and their characterization, the glassy and crystalline state, rubber elasticity, flow and viscoelasticity, environmental degradation.

5731. MAIN GROUP INORGANIC CHEMISTRY.

(3 cr; prereq 5533 or ¶5533 or 5534 or ¶5534, chem or chem eng major)

Structure and bonding concepts in compounds where s and p electrons are important. Descriptive main group inorganic chemistry; symmetry concepts applied to inorganic molecules.

5732. TRANSITION METAL INORGANIC CHEMISTRY.

(3 cr; prereq 5533 or ¶5533 or 5534 or ¶5534, chem or chem eng major)

Transition metal compounds where d electrons are important. Organometallic, bioinorganic, and metal cluster chemistry.

5740. INORGANIC CHEMISTRY LABORATORY.

(3 cr; prereq chem major, 5731, 5732 or ¶5732; 1 lect and 8 lab hrs per wk)

Experiments in inorganic and organometallic chemistry illustrating synthetic and spectroscopic techniques.

5803. THE CHEMISTRY OF INDUSTRY. (4 cr;

prereq chem sr or grad student or #)

Basic industry and polymer chemistry, and technology on which industry is based. Relationship of basic properties to industrial utility. Emphasis on economics, social problems, and industrial environment.

5991, 5992, 5993. SELECTED TOPICS IN CHEMISTRY. (Cr ar; prereq sr, Δ)

Topics of current interest in chemistry. Consult department for details of offerings for any particular quarter.

8001. APPLIED CHEMICAL THERMODYNAMICS.

(4 cr; prereq chem grad student or #; 3 lect hrs per wk)

Systems in gas and solution phase, inorganic, organic, and biochemical reactions. Chemically important consequences of first and second laws. Heat reaction, entropy of reaction, and heat capacity changes from chemical measurement. Fluid, solid state equilibria, electrochemical equilibria, and surface processes. Phenomenological interpretation of phase diagrams in solid state chemistry and polymer mixtures.

Graduate Programs

8002. MECHANISMS OF CHEMICAL REACTIONS. (4 cr; prereq chem grad student or #; 3 lect hrs per wk)

Reaction mechanisms and methods of study. Mechanistic concepts in chemistry. Topics include gas phase reactions to mechanisms, "electron pushing" mechanisms in organic reactions, mechanism of enzymatic reactions. Kinetic schemes and other strategies to investigate mechanisms.

8003. COMPUTATIONAL CHEMISTRY. (4 cr; prereq chem grad student or #; 3 lect hrs per wk)
Modern theoretical methods used in study of molecular structure, bonding, and reactivity. Concepts and practical applications. *Ab initio* and semi-empirical calculations of molecular electronic structure. Theoretical determination of molecular structure and spectra; relationship to experimental techniques. Molecular mechanics. Structure determination of large systems. Study of molecular properties and reactivity by theoretical methods. Computational tools for theoretical determination and lab for hands-on experience. Critical assessment of reliability of methods and theoretical work in literature.

8104. SPECTROSCOPIC METHODS OF ANALYSIS. (4 cr; prereq 5133 or equiv or #)
Systematic treatment of modern optical methods of analysis.

8133. MODERN ELECTROANALYTICAL TECHNIQUES, PRINCIPLES, AND PRACTICES. (3 cr; prereq 5122)
Polarography, galvanostatic and potentiostatic methodology, coulometry, linear scan and cyclic voltammetry, pulse methods, and OTTL applications.

8134. BIOANALYTICAL CHEMISTRY. (3 cr; prereq 5133 or equiv and BioC 5001 or equiv)
Theory and practical aspects of analytical methods used in determination and characterization of biologically important materials. Enzymatic and kinetic methods in study of amino acids, proteins, carbohydrates, lipids, and nucleic acids.

8135. MASS SPECTROMETRY. (3 cr; prereq #)
Introduction to physical and chemical aspects of mass spectrometric analysis.

8136. SURFACE AND THIN FILM ANALYSIS. (3 cr; prereq #)
Survey of modern ultrahigh vacuum techniques appropriate to analysis of surface and thin film structure.

8190. SEMINAR: MODERN PROBLEMS IN CHEMICAL INSTRUMENTATION AND ANALYSIS. (1 cr [may be repeated for cr]; prereq chem grad student or #)

8191. SEMINAR PRESENTATION: MODERN PROBLEMS IN CHEMICAL INSTRUMENTATION AND ANALYSIS. (1 cr; prereq chem grad student, #)

8290. SEMINAR: MATERIALS CHEMISTRY. (1 cr; prereq chem grad student or #)

8291. SEMINAR PRESENTATION: MATERIALS CHEMISTRY. (1 cr; prereq chem grad student, #)

8301. ADVANCED ORGANIC CHEMISTRY I. (4 cr; prereq 3303 or 3333 or equiv)
Chemistry of reactive intermediates: free radicals, carbonium ions, carbanions, and carbenes. Use of these in syntheses. Reactions of olefins, acetylenes, and ylids.

8302. INTERPRETATION OF ORGANIC SPECTRA. (4 cr; prereq 1 yr undergrad organic chem or #)
Practical application of nuclear magnetic resonance, mass, ultraviolet, and infrared spectral analyses to the solution of organic structural problems.

8304. ADVANCED ORGANIC CHEMISTRY II. (4 cr; prereq 8301 or #)
Carbonyl chemistry (carbonyl additions, Michael-type additions, α -substitutions, methods of synthesis), aromaticity, and antiaromaticity. Concerted reactions of olefins, both thermal and photochemical, discussed using simple molecular orbital theory and Woodward-Hoffmann-type relationships.

8305. ADVANCED ORGANIC CHEMISTRY III. (4 cr; prereq 8304 or #)
(Continuation of 8304) Introduction to heterocyclic chemistry and to complex syntheses of natural products, with emphasis on stereochemical control, selective reagents, and use of blocking groups.

8311. ORGANIC SYNTHESIS I. (4 cr; prereq 3303 or equiv or #)
Core course; fundamental concepts, reactions, reagents, structural and stereochemical issues, and mechanistic skills necessary for understanding organic chemistry.

8312. ORGANIC SYNTHESIS II. (4 cr; prereq 8311 or #)
Topics such as complex carbon skeleton synthesis, asymmetric synthesis, and/or modern studies in organic chemistry.

8321. PHYSICAL ORGANIC CHEMISTRY I. (4 cr; prereq 8002 or #)
Core course. Fundamental concepts, mechanistic tools, and methods for the understanding and critical analysis of detailed mechanistic studies in organic chemistry.

8322. PHYSICAL ORGANIC CHEMISTRY II. (4 cr; prereq 8321 or #)
Topics such as reactive intermediates, gas-phase chemistry, photochemistry, and/or strained-ring chemistry.

8331. ADVANCED ORGANIC CHEMISTRY I. (4 cr, §5331; prereq 3303 or #)
Topics such as heterocyclic chemistry, natural products chemistry, organic electrochemistry, synthetic applications of organometallic chemistry, solid-state chemistry, polymer chemistry, and/or stereochemistry.

8390. SEMINAR: ORGANIC CHEMISTRY. (1 cr; prereq chem grad student or #)

8391. SEMINAR PRESENTATION: ORGANIC CHEMISTRY. (1 cr; prereq chem grad student, #)

8401. BIOORGANIC CHEMISTRY I. (4 cr; prereq 3303 or equiv)

Chemistry of amino acids, peptides, and proteins; peptide structure determination, synthesis, and reactivity; biological applications of synthetic peptides.

8402. BIOORGANIC CHEMISTRY II. (4 cr; prereq 3303 or equiv)

Chemistry of lipids and carbohydrates: structure, nomenclature, characterization by NMR spectroscopy, synthesis, and reactivity.

8403. BIOORGANIC CHEMISTRY III. (4 cr; prereq 3303 or equiv)

Chemistry of nucleic acids: structure and reactivity, interactions with small molecules and proteins, chemical oligonucleotide synthesis, ribozymes, overview of techniques used in nucleic acid research.

8404. BIOORGANIC CHEMISTRY IV. (4 cr; prereq 3303 or equiv)

Enzymecatalyzed reactions: group transfers, eliminations, isomerizations, rearrangements, oxidation-reduction reactions, chemical mechanisms in enzymatic systems.

8512. CHEMICAL THERMODYNAMICS. (4 cr; prereq undergrad physical chem)

Fundamentals of classical thermodynamics and application to chemical phenomena including chemical equilibrium, phase transitions, surface and solution thermodynamics.

8521. METHODS OF THEORETICAL CHEMISTRY. (4 cr; prereq undergrad physical chem)

Basic theoretical techniques of physical chemistry, application to selected chemical problems.

8531-8532-8533. INTRODUCTORY QUANTUM MECHANICS AND SPECTROSCOPY. (4 cr per qtr; prereq 8521 or equiv)

Wave mechanics, soluble problems, approximate methods, chemical applications, structure of molecules, group theory, elementary treatment of scattering, atomic and molecular spectroscopy.

8535. MOLECULAR QUANTUM MECHANICS. (4 cr; prereq 8531)

Application of quantum mechanics to molecular problems including topics such as Born-Oppenheimer approximation, symmetry of electronic and vibrational wave functions, molecular orbital theory, and rotational and vibrational eigenstates and spectra.

8545. REACTION DYNAMICS. (4 cr; prereq undergrad physical chem)

Reaction dynamics from microscopic viewpoint with an emphasis on modern experimental methods and interpretation of scattering data.

8547. ELEMENTS OF STATISTICAL MECHANICS. (4 cr; prereq undergrad physical chem)

Principles of equilibrium statistical mechanics, ensemble theory, partition functions; application to simple systems such as ideal gases and crystals, and simple lattice statistics.

8548. ADVANCED STATISTICAL MECHANICS. (4 cr; prereq 8547)

More advanced topics in statistical mechanics, such as nonequilibrium gases and solutions, distribution functions, and nonequilibrium statistical mechanics.

8560. SEMINAR: BIOLOGICAL SYSTEMS. (1 cr; chem grad student or #)**8561. SEMINAR PRESENTATION: BIOLOGICAL SYSTEMS.** (1 cr; prereq chem grad student, #)**8590. SEMINAR: PHYSICAL CHEMISTRY.** (1 cr; prereq chem or chem phys grad student; S-N only)**8591. SEMINAR PRESENTATION: PHYSICAL CHEMISTRY.** (1 cr; prereq chem or chem phys grad student or #)**8611. INTRODUCTION TO POLYMER PROPERTIES.** (3 cr; prereq 5534 or #)

Molecular weight distribution, formation of network polymers, statistical thermodynamics of polymer solutions, polymers characterization by viscosity, light scattering, sedimentation methods, viscoelastic behavior of polymers.

8612. ADVANCED TOPICS IN POLYMER SCIENCE. (3 cr; prereq 8611 or #; offered alt yrs)

For graduate students in chemistry, chemical engineering, and materials science, and others interested in modern statistical theories of equilibrium and nonequilibrium polymer systems.

8751. PHYSICAL INORGANIC CHEMISTRY I. (4 cr, §5751; prereq chem grad student or #)

Physical methods and concepts applied to inorganic and organometallic systems, including NMR, IR, UV-VIS, ESR, Mossbauer and mass spectroscopy, magnetic measurements, X-ray crystallography.

8752. PHYSICAL INORGANIC CHEMISTRY II. (4 cr, §5752; prereq chem grad student or #)

Solution thermodynamics and kinetics applied to inorganic and organometallic systems; determination of reaction mechanisms; symmetry and ligand field concepts.

8756. X-RAY CRYSTALLOGRAPHY. (4 cr, §5756; prereq chem grad student or #)

Determination of crystal structures by X-ray diffraction of single crystals. Data collection, structure solving and refining for inorganic and organic molecules of 100 or fewer atoms.

8761. ORGANOMETALLIC CHEMISTRY. (4 cr, §5761; prereq chem grad student or #)

Syntheses, reactions, structures, and other important properties of main group and transition metal organometallic compounds; treatment in terms of modern electronic and structural theory; emphasis on their use as stoichiometric and homogeneous catalytic reagents in organic and inorganic systems.

8762. CHEMISTRY OF THE ELEMENTS. (4 cr, §5762; prereq chem grad student or #)

Survey of synthesis, structure, physical properties, and chemical reactivity of the elements. Topics equally divided between transition and nontransition elements.

Graduate Programs

8765. BIOINORGANIC CHEMISTRY. (4 cr, \$5765; prereq chem grad student or #)

Survey of role of metal ions in biology with emphasis on structure, function, and spectroscopy of metalloproteins and their synthetic analogs.

8766. SOLID STATE CHEMISTRY. (4 cr; prereq chem grad student or #)

Synthetic methods, structures of crystalline solids, and bonding in solids. Solid state phase diagrams and kinetics of solid state reactions. Classes of solids include molecular, ionic, metallic, and semiconducting compounds.

8790. SEMINAR: MODERN PROBLEMS IN INORGANIC CHEMISTRY. (1 cr; prereq chem grad student or #)

8791. SEMINAR PRESENTATION: MODERN PROBLEMS IN INORGANIC CHEMISTRY. (1 cr; prereq chem grad student, #)

8881, 8882, 8883. M.S. PLAN B PROJECT I, II, III. (4, 1-4, 1-4 cr; prereq grad major in chem or chem physics, Δ)

Satisfies project requirement for Plan B master's degree. May appear on M.S. degree program, but does not count toward 20-credit minimum in major field. Topic arranged by student and adviser; written report required. 8881 required; 8882 and 8883 optional.

8990. RESEARCH IN CHEMISTRY. (Cr ar; prereq chem grad student or Δ)

8991. SPECIAL TOPICS IN CHEMISTRY. (Cr ar; prereq Δ)

8992. SPECIAL TOPICS IN CHEMISTRY. (Cr ar; prereq #)

8993. SPECIAL TOPICS IN CHEMISTRY. (Cr ar; prereq Δ)

8994, 8995, 8996. SPECIAL TOPICS IN CHEMISTRY. (Cr ar; prereq Δ)

8997, 8998. SPECIAL TOPICS IN CHEMISTRY. (Cr ar; prereq chem grad student or Δ)

Child Psychology (CPsy)¹

Professor: Richard A. Weinberg, *director*; Charles A. Nelson, *director of graduate studies*; Geraldine K. Brookins; William R. Charlesworth; W. Andrew Collins; Byron R. Egeland; Harold D. Grotevant; Megan R. Gunnar; Willard W. Hartup; Susan C. Hupp; Gloria R. Leon; Michael P. Maratsos; Anne C. Petersen (on leave); Anne D. Pick; Herbert L. Pick, Jr.; L. Alan Sroufe; James E. Turnure; Albert Yonas

Associate Professor: Patricia J. Bauer; Ann S. Masten; Scott R. McConnell; Charles N. Oberg; Maria D. Sera; Elsa G. Shapiro; Paulus W. van den Broek; Carolyn L. Williams

Assistant Professor: Harry M. Hoberman

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D. The M.A. program is usually an integral part of the Ph.D. program; students are rarely admitted for a terminal M.A. degree.

Curriculum—Emphases include developmental aspects of cognition, genetics-ethology, language, learning, cognitive neuroscience, perception, personality, social psychology, child clinical, and school psychology.

Prerequisites for Admission—For both the M.A. and Ph.D., at least 12 quarter credits in psychology and one course in statistics are required.

Special Application Requirements—New students are normally admitted in fall quarter. Application deadline is January 15 of the preceding year. A department application, a statement of goals and interests, three letters of recommendation, and scores from the General (Aptitude) Test of the Graduate Record Examination are also required. A résumé is also recommended.

Master's Degree Requirements—Courses in history, current issues, and research methods of child psychology and in advanced statistics are required. Other courses, including those for a minor or supporting field, are selected in consultation with the adviser. The individual examining committee determines whether the final examination is written, oral, or both.

Doctoral Degree Requirements—Courses in history, current issues, and research methods in child psychology, statistical analysis, and research are required. Other courses are selected in consultation with the adviser. Completion of a supporting program, rather than a minor, is required. Non-coursework requirements include successful completion of a predoctoral research paper, a teaching apprenticeship, preliminary written and oral examinations, and a dissertation.

¹ See the College of Education Bulletin for information on the Master of Education (M.Ed.) program in early childhood education.

Language Requirement—None.

Minor Requirements for Student

Majoring in Other Fields—For the doctoral degree, at least 12 of the minimum 18 credits must be at the 8xxx level.

For Further Information and

Applications—Contact the Child Psychology Program, University of Minnesota, 156 Child Development Building, 51 East River Road, Minneapolis, MN 55455 (612/624-0526).

CPsy 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

CPsy 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

CPsy 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5301. ADVANCED CHILD DEVELOPMENT. (4 cr, §3309, §1301; prereq 5 cr introductory psychology; primarily for non-majors)

Theory and research in child development with emphasis on perception, language, learning, cognition, personality, and social development in children.

5302. INFANCY. (4 cr, §3302; prereq 1301 or #) Nelson, Yonas

Perceptual, motor, emotional, social, and cognitive development during first two years of life; developing infant in its social and physical environment.

5303. ADOLESCENT PSYCHOLOGY. (4 cr, §3303; prereq 5 cr introductory psychology) Collins
Physical, cognitive, and social development during adolescence.

5305. MULTIDISCIPLINARY PERSPECTIVES ON AGING. (4 cr, §AdEd 5440, §HSU 5009, §PA 5414, §PubH 5737, §SW 5024, §Soc 5960) Staff
Multidisciplinary introduction to aging and the aging process.

5310. TOPICS IN CHILD PSYCHOLOGY. (1-4 cr; prereq 1301)
Selected topics in general content area.

5311. INTRODUCTION TO DEVELOPMENTAL PSYCHOPATHOLOGY. (4 cr, §3311; prereq 1301 or equiv, 3308 or Psy 1005) Egeland, Masten, Sroufe
Theories and research strategies to investigate origins and course of disordered behavior in childhood and adulthood, including description, etiology, development.

5313. PSYCHOLOGY OF ATYPICAL CHILDREN. (4 cr, §3313; prereq 1301 or equiv)
Problems of research, assessment, and behavior associated with atypicality; evaluation of research in areas of major concern for sensory, language, intellectual, and physical deviation.

5315. INTRODUCTION TO MENTAL RETARDATION. (4 cr, §EPsy 5620; prereq 1301 or equiv) Turnure
Psychological and educational problems related to the mentally retarded.

5319. INTRODUCTION TO CLINICAL CHILD PSYCHOLOGY. (4 cr; prereq 12 cr child psych or educ psych or psych or sociology) Masten
Survey of assessment and intervention procedures of child clinical psychology in clinical and community settings. Primarily for students not majoring in clinical psychology.

5322. MOTOR DEVELOPMENT. (3 cr, §Kin 5132; prereq 3132 or #) Wade
Motor skill development from birth to physical maturity.

5329. GENETICS, ETHOLOGY, AND DEVELOPMENT. (4 cr; prereq 1301 or equiv) Charlesworth
Survey of evolutionary theory, behavioral genetics applied to understanding of development of human behavior; formation of species-typical adaptive behavior and individual differences in infancy, childhood, and adolescence.

5330. DIRECTED EXPERIENCES WITH CHILDREN. (4 cr; prereq 3301, #)
Intellectual and/or social development of children as individuals or members of peer groups. Experiences offered in case study, social behavior, and cognitive stimulation of children.

5331. PROCESSES OF SOCIAL DEVELOPMENT. (4 cr, §3331; prereq 1301 or equiv) Collins, Hartup
Processes of individual change from infancy through adolescence and development of capacities for and influences of social relations; research, methodology, and theoretical perspectives.

5332. CROSS-CULTURAL CHILD DEVELOPMENT. (4 cr, §3332; prereq 4 cr child psych, 3308 or Psy 1005)
Interdisciplinary, cross-cultural survey of theories and research on similarities and differences in cognitive, perceptual, socioemotional, and personality development; emphasis on child-caretaker relations and Asian and Hispanic cultures.

5334. CHILDREN AND YOUTH IN SOCIETY. (4 cr; prereq 4 cr child psych)
Child development principles relative to social policy decision making; application of theories and findings to such issues as media influences, mainstreaming, day care, child abuse, effects of peers.

5336. DEVELOPMENT AND INTERPERSONAL RELATIONS. (4 cr, §5339; prereq 1301 or equiv, 3331 or 5331, 3308 or Psy 1005) Collins, Hartup
Processes and functions of interactions with parents and peers; analysis of theory and research on developmental changes and influences.

5341. PERCEPTUAL DEVELOPMENT. (4 cr; prereq 1301 or #, 3308 or Psy 1005) H Pick, Yonas
Perceptual learning and the development of sensory and perceptual processes.

Graduate Programs

5343. COGNITIVE DEVELOPMENT. (4 cr; prereq 3343, 3308 or Psy 1005) Bauer, A Pick, H Pick, Sera
Cognitive processes; relevant theory, research literature, and methodology.

5345. LANGUAGE DEVELOPMENT. (4 cr; prereq 1301 or #, 3308 or Psy 1005) Maratsos
Structure and function of language; factors influencing development; methodological problems, language scales, theories.

5349. CHILDREN'S LEARNING AND INTELLECTUAL SKILLS. (4 cr; prereq 1301, 3343 or #)

Current research on learning, problem solving, intellectual performance in children; practical applications.

5353. DEVELOPMENT DURING THE SCHOOL YEARS. (4 cr; prereq 4 cr psych)

Principles of psychological development, emphasizing ages 5-18. Theory and research from developmental psychology relevant to individual growth and achievement; issues in applying developmental perspective to topics in child and adolescent development (e.g., fostering learning, risk for school failure, behavior and emotional problems, diversity).

5970. DIRECTED STUDY IN CHILD PSYCHOLOGY. (Cr ar; prereq #)
Independent reading.

5990. DIRECTED RESEARCH IN CHILD PSYCHOLOGY. (Cr ar; prereq #)
Individual empirical investigation.

8304. RESEARCH METHODS IN CHILD PSYCHOLOGY. (3 cr) A Pick
Review of principal research methods and designs in child psychology, including issues of scientific integrity.

8310. SEMINAR: HISTORY OF CHILD DEVELOPMENT. (1 cr) Hartup, Weinberg
Problems and issues in professional child psychology for first-year graduate students.

8320. SEMINAR: CURRENT ISSUES IN TEACHING DEVELOPMENTAL PSYCHOLOGY. (1 cr) Charlesworth, Collins
Problems and issues in professional child psychology for advanced graduate students.

8325. DEVELOPMENTAL NEUROPSYCHOBIOLOGY. (3 cr; students taking course to fulfill core reqs for PhD in CPsy must take course A-F) Gunnar, Nelson
Survey of research and theory on human brain and endocrine activity and their relations to behavioral development. Memory development, stress and coping in children, and development of sex differences.

8327. ETHOLOGY OF CHILD BEHAVIOR. (3 cr) Charlesworth
Theory and research on phylogenetic and ontogenetic factors in children's adaptive behavior.

8330. DIRECTED FIELD EXPERIENCES. (1-6 cr; prereq #; S-N only)
Intellectual and/or social development of children as individuals or members of groups; may include interactions with children in natural settings, or research on applied topics or with atypical populations.

8333. ADVANCED SOCIAL DEVELOPMENT I. (3 cr) Collins, Hartup
Processes in socialization and personality development emphasizing theory and including predispositional, acquisitional, mediational, and interactional processes.

8341. ADVANCED PERCEPTUAL DEVELOPMENT. (3 cr; prereq Psy 5031) H Pick, Yonas
Review and discussion of experimental and theoretical literature on children's perception; change of perception with age and experience.

8343. ADVANCED COGNITIVE DEVELOPMENT I. (3 cr; prereq 12 cr child psychology or psychology) Bauer, Sera
Theory and research emphasizing Piagetian and psychometric (differential) perspectives.

8345. ADVANCED LANGUAGE DEVELOPMENT. (3 cr; prereq Ling 5001, 12 cr child psychology or psychology) Maratsos
Critical evaluation of current theory and research in language development.

8347. ADVANCED COGNITIVE DEVELOPMENT II. (3 cr; prereq Psy 5013 or #; offered when feasible) Bauer, Sera

8360. SEMINAR: DEVELOPMENTAL PSYCHOLOGY. (Cr ar)
Intensive study of selected topics.

8605. DEVELOPMENTAL PSYCHOPATHOLOGY. (3 cr; prereq 8333) Masten, Sroufe
Dynamics of psychopathology in children; critical evaluation of current theory and research.

8606. NEW APPROACHES TO PSYCHOPATHOLOGY IN CHILDREN AND ADOLESCENTS. (3 cr, \$EPsy 8853) Egeland, Masten
Alternative formulation of childhood disorders, emphasizing competency training rather than medical nosology.

8970. INDEPENDENT STUDY. (Cr ar)
Independent reading.

8980. RESEARCH SEMINAR. (1-3 cr; S-N only)
Participation in organized research group in developmental psychology.

8990. RESEARCH PROBLEMS. (Cr ar)
Individual empirical investigation.

Chinese

See East Asian Languages, Literatures, and Linguistics.

Civil Engineering (CE)

Professor: Steven L. Crouch, *head*; Roger E. A. Arndt; Patrick Brezonik; Andrew Drescher; Steven J. Eisenreich; Charles Fairhurst; Cesar Farell; Theodore V. Galambos; Malcolm T. Hepworth; Walter J. Maier; Panos G. Michalopoulos; Gary Parker; Michael J. Semmens; Charles C. S. Song; Heinz Stefan; Yorgos J. Stephanedes; Otto D. L. Strack

Adjunct Professor: Peter A. Cundall

Associate Professor: Randal J. Barnes; Ladislav Cerny; Emmanuel M. Detournay; Daryl F. Dwyer; Efi Foufoula-Georgiou; Catherine E. French; John S. Gulliver; Gerald W. Johnson; Joseph F. Labuz; Roberto T. Leon; David E. Newcomb; John L. Nieber; Karl A. Smith; Raymond L. Sterling; Henryk K. Stolarski; Vaughan R. Voller

Assistant Professor: Gary A. Davis; Jerome F. Hajjar; Carol Kittredge Shield; Mark B. Snyder

Adjunct Assistant Professor: Paul D. Capel

Research Associate: Louis F. Goldberg; Eil Kwon

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B), M.C.E. (Coursework Only and Design Project), and Ph.D.

Curriculum—The professional master's degree (M.C.E.) is intended for engineering graduates interested in design, planning, operation, or management rather than in research. It is offered under both the design project track and the coursework only track. All subdisciplines of civil engineering (e.g., environmental engineering, water resources, structures, transportation, geotechnical engineering) are available. The coursework only track requires 44 course credits, of which 12 should be from a set of core courses in one of the subdisciplines.

Emphases in the Ph.D. program are structural design and analysis; construction materials engineering; water resources engineering (including fluid mechanics, hydrology, hydraulic engineering, and water resources management); environmental engineering (including water and wastewater process engineering and environmental chemistry); transportation engineering (including traffic and pavement engineering); and geotechnical engineering. Students are expected to concentrate the major part of their work in one of these areas.

Prerequisites for Admission—For the master's and doctoral programs, the normal requirement for admission is a good academic record in a civil engineering undergraduate program accredited by the Accreditation Board for Engineering and Technology (ABET). Some areas of civil engineering are so broad that students with other undergraduate preparation may be considered for admission. For example, in environmental engineering, students with an undergraduate concentration in chemistry, chemical engineering, physics, or certain of the biological sciences may be admitted. In transportation, applicants with an undergraduate concentration in electrical engineering, computer science, mathematics, or physics may be admitted. Applicants who lack civil engineering training are often required to complete one or more appropriate courses from the undergraduate civil engineering program. Graduate degree credit is not awarded for such preparatory work. For the M.C.E. program, an ABET-accredited bachelor's degree in engineering is required.

Special Application Requirements—Applicants should submit to the director of graduate studies three letters of recommendation, either from professors qualified to estimate their class rank and evaluate their ability to complete a program of graduate study, or from engineering professionals who can assess their professional potential. These letters may also be used in applying for financial aid. Applicants for admission should also submit a résumé of their academic history and professional experience and a statement of purpose, including the proposed area of emphasis within civil engineering. Applicants are strongly encouraged but not required to submit results of the Graduate Record Examination (GRE). Those who have not taken the GRE are at a disadvantage in fellowship competitions. Students are admitted each quarter, but applicants are strongly encouraged to begin fall quarter and to submit their applications the December before the year their studies are expected to begin.

Graduate Programs

Professional Registration—Applicants who have as their goal a professional career as a civil, structural, or geological engineer need to obtain registration as a professional engineer. Admission to the registration examination is, in most states, restricted to graduates of an ABET-accredited curriculum for the bachelor's degree in engineering (B.C.E., B.Geo.E.). Students who lack this preparation should seriously consider obtaining the training before entering a graduate program. For a student with an undergraduate background in mathematics, for example, this can normally be accomplished in four quarters. Prospective students may receive counseling on the need for professional registration in light of their career objectives from the director of graduate studies.

Degree Requirements—Certain graduate-level civil engineering courses are acceptable for graduate credit only as part of a minor or supporting program for students majoring in a field other than civil engineering. Consult the director of graduate studies for further information.

For M.C.E. degree requirements, see Professional Master's Degree in Engineering in the General Information section of this bulletin.

The final examination for the M.S. and M.C.E. degrees is oral.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Civil Engineering, University of Minnesota, 122 Civil Engineering Building, 500 Pillsbury Drive S.E., Minneapolis, MN 55455 (612/625-5522).

CE 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

CE 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

CE 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

General

5002. ENGINEERING ECONOMICS. (2 cr; prereq jr, IT student or adult spec or grad student)
Time value of money; compound amount factors; present worth of uniform and single payments; cost-benefit analysis; net present worth analysis; internal rate of return.

5021. COMPUTER APPLICATIONS IN CIVIL ENGINEERING II. (4 cr; prereq 3020, Math 3221 or Math 3212 or #)
Introduction to three methods (finite differences, finite elements, and boundary elements) for solution of problems in hydrology, structural engineering, geomechanics, transportation, and environmental engineering that reduce to partial differential equations. Each method illustrated in context of one or more practical problems.

5097-5098-5099. ADVANCED DESIGN, ANALYSIS, RESEARCH OR TUTORIAL IN CIVIL ENGINEERING. (Cr ar [may be repeated for cr]; prereq approval of adviser)
Planning, design, or analysis of complex civil engineering systems. Individual lab research problems, literature studies, and reports supervised by staff. Studies may be conducted in any discipline within civil engineering and hydraulics, including, but not limited to, land development, materials, environmental engineering, soil and rock mechanics, structures, and transportation.

5700. SYSTEMS ANALYSIS FOR CIVIL ENGINEERS. (4 cr, §GeoE 5700; prereq IT or grad student)
Introduction to systems analysis and decision making; expert systems; operations research techniques, modeling, and simulation. Applications in civil engineering and related areas.

5703. PROJECT MANAGEMENT. (4 cr; prereq sr, IT major)
Practical approach to construction project management including project planning, budgeting, scheduling, staffing, task and cost control, and communicating with, motivating, and managing team members.

8022. NUMERICAL METHODS FOR FREE AND MOVING BOUNDARY PROBLEMS. (4 cr; prereq 8605 or #)
Examples of free and moving boundary problems: metal solidification, filling, polymer molding, flow in porous media, ground freezing. Solutions of free and moving boundary problems: analytical, fixed finite difference, fixed finite element, front tracking schemes, general deforming finite element methods.

8097-8098-8099.* CIVIL ENGINEERING RESEARCH. (1-5 cr per qtr; prereq #) Staff
Original work in concrete, structural steel, soils, hydraulics, hydrology, and municipal, environmental, and transportation problems. Investigations, reports, tests, designs.

8970. DIRECTED RESEARCH: DOCTORAL. (Cr ar; prereq PhD student, #)

Surveying and Land Use Planning

5102. SITE AND ROUTE ENGINEERING. (4 cr; prereq 3100, IT or grad student)
Site and route design fundamentals and problems based on spatial data obtained through photogrammetric mapping. Problems in geometric design; grades, horizontal and vertical curves; fitting of design to topography; earthwork, area and volumes; drainage. Construction control and layout.

Transportation

5200. GEOMETRIC DESIGN OF HIGHWAYS. (4 cr; prereq 3200 or #, IT student or grad)
Forecast of traffic volume demand; impact of vehicle type on geometric design; vertical and horizontal alignment; intersection design; highway capacity.

5201. HIGHWAY TRAFFIC CHARACTERISTICS AND OPERATIONS. (4 cr; prereq 3200, IT or grad student) Davis
Characteristics and measurements of volume, speed, density, and travel time; characteristics of vehicles and road users; parking characteristics and design of facilities; applications of signs, signals, and markings in traffic control.

5210. INTRODUCTION TO TRANSPORTATION SYSTEMS ANALYSIS. (4 cr; prereq #; offered alt yrs) Stephanedes
Techniques of analysis and planning for transportation services; demand-supply interactions; evaluating transportation alternatives; travel demand forecasting; integrated modal systems; citizen participation in decision making; proposal writing.

8200. THEORY OF TRAFFIC FLOW. (4 cr; prereq #) Michalopoulos
Definitions and measurements of basic flow parameters. Macroscopic and microscopic traffic flow models, dynamic models, shock waves, flow speed and travel time distributions, gap availability and acceptance, simulation of traffic flow, traffic control theory and applications, queuing theory and applications.

8201. URBAN TRAFFIC OPERATIONS. (4 cr; prereq #) Michalopoulos
Capacity analysis techniques for urban streets, optimal traffic signal control, real time control, signal hardware and detectors, operational techniques for optimizing traffic flow, use of computer programs in traffic engineering practice, air and noise pollution, street and intersection design.

8210. MODELING CONSUMER CHOICES IN TRANSPORTATION. (4 cr; prereq Stat 3091 or #; offered alt yrs) Davis, Stephanedes
Overview of existing models derived from theories on individual choice behavior; properties of statistical estimators, model specification, and sources of model error; applications in urban and rural transportation; transportation-energy interactions; transportation as related to social services, recreation, and other human activities.

8211. TRAVEL DEMAND FORECASTING. (4 cr; prereq 5210 or 8210 or #; offered alt yrs) Davis, Stephanedes
Predicting shifts in travel demand, auto ownership, and residential location due to implementation of transportation policy changes; state-of-the-art demand-supply models used in case studies; effectiveness of managerial and governmental policies in increasing productivity and efficiency of transport systems.

8212. AUTOMATIC INCIDENT DETECTION. (4 cr; prereq Math 3211 or #; offered alt yrs) Stephanedes
Algorithms for detection of incidents. Pattern recognition, time-series, filters, dynamic models, neural networks. Detection and false alarm rates. Performance curves. Implementation with real traffic data.

8214. TRANSPORTATION SYSTEMS DYNAMICS AND CONTROL. (4 cr; prereq Math 3211 or #; offered alt yrs) Stephanedes
Nonlinear differential equations describing demand, service, economics, and energy consumption of transportation systems. Optimal control policies to improve typical performance indices such as transit service frequency and energy consumption by all transportation modes. Second order linear approximation. Stability analysis and controllability. System synthesis and simulation.

Water Resources Engineering and Hydromechanics

5401. WATER RESOURCES ENGINEERING. (4 cr; prereq 3400 or #, IT or grad student)
Introduction to water resources engineering including flow in conduits, pumps, open channels, and culverts; introduction to flow measurements, hydraulic structures, and systems approach to water resources engineering.

5402. COMPUTATIONAL HYDRAULICS. (4 cr; prereq 5401, CSci 3101 or #, IT or grad student)
Computer applications and numerical methods in hydraulic engineering. Computational analysis of water surface profiles in open channel and river flow; bridge waterways; culverts, pipe system; flow in sewer systems; reservoir routing. Numerical interpolation and integration.

5403. HYDRAULIC STRUCTURES. (4 cr; prereq 5401 or #, IT or grad student; offered alt yrs) Stefan
Hydraulic design procedures for such structures as culverts, dams, spillways, outlet works; river control works; drop structures, water intakes, bridge crossings, pipeline crossings.

5405. HYDROLOGY AND HYDROLOGIC DESIGN. (4 cr; prereq 5401 or #, IT or grad student)
Hydrologic cycle, precipitation, evaporation, infiltration, runoff analysis, flood routing, statistical procedures in hydrology, urban hydrology, introduction to mathematical models of medium and large watersheds, application of hydrology to design of outlet works and flow control structures.

Graduate Programs

5410. OPEN CHANNEL HYDRAULICS. (4 cr; prereq 3400, 5401 or #, IT or grad student)

Mechanics of flow in open channels including gradually varied, spatially varied, and rapidly varied flow; unsteady flow (waves and surges); and flow in alluvial channels.

5425. GROUNDWATER MECHANICS. (4 cr; prereq 3400 or #, IT or grad student) Strack

Basic equations. Horizontal confined, unconfined, and interface flow. Flow from rivers and lakes toward wells. Systems of interconnected aquifers. Leaky flow. Modeling of aquifers by use of boundary integral equation techniques. Non-steady flow. Application of finite element methods. Explicit finite difference methods.

5435. INTERMEDIATE FLUID MECHANICS WITH APPLICATIONS. (4 cr; prereq 3400, IT or grad student)

Basic laws and equations of mass, energy, and momentum transport in fluid flow; exact and approximate solutions; viscous flow; irrotational flow; similitude and inspectional analysis. Application to engineering problems.

8401. INTRODUCTION TO ENVIRONMENTAL BOUNDARY LAYER THEORY. (4 cr; prereq 5435 or #)

Laminar and turbulent boundary layers and their interaction with potential flow. Application to engineering problems.

8402. INTRODUCTION TO THE THEORY AND MEASUREMENT OF TURBULENT FLOWS. (4 cr; prereq 8401 or #)

Free-turbulence shear flows, dimensional analysis; statistical description of turbulence; random data analysis, measurement in transient flows.

8407. STOCHASTIC HYDROLOGY. (4 cr; prereq Stat 5021 or #) Foufoula-Georgiou

Analysis and synthesis of hydrologic series and systems; derived distributions; flood frequency analysis; hydrologic time series; correlation and spectral analysis; reservoir range analysis; linear analysis; linear estimation; geostatistics; sampling networks; and real-time hydrologic forecasting.

8408. SPECIAL TOPICS IN HYDROLOGY. (4 cr; prereq 8407) Foufoula-Georgiou

Dynamical systems theory, systems approach in hydrology, state-space representation of hydrologic systems, optimal control and estimation, Kalman filtering; scaling processes in hydrology, multiresolution and space-scale analysis.

8413.* MECHANICS OF SEDIMENT TRANSPORT. (3 cr; prereq 5410 or #) Parker

Theories of sediment transport. Transport processes and types of movement. Interrelationship of sediment transport, channel geometry, and channel stability in alluvial streams. Applications to river regulation, artificial channels, local scour, deposition in reservoirs, beach processes, other areas.

8415. HYDROPOWER DEVELOPMENT. (3 cr; prereq 5405)

Stream flow and water power estimates. Storage problems. Analysis, design, and selection of water power structures and equipment. Types and purposes of dams. Turbine analysis. Transmission lines. Cost and value of water power. Typical problems, inspection trips.

8418. COMPUTATIONAL HYDRODYNAMICS I. (4 cr; prereq 5401 or #) Song

Theory and applications of finite difference methods to solving unsteady one-dimensional flow problems.

8419. COMPUTATIONAL HYDRODYNAMICS II. (4 cr; prereq 8418 or #) Song

Computer simulation of 1-, 2-, and 3-dimensional flows of incompressible and weakly compressible fluids with and without free-surface. Basic principles of governing equations, finite difference, and other numerical schemes, and their application to hydraulic and water resources engineering problems.

8425. ADVANCED GROUNDWATER MECHANICS I. (4 cr; prereq 5425 or #) Strack

Solute transport. Shallow flow in leaky aquifers. Complex variable methods in groundwater flow. Analytic element-method: potentials for line sinks, line doublets, line dipoles, area sinks, and special analytic elements. Singular Cauchy integrals. Analytic elements in domains with closed boundaries.

8426. ADVANCED GROUNDWATER MECHANICS II. (4 cr; prereq 5425 or #) Strack

Applying complex variable methods, including conformal mapping, in groundwater mechanics. Solving problems with free boundaries using hodograph method. Drains in aquifers with free boundary; superposition of solutions with drains. Singular Cauchy integrals. Boundary elements.

8430. LAKE AND RESERVOIR HYDRODYNAMICS. (3 cr; prereq #) Stefan

Overview of hydrodynamic phenomena; analysis of density stratification; energy and momentum transfer through a water surface; wind effects of stratification and circulation; standing or progressive waves; stratified flow; density currents; selective withdrawal; mixing.

8435. SPECIAL TOPICS IN HYDRODYNAMIC THEORY. (3 cr; prereq #)

Linearized theory, wave motion, cavity and separated flow, and other topics to meet special requirements of students.

8440. FLOW EFFECTS ON STRUCTURES. (4 cr; prereq 5435 or #) Farell

Flow around bluff bodies. Hydroelastic (aeroelastic) phenomena; vortex-induced vibrations, lock in, galloping, flutter. Vibrations induced by oscillating flows and turbulence. Analytical and experimental modeling. Wind loads on buildings, forces on hydraulic structures, and propulsion devices. Wave forces on submerged structures, piles, walls, floating bodies.

Environmental Engineering**5500. ANALYSIS AND DESIGN OF WATER SUPPLY SYSTEMS.** (4 cr; prereq 3400 or #, IT or grad student)

Planning and engineering design considerations in developing water supply systems for urban centers. Supply quality, storage, treatment, distribution, and cost analysis.

5501. ANALYSIS AND DESIGN OF WASTEWATER SYSTEMS. (4 cr; prereq Chem 1005, 3400 or #, IT or grad student)

Planning and engineering design considerations in developing wastewater disposal systems for urban centers. Volumes and quality of waste streams, treatment and ultimate disposal of domestic and industrial wastewaters, storm water run-off. Environmental effects, cost, and political aspects of ultimate disposal.

5505. WATER QUALITY ENGINEERING. (4 cr; prereq Chem 1005, #, IT upper div)

Chemical/physical/biological properties of natural waters; elemental cycles of C, N, S, O, P; impact of industrial/municipal discharges on receiving waters; transfer/transport processes in rivers and lakes; groundwater pollution problems.

5506. ENVIRONMENTAL WATER CHEMISTRY.

(4 cr; prereq Chem 1006 or #, IT or grad student) Description of composition of natural waters and wastewater; chemical processes affecting distribution of pollutants and water quality parameters in natural waters; methods of evaluation to determine fate of organic pollutants.

5510. SOLID AND HAZARDOUS WASTE MANAGEMENT. (4 cr)

Analysis and design of engineered systems for collection, transportation, processing, and disposal of solid and hazardous waste materials. Waste characteristics affecting management options, discussion of relevant regulatory legislation.

5515. WATER AND WASTEWATER MICROBIOLOGY. (4 cr; prereq Math 1221, Math 1222, Math 1231, Chem 1004, Chem 1005)

Role of microbes in environmental degradation and pollution control. Organism growth and selection in wastewater treatment systems. Pathogenic organisms in water supplies. System control using microbial based indicators.

5540. ANALYSIS OF GROUNDWATER-SOIL POLLUTION ABATEMENT TECHNOLOGY. (4 cr; prereq IT major or grad student, 5401, 5501 or #)

Fate of chemicals in groundwater and soils analyzed and modeled. Combined effects of chemical-biological transformation, transport, dispersion, and accumulation. Models for studying in situ clean-up of groundwater and aquifers and for simulating time-dependent changes in pollutant concentration.

8500.* PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT. (3 cr; prereq 5500, 5501 or #)

Theoretical principles underlying physical and chemical processes for water and wastewater treatment including sedimentation, flotation, adsorption, precipitation, and disinfection.

8501.* PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT—PART II. (3 cr; prereq 5500, 5501, 5506 or #)

Theoretical principles, design considerations, and performance of processes not covered in CE 8500. Coagulation flocculation, filtration, membrane processes, gas transfer, sludge dewatering, mixing, and other processes commonly used in water pollution control.

8502.* BIOLOGICAL AND CHEMICAL PROCESSES FOR WASTEWATER TREATMENT. (3 cr; prereq 5501 or #)

Theoretical principles underlying chemical and biological wastewater treatment processes including aerobic and anaerobic biological processes for carbon and nitrogen removal, aeration, and chemical processes for phosphorus and nitrogen removal.

8505.* AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS. (4 cr; prereq Chem 5506 or #)

Application of principles of physical chemistry to quantification of chemical processes in aquatic systems. Natural waters as equilibrium and dynamic systems. Ionic equilibria; protolysis, complexation, solubility, and redox equilibria. Precipitation and mineral dissolution kinetics. Aqueous metal species in electrolyte solutions.

8507s. ENVIRONMENTAL PROCESSING OF ORGANIC CHEMICALS. (3 cr; prereq grad student, 5506 or #; offered alt yrs)

Occurrence, composition, and reactions of organic matter in surface- and groundwaters. Physical-chemical properties of organic contaminants; solubility; activity of organic chemicals in water. Processes controlling organic contaminant fate in natural waters. Environmental processing of organic chemicals in atmosphere, hydrosphere, sediments, and groundwaters case studies.

8540. INTERFACIAL MASS TRANSFER WITH ENVIRONMENTAL APPLICATIONS. (4 cr; prereq 5504 or #) Gulliver

Principles of interfacial mass transfer in laminar and turbulent flows. Applications to aeration devices, toxic transport, pollution remediation, etc. Techniques for measuring and scaling interfacial mass transfer.

Graduate Programs

8550. ANALYSIS AND MODELING OF AQUATIC ENVIRONMENTS.

(4 cr; prereq #) Stefan
Introduction to hydrologic transport and water quality simulation in natural water systems. Mixed cell models, advection, turbulent diffusion and dispersion in one- and two-dimensional systems. Chemical and biological kinetics in water quality models. Applications to temperature, dissolved oxygen, primary productivity, and other water quality management problems in rivers, lakes, and reservoirs. Deterministic versus stochastic models. Water quality dynamics.

8551. SEMINAR: MODELS OF AQUATIC ENVIRONMENTS.

(1-5 cr; prereq 8550) Stefan
Case studies of specific aquatic streams and lake systems.

Structural Engineering, Soil and Rock Mechanics, Construction Materials

5301. FOUNDATION ENGINEERING.

(4 cr; prereq 3300, 3301, IT upper div or grad student)
Settlement analysis; retaining walls and earth pressure theories; stability of slopes; bearing capacity of shallow foundations; deep foundations.

5304. DESIGN OF HIGHWAY AND AIRPORT PAVEMENTS.

(4 cr; prereq 3300, 3700, IT or grad student)
Theories of pavement design, flexible and rigid; equivalent wheel loads. Strength tests and frost action. Design procedures for flexible and rigid pavements.

5600. LINEAR STRUCTURAL SYSTEMS. (4 cr; prereq AEM 1015, 3016, IT or grad student) Staff
Analysis of determinate and indeterminate linear structural systems: analysis of trusses and frames by virtual work, moment distribution, energy methods, and slope-deflection equations. Influence lines. Approximate methods of analysis. Design considerations.

5601. MATRIX ANALYSIS OF STRUCTURES. (4 cr; prereq 5600, IT or grad student) Leon, Stolarski
Analysis of linear structural systems by matrix methods; stiffness and flexibility methods of analysis. Introduction to computerized structural analysis of trusses and frames.

5602. TOPICS IN STRUCTURAL MECHANICS.

(4 cr; prereq 5600, AEM 3036, IT upper div or grad student) Shield
Introduction to theory of elasticity; theory of vibration for single-degree-of-freedom structures; energy methods of approximate structural analysis; torsion of beams; numerical calculation of buckling loads of bars and plates.

5603. INTRODUCTION TO CONSTRUCTION MATERIALS.

(4 cr; prereq upper div IT student, AEM 3016; 3 lab hrs per wk) Cerny, Leon
Basic concepts of behavior mechanisms of materials. Characteristics of materials such as concretes, metals, and woods.

5610. DESIGN OF METAL STRUCTURES:

INTRODUCTION. (4 cr; prereq 5600, 5603 or ¶5603, upper div IT or grad student) Connors, Galambos, Leon, Shield

Loads on civil structures, load factor and working stress philosophies of design. Design of tension, compression, and flexural members and their connections. Codes, properties of structural metals.

5611. DESIGN OF REINFORCED CONCRETE STRUCTURES.

(4 cr; prereq 5600, 5603 or ¶5603, upper div IT or grad student) Cerny, Connors, French
Principles of strength and serviceability in reinforced concrete structural design. Strength analysis, design of beams, joists, one-way slabs for flexure and shear. Anchorage development, splicing of reinforcement. Stresses at service, deflections, cracking, long-term effects. Introduction to design of columns; continuity; simple footings.

5612. DESIGN OF METAL STRUCTURES:

INTERMEDIATE. (4 cr; prereq 5610, IT or grad student) Galambos, Leon
Design of complete metal structures; plate girder bridges, industrial buildings, multistory structural frames.

5613. INTERMEDIATE REINFORCED

CONCRETE DESIGN. (4 cr; prereq 5611, IT or grad student) Cerny, French
Eccentrically loaded columns. Shear friction; design of brackets. Deep beam design. Continuous beams and frames. Combined and continuous footings. Retaining walls. Combination of shear and torsion. Two-way slabs.

5615. PRESTRESSED CONCRETE. (4 cr; prereq 5611; 5613 recommended, IT or grad student; offered alt yrs) Cerny, French, Leon

Types and properties of high-strength concretes and steels for prestressed concretes. Design of pretensioned and posttensioned members. Posttensioning systems. Precast, prestressed building systems, floors, roofs, bridges. Continuity in precast, prestressed systems. Design of connections.

5617. DESIGN OF MASONRY STRUCTURES. (4 cr; prereq 5600 or #, IT or grad student; offered alt yrs) Cerny

Masonry materials and their production; mortars and grouts; design of nonreinforced and reinforced masonry structural systems; walls; columns; lintels; arches. Codes and specification, testing and inspection.

5701. CEMENTED MATERIALS: PROPERTIES, EVALUATION, AND MIXTURE DESIGN.

(4 cr; prereq 5603, IT upper div or grad student; 3 lect and 3 lab hrs per wk) Newcomb
Characteristics and performance evaluation concepts of construction materials, properties and design of cemented mixtures such as concrete, bituminous mixtures, stabilized soils and rocks.

8302. SOIL/ROCK PLASTICITY AND LIMIT ANALYSIS. (4 cr, §GeoE 8302; prereq 3300; offered alt yrs)

Plasticity of soils and rocks. Hardening and perfectly plastic models. Yield conditions, flow rules. Theorems of limit analysis. Static solutions, method of characteristics. Kinematic solutions, hodograph, energy balance. Applications to soil/rock engineering problems.

8321. MECHANICS OF GRANULAR MEDIA. (4 cr; prereq 5301 or 5302 or #; offered alt yrs)

Advanced constitutive models for granular media; simple hardening and double hardening plastic models. Bifurcation analysis; localized and diffuse bifurcation. Experimental methods for validation of constitutive models.

8322. STORAGE AND FLOW OF GRANULAR MATERIALS. (4 cr; prereq 5301 or 5302 or #; offered alt yrs)

Plasticity of granular media; static and dynamic method of slices; storage and flow of granular materials in bins and hoppers; stress concentrations, rarefaction waves, arching, piping.

8360. ENGINEERING MODEL FITTING. (4 cr; prereq civil or geo or mineral engr grad student or #) Barnes

Parameter estimating and inverse modeling in civil, geological, and mineral engineering. Formulating engineering model fitting problems, comparing and selecting various fit criteria, selecting and implementing solution algorithms on computer, analyzing and interpreting results, and designing future measurement plans.

8605. THE FINITE ELEMENT METHOD IN CIVIL ENGINEERING. (4 cr; prereq 5601 or #) Stolarski

Theoretical foundations for formulation of finite element representation in structural analysis. Methods for the construction of element and system stiffness matrices. Applications to static problems of linear elastic structures and solids. Some applications to soil and fluid mechanics.

8606. ADVANCED TOPICS IN FINITE ELEMENT ANALYSIS. (4 cr; prereq 8605 or #; offered alt yrs) Stolarski

Large strains and work conjugate stresses; equilibrium and principle of virtual work for nonlinear problems; nonlinear elasticity and plasticity; finite element discretization and discrete nonlinear equations; linearization and solution algorithms for nonlinear problems; structural stability.

8608. ADVANCED THEORY OF STRUCTURES. (4 cr; prereq #; offered when feasible) Hajjar

8609. PRINCIPLES OF STRUCTURAL STABILITY. (4 cr; prereq #; offered alt yrs) Galambos
Classification of discrete and continuous conservative and nonconservative systems; buckling analysis of structural members, frameworks, plates, etc., by classical and numerical methods.

8610. SHELL STRUCTURES. (4 cr; prereq #; offered alt yrs) French, Shield, Stolarski
Static analysis of thin elastic shells based on Love's postulates; membrane and bending resistance; approximate analytical solutions; higher order theories; design considerations.

8611. PLATE STRUCTURES. (4 cr; prereq #; offered alt yrs) French, Shield, Stolarski
Analysis and design of flat plate structures based on the small-deflection elastic Kirchhoff-Love theory. Classical and numerical design methods. Skew and orthotropic plate structures. Large-deflection theory.

8612. PLASTIC DESIGN OF STEEL STRUCTURES. (4 cr; prereq 5610 or #; offered alt yrs) Galambos, Leon
Plastic analysis and design of structures with applications to grillages, continuous beams, portal and gable frames, collapse mechanisms, minimum weight design, plastic deformations.

8616. NONLINEAR STRUCTURAL SYSTEMS. (4 cr; prereq 5610 or #; offered alt yrs) Galambos
Modern analysis of structural members and systems taking into account geometrical and material sources of nonlinearity. Second-order analysis of simple structures. Inelastic buckling. Emphasis on design considerations.

8618. RELIABILITY IN STRUCTURAL ENGINEERING. (4 cr; prereq 5612, 5613 or equiv) Galambos
Structural design standards and methods, uncertainties in structural design, basic probabilities concepts and statistical distributions, resistance and load statistics, first- and second-order reliability methods, systems reliability, development of probability-based design codes.

8620. STRUCTURAL DYNAMICS I. (4 cr; prereq AEM 3036 or #) French, Galambos, Shield, Stolarski
Response of lumped parameter systems to dynamic loading; formulation and solution of problems of one or more degrees of freedom for discrete systems, modal analysis, numerical integration, and transform techniques. Response of continuous systems.

8621. STRUCTURAL DYNAMICS II. (4 cr; prereq 8620 or #) French, Leon
Introduction to earthquake engineering; response spectra; energy absorption capacity of structures; estimation of damping; aseismic design; seismic codes; soil-structure interaction. Wind effects on structures. Blast resistant design. Approximate design methods.

8625. BEHAVIOR OF REINFORCED CONCRETE STRUCTURES. (4 cr; prereq 5611, 5613, 5615) French, Leon
Advanced topics in behavior of reinforced concrete structures, relationship with element design. Code requirements, reasons behind theoretical and experimental studies for understanding structural behavior and applications to design.

8690. STRUCTURES: SPECIAL TOPICS. (4 cr; prereq #)
Syllabus varies according to faculty interests. Topics include structural reliability, bridge design, optimization.

Graduate Programs

8697-8698-8699. SEMINAR: STRUCTURES. (1 cr per qtr)

Syllabus varies according to interests of instructor and student; in recent years the following topics have been offered: theory of elasticity, optimization and reliability, wave propagation, soil dynamics, structural lab, wind forces on structures, design in prestressed concrete, modern construction practices.

Classical and Near Eastern Studies

Regents' Professor: Rutherford Aris

Professor: Elizabeth S. Belfiore; Thomas S. Clayton; Frederick Cooper; Gerald M. Erickson; Jackson Hershbell; Thomas Kelly; Eva Keuls; Sheila McNally; Robert P. Sonkowsky; Theofanis Stavrou; Tzvee Zahavy

Adjunct Professor: William D. E. Coulson

Associate Professor: Philip H. Sellew, *director of graduate studies;* Nita Krevans; Jonathan S. Paradise; Sandra L. Peterson; George A. Sheets

Assistant Professor: Joseph D. Alcherms; Joan Fagerlie; Oliver P. Nicholson

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—Classics¹, Greek, Latin, and Ancient and Medieval Art and Archaeology: M.A. (Plan B and, in exceptional cases only, Plan A) and Ph.D.

Curriculum—In addition to Classical Greek and Latin literary studies, flexible degree programs under the Greek and Latin rubrics permit minors or supporting programs in other disciplinary areas such as archaeology, linguistics, modern Greek and Hellenic studies, Medieval and Renaissance Latin, myth and folklore, oral performance, philosophy, and religious studies. The art and archaeology degree includes a variety of programs ranging broadly over ancient and medieval (including Byzantine) periods, with flexible emphases on languages and textual studies. While full faculty participation from a wide variety of fields provides differing coursework, all students take a common core of courses to promote

optimum collegiality and intellectual exchange. Related special facilities include Interdisciplinary Archaeological Studies, the Center for Medieval Studies, the Center for Modern Greek Studies, and the Humanities Computer Lab.

Prerequisites for Admission—Prerequisites for unqualified admission to majors in Classics, Greek, and Latin include sufficient knowledge to begin graduate reading courses in at least one of the two Classical languages and at least intermediate ability in the other. For a major in Ancient and Medieval Art and Archaeology, a background in archaeology, art history, and history sufficient for beginning graduate-level studies, and evidence of language acquisition ability, are required for unqualified admission. Ability, motivation, imagination, and creativity are important criteria. Some course prerequisites can be made up on provisional admission.

Applications from students with undergraduate majors in such fields as the following are welcomed: English, history, Greek and Latin, Near Eastern languages, philosophy, comparative literature, anthropology, theatre, religious studies, art history, political science, the modern languages, and linguistics.

Special Application Requirements—Applicants must send the following directly to the Department of Classical and Near Eastern Studies: results of the Graduate Record Examination; three letters of recommendation from persons well acquainted with their academic work and professional experience; and a two-page statement describing their previous experience and academic training as related to the intended course of study and professional goals. Students may be admitted in any academic term, but financial assistance is normally available only to applicants admitted in the fall quarter (deadline: January 15).

Master's Degree Requirements—There are four degree programs:

M.A. in Greek: Advanced courses and seminars in Greek literature and supporting

¹ For degree purposes, "Classics" indicates a program in which courses in Greek and Latin are combined to form a major. This use of the term should not be confused with the course designation "Classics (Clas)," which indicates courses that do not require knowledge of Greek or Latin.

work in related fields such as Latin, Modern Greek, myth, Near Eastern language, and religion are required.

M.A. in Latin: Advanced courses and seminars in Latin literature and supporting work in related fields such as Greek, English, and Medieval and Renaissance Latin are required.

M.A. in Classics: This program requires nearly equal emphasis on courses and seminars in Greek and Latin, as well as in related fields.

M.A. in Ancient and Medieval Art and Archaeology: This program includes not only core courses and seminars in the Department of Classical and Near Eastern Studies, but also work in related fields in the Department or other departments. It is offered in cooperation with the Department of Art History, Interdisciplinary Archaeological Studies, and the Center for Medieval Studies.

The final examinations for all master's degrees are both written and oral. Consult the department's *Graduate Student Handbook* for details.

Doctoral Degree Requirements—Although the M.A. degree is not a prerequisite for admission to the Ph.D. program, doctoral students must complete departmental M.A. course requirements or their equivalent and incorporate them into their Ph.D. programs. In the Classics, Greek, and Latin programs, additional work leads to specialized study and research in Greek and Latin literature, a special (elective) author or genre, and a special (elective) topic or subdiscipline. In the Ancient and Medieval Art and Archaeology program, the four foci are art and archaeology, an ancient textual component, a complementary area (e.g., ancient and medieval history, geology, anthropology), and a special (elective) topic.

Modern Language Requirements—For the M.A. degree, reading knowledge of one modern foreign language appropriate to the student's program is required (normally German or French). For the Ph.D. degree, reading knowledge of German and one other

modern foreign language appropriate to the program (normally French) is required.

For Further Information and Applications—Contact the Department of Classical and Near Eastern Studies, University of Minnesota, 330 Folwell Hall, 9 Pleasant Street S.E., Minneapolis, MN 55455 (612/625-5353).

Clas 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Clas 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Clas 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Grk 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Grk 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Grk 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Lat 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Lat 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Lat 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

CLASSICAL LANGUAGES, LITERATURES, AND CULTURES

Greek (Grk)

5012. PROSE COMPOSITION. (4 cr; prereq 3106 or Δ) Keuls

5032. TEXTUAL CRITICISM. (4 cr)
Theory and practice. Basic tools for analyzing a textual apparatus with some independence; constructing a critical edition of Greek or Latin literary text.

5121. BIBLICAL AND PATRISTIC GREEK. (4 cr; prereq 3106 or 3120 or Δ) Sellw
The Septuagint, Philo, Josephus, New Testament, Apostolic Fathers, and other patristic literature. Reading and discussion of selected texts in the major genres to the fifth century A.D.

5310, 5320, 5330, 5340, 5350, 5360, 5370, 5380, 5390. GREEK LITERATURE. (4 cr per qtr [max 12 cr in each course])

One or more appropriate authors studied in a given course. Authors vary from term to term and from year to year. *5310:* oratory. *5320:* tragedy. *5330:* comedy. *5340:* history. *5350:* philosophy. *5360:* religious texts. *5370:* epic. *5380:* lyric. *5390:* romance.

Graduate Programs

5715. INTRODUCTION TO CLASSICAL PHILOLOGY. (4 cr, §Lat 5715) Sheets
Historical grammar of Greek and Latin from their Indo-European origin to Classical norms.

5716. HISTORY OF GREEK. (4 cr; prereq Grk/Lat 5715 or equiv, 2 yrs Greek) Sheets
Reading and analysis of documents illustrating the evolution of the Greek language from Mycenaean to modern times.

5718. GREEK DIALECTS. (4 cr; prereq 3 yrs Greek or #) Sheets
Nature and extent of dialectal variation within ancient Greek through reading and analysis of inscriptions and earlier Greek literature.

5810. BYZANTINE TEXTS. (4 cr per qtr [max 12 cr]; prereq 2 yrs Classical Greek or #; offered when feasible) Alchemes

5970. DIRECTED STUDY. (1-5 cr; prereq #, Δ, CLA approved)

5980. DIRECTED TEACHING. (Cr ar; prereq #, Δ, CLA approval)

5990. DIRECTED RESEARCH. (Cr ar; prereq #, Δ, CLA approval)

8120. GREEK TEXT COURSE. (4 cr; prereq 3052 or Δ; restricted to students in depts other than Classical and Nr East Sts)
Students attend 3xxx Greek courses if they meet the prerequisites for these courses. Supplementary work at the discretion of the instructor.

8264. SURVEY OF GREEK LITERATURE: ARCHAIC. (4 cr)

8265. SURVEY OF GREEK LITERATURE: LITERATURE OF THE FIFTH CENTURY. (4 cr)

8266. SURVEY OF GREEK LITERATURE: LITERATURE OF THE FOURTH AND THIRD CENTURIES. (4 cr)

8510. SEMINAR: PHILOSOPHY. (4 cr; offered when feasible) Hershbell

8910. SEMINAR. (4 cr)
Seminars on various topics or authors, such as Greek lyric poetry, Greek tragedy, Greek rhetoric, Greek comedy, Homer, Pindar, and Euripides.

Latin (Lat)

5012. PROSE COMPOSITION. (4 cr; prereq 3106 or Δ) Keuls

5032. TEXTUAL CRITICISM. (4 cr)
Theory and practice. Basic tools for analyzing a textual apparatus with some independence; constructing a critical edition of Greek or Latin literary text.

5310, 5320, 5330, 5340, 5350, 5360, 5370, 5380, 5390. LATIN LITERATURE. (4 cr per qtr [max 12 cr in each course])

One or more appropriate authors studied in each course. Authors vary from term to term and from year to year. 5310: history. 5320: epistles and essays. 5330: oratory. 5340: epic and pastoral. 5350: lyric and elegiac poetry. 5360: drama. 5370: satire. 5380: law. 5390: religious texts.

5410. LATIN LITERATURE OF LATE ANTIQUITY. (4 cr [max 12 cr]) Nicholson, Sonkowsky
Pagan and Christian Latin literature from 3rd to 8th centuries.

5420. MEDIEVAL LATIN. (4 cr [max 12 cr]) Nicholson, Sonkowsky
Literature from 6th to 15th centuries. Authors and genres vary.

5430 (formerly 5236). RENAISSANCE LATIN. (4 cr [max 12 cr]) Nicholson, Sonkowsky
Literature after 14th century.

5621. LATIN PALEOGRAPHY. (4 cr; prereq 3 cr 3xxx-5xxx Latin or #) Aris
Analysis of various hands used in manuscripts of Latin authors with attention to date and provenance; transmission of ancient Latin literature.

5715. INTRODUCTION TO CLASSICAL PHILOLOGY. (4 cr, §Grk 5715) Sheets
Historical grammar of Greek and Latin from their Indo-European origin to Classical norms.

5717. HISTORY OF LATIN. (4 cr; prereq Grk/Lat 5715 or equiv or #, 2 yrs Latin) Sheets
Reading and analysis of documents illustrating the evolution of the Latin language from its origins to late antiquity.

5735. ITALIC DIALECTS. (4 cr; prereq Grk/Lat 5715 or #; offered when feasible) Sheets

5970. DIRECTED STUDY. (1-5 cr; prereq #, Δ, CLA approval)

5980. DIRECTED INSTRUCTION. (Cr ar; prereq #, Δ, CLA approval)

5990. DIRECTED RESEARCH. (Cr ar; prereq #, Δ, CLA approval)

8120. LATIN TEXT COURSE. (4 cr; prereq 3052 or Δ; restricted to students in depts other than Classical and Nr East Sts)
Students attend 3xxx Latin courses if they meet the prerequisites for these courses. Supplementary work at the discretion of the instructor.

8150. MEDIEVAL LATIN TEXTS. (4 cr; prereq #; offered when feasible) Nicholson, Sonkowsky

8160. RENAISSANCE LATIN TEXTS. (4 cr; prereq #; offered when feasible) Nicholson, Sonkowsky

8264. GRADUATE SURVEY: LITERATURE OF THE REPUBLIC. (4 cr)

8265. GRADUATE SURVEY: LITERATURE OF THE AUGUSTAN AGE. (4 cr)

8266. GRADUATE SURVEY: LITERATURE OF THE EMPIRE. (4 cr)

8910. SEMINAR. (4 cr)

Various topics or authors such as Roman drama, Cicero, Lucretius, odes and epodes of Horace, Ovid, and Juvenal.

Classics (Clas)

Courses for which knowledge of Latin or Greek is not required

Classical Humanities

5001. GREEK, ROMAN LYRIC POETRY IN TRANSLATION. (4 cr, §3001; prereq 2 courses in Engl lit beyond Engl 1002 or in foreign lit or Δ; offered when feasible)

5004. EROTICISM AND FAMILY LIFE IN THE GRECO-ROMAN WORLD. (4 cr; prereq soph; offered when feasible) Erickson

5007. THE PASTORAL TRADITION. (4 cr; prereq 2 lit courses or #) Krevans
Origins and development of pastoral poetry and prose. Readings in English translation from Greek and Latin pastoral poets, and vernacular imitations of the Middle Ages and Renaissance. Nature of allegory, "debate poems," *pastourelle*, pastoral genre.

5011su. THE WORLD OF GREECE. (4 cr, §3011)
Survey of Greek civilization from Homer to Alexander. Way of life as seen in art, history, literature, and philosophy. Special attention to golden age in fifth century B.C. and to expansion of Greek presence under Alexander.

5012su. THE WORLD OF ROME. (4 cr, §3012)
Survey of Roman civilization from origins to Constantine. Way of life as seen in art, history, literature, and philosophy. Special attention to Etruscans and golden age under Augustus.

5013. ROMAN LAW AND SOCIETY. (4 cr) Sheets
Roman law as a social institution: basic concepts of persons, property, obligations in historical and social perspective.

5061. INTRODUCTION TO BYZANTINE CIVILIZATION. (4 cr, §1061) Alchermes
Greco-Roman backgrounds of Byzantine civilization. Culture of Eastern Empire through study of history, religion, education, art, literature in translation.

5071. GREEK AND HELLENISTIC RELIGIONS. (4 cr, §3071, §3071H, §ReIS 3071, §ReIS 5071) Sellow
Greek religion of the archaic, classical, and Hellenistic periods. Eclipse of city-state and "failure of nerve." Mystery religions and impact of Eastern cults. Ancient myths and need for allegory. Ruler worship. Gnosticism. Judaism in Greek world; Dead Sea scrolls. Meets with 3071; students do additional work for graduate credit.

5072. RELIGION IN ANTIQUITY: THE NEW TESTAMENT. (4 cr, §3072, §ReIS 3072, §ReIS 5072) Sellow

First-century Israel under Roman rule. Jesus of Nazareth. Earliest Christian communities. Mission to gentiles. Paul the apostle. Beginnings of New Testament. Meets with 3072; students do additional work for graduate credit.

5073. ROMAN RELIGION AND EARLY CHRISTIANITY. (4 cr, §3073, §ReIS 3073, §ReIS 5073; prereq #) Nicholson, Sellow

The Etruscans. Republican religion. Appeal of non-Roman cults. Ruler worship. Christians in Asia Minor, Egypt, and the West. Popular piety, Christian and non-Christian. Rabbinic Judaism. Varieties of Christianity in 2nd and 3rd centuries. Influence of Greco-Roman culture upon emerging church. Constantine and Julian. Meets with 3073; students do additional work for graduate credit.

5080. NEW TESTAMENT PROSEMINAR. (4 cr per qtr [max 12 cr]; prereq 3072 or 5072 or #) Sellow
Selected topics in study of the New Testament and related ancient literatures. Topics announced in the *Class Schedule*.

5081. CLASSICAL EPIC IN TRANSLATION. (4 cr, §3081)
Homer's *Iliad* and *Odyssey*, Virgil's *Aeneid*; cultural context of epic, the heroic character, epic formulas, and poetic techniques.

5082. GREEK TRAGEDY IN TRANSLATION. (4 cr, §3082)
Origin of European drama as distinct literary form; characteristics of Greek tragedy; ancient theatres and theatrical conventions. Selected tragedies. Problems posed in relation to cultural patterns of the time.

5085. GREEK PHILOSOPHY: THE PRE-SOCRATICS TO PLATO. (4 cr; prereq jr) Hershbell
Fragments of the pre-Socratics and Sophists and selected dialogues of Plato.

5090. TOPICS IN GREEK PHILOSOPHY. (4 cr; prereq #)
Selected topics in ancient Greek philosophy to be announced in the *Class Schedule*.

5145. GREEK AND ROMAN MYTHOLOGY II. (4 cr, §3145; prereq 1042 or #)
Methodologies for the interpretation of myth, such as those of Müller, Jung, and Levi-Strauss, examined on the basis of Classical mythology; successive reinterpretations and applications of selected myths in literature, art, music, and modern sociological disciplines. Independent reading and research assignments completed in consultation with instructor. Meets with 3145; students do additional work for graduate credit.

5794. PROSEMINAR: INTRODUCTION TO CLASSICAL AND NEAR EASTERN STUDIES. (1 cr; prereq grad major or #) Fagerlie
Introduction to core research materials in classical studies and reference tools that give access to them. Organization of library collections and services.

Graduate Programs

5950. CULTURAL ASPECTS OF CLASSICAL ANTIQUITY. (4 cr)

Art, archaeology, and social history of Greco-Roman antiquity.

5970. DIRECTED STUDY. (1-5 cr; prereq #, Δ, CLA approval)

5980. DIRECTED INSTRUCTION. (Cr ar; prereq #, Δ, CLA approval)

Spch 5611. CLASSICAL RHETORIC. (4 cr; prereq Spch 1101 or 1101H) Scott

Art and Archaeology

5089. INTRODUCTION TO BIBLICAL ARCHAEOLOGY. (4 cr, §RelS 5089; offered when feasible) Sellow

5102. CLASSICAL GREEK ART. (5 cr, §ArH 5102) McNally

Architecture, sculpture, and painting in Greece from Persian Wars to conquests of Alexander.

5104. ROMAN ARCHITECTURE. (5 cr, §ArH 5104; prereq jr or #) Cooper, McNally

Buildings in Rome and the empire from the 5th century B.C. to the 4th century A.D. Major archaeological sites.

5105. ROMAN PAINTING AND MOSAICS. (5 cr, §ArH 5105; prereq jr or #) McNally

Specific problems; sites such as Pompeii and Antioch.

5106. GREEK PAINTING. (5 cr, §ArH 5106; prereq jr or #)

Research and analysis in Classical art as applied to the study of vases, original objects, and sources.

5107. ROMAN SCULPTURE. (4 cr, §ArH 5107; prereq jr or #) McNally

Sculpture of Rome and its provinces from the 1st century B.C. to the 4th century A.D.; role of sculpture in Roman politics and religion.

5108. GREEK ARCHITECTURE. (4 cr, §ArH 5108; prereq jr or #) Cooper

Archaic and Classical examples of religious and secular architecture, their setting in major archaeological sites.

5111. BRONZE AGE ART AND ARCHITECTURE IN GREECE, CA. 3000-1100 B.C. (4 cr, §ArH 5111; prereq one ancient art or archaeology course) Cooper

Artistic and architectural forms in the Neolithic period in the Aegean area and the Cycladic, Minoan, and Mycenaean cultures.

5113. ARCHAIC GREEK ART. (4 cr, §ArH 5113; prereq jr or #) McNally

Architecture, sculpture, and painting from 9th century B.C. through 480 B.C. Material remains of Greek culture; scholarly problems such as identifying and dating buildings; analysis of methods and techniques.

5120. FIELD RESEARCH IN ARCHAEOLOGY. (3-6 cr; prereq #; offered when feasible)

5122. GREEK ART, ARCHITECTURE, AND ARCHAEOLOGY. (4 cr, §3122) McNally

Survey of Greek art from earliest times to 31 B.C. Main trends and concepts in architecture, sculpture, and painting; the art in its social, literary, and historical context.

5175. THE TOPOGRAPHY OF A MEDIEVAL CITY: CONSTANTINOPLE. (4 cr, §3175, §ArH 3175, §ArH 5175) Alchermes

Study of Constantinople, a world capital and imperial residence for more than a millenium. Original and translated texts and archaeological evidence used to reconstruct individual monuments and broader patterns of urban life and urban development from ca. 200 until Turkish conquest of 1453.

5252. HISTORY OF EARLY CHRISTIAN AND BYZANTINE ART. (4 cr, §ArH 5252) Alchermes

Architecture, sculpture, and painting in Eastern Christian regions from founding of Constantinople to its fall in 15th century. Emphasis on meaning and broader cultural context in which works of art were created.

5340. PRACTICUM IN ARCHAEOLOGICAL FIELD TECHNIQUES. (4 cr, §3340, §ClCv 3340;

prereq major in Grk or Lat or Clas or Hebr or ANE Studies or ClCv or #, 1 course in ancient art or archaeology) Cooper

Introduction to methods of excavation on classical sites. Meets at selected Minnesota site for day-long sessions for half of quarter. Arranged according to procedures in field: handling instruments, setting up field notebooks, preparing trenches, excavating, and recording and analyzing strata and artifacts.

8114. SEMINAR: THE TOPOGRAPHY OF ATHENS. (4 cr, §ArH 8114; prereq #)

8151. TOPOGRAPHY OF ANCIENT ROME. (4 cr) Alchermes

Layout of Rome at its urban peak about 300 A.D. General development patterns; concerns of developers and builders at key moments throughout Rome's history, from beginning of the Republic through Constantine's reign. Building and urban growth placed in their political, ideological, social, and art-historical contexts.

8190. SEMINAR: PROBLEMS IN ANCIENT ART. (4 cr [may be repeated for cr], §ArH 8190; prereq #)

8910. SEMINAR: PROBLEMS IN CLASSICAL ARCHAEOLOGY. (4 cr [may be repeated for cr], §ArH 8910; prereq #)

MODERN GREEK

Modern Greek (MdGk)

5970. DIRECTED STUDY. (1-5 cr; prereq #, Δ, CLA approval)

5980. DIRECTED TEACHING. (Cr ar; prereq #, Δ, CLA approval)

5990. DIRECTED RESEARCH. (Cr ar; prereq #, Δ, CLA approval)

NEAR EASTERN STUDIES

Akkadian (Akka)

5011-5012-5013. ELEMENTARY AKKADIAN. (4 cr per qtr; prereq advanced undergrad with permission or grad student; offered alt yrs)
Introduction to cuneiform script. Outline of Akkadian grammar, written drills, selected readings from historical annals, law collections, religion and epic literature.

Ancient Near Eastern (ANE)

5501, 5502. ANCIENT ISRAEL. (4 cr per qtr, §3501, 3502; prereq grad student or #; knowledge of Hebrew not required)
History of Israel and development of its religion, from earliest times through intertestamental period. *5501:* Formation of Hebrew people; patriarchal period; development of Israelite religious and legal institutions; conquest of Canaan; development of monarchy and United Kingdom. *5502:* Divided kingdom; classical prophecy, destruction, exile, and restoration.

5505. ANCIENT ISRAEL: THE HELLENISTIC PERIOD. (4 cr, §3505; prereq grad student or #; knowledge of Hebrew not required)
Period of Ezra and Nehemiah, Samaritans; apocalyptic and other eschatological types; Maccabean period; Sadducees, Pharisees, Zealots, Christians, Qumran, wisdom literature; Philo; Josephus; Jewish rights in Roman Empire. Emphasis on evaluation of sources for historical reliability.

5711. NORTHWEST SEMITIC INSCRIPTIONS. (4 cr; prereq Hebr 3013 or #; offered when feasible)

5970. DIRECTED STUDIES. (1-4 cr; prereq #)

Aramaic (Arm)

5011, 5012, 5013. ARAMAIC. (4 cr per qtr; for students preparing for biblical studies, ancient history majors, and students specializing in Semitic languages; recommended for students of Talmud; prereq 1 yr Hebrew or Arabic or #; offered alt yrs)
5011: Biblical Aramaic—fundamentals of grammar and fluency in reading of biblical and ancient Aramaic.
5012: Syriac—grammar, fluency of reading Syriac texts.
5013: Aramaic inscriptions—study of epigraphy, morphology, and syntax of old Aramaic inscriptions from the 9th to 5th centuries B.C.

Coptic (Copt)

5011-5012. ELEMENTARY COPTIC. (4 cr per qtr; prereq some knowledge of another ancient language, preferably Greek) Sellw
5011: Introduction to Coptic grammar and vocabulary (Sahidic dialect). *5012:* Further instruction in grammar, introduction to other dialects; first reading of texts.

5300. READINGS IN COPTIC. (4 cr [may be repeated twice for cr]; prereq 5012 or equiv) Sellw
Advanced reading in variety of Coptic literature, such as Nag Hammadi treatises, Hermetic writings, and Egyptian monastic texts. Authors vary each year.

Hebrew (Hebr)

5200. PROBLEMS IN BIBLICAL STUDIES. (4 cr per qtr; for majors and others adequately prepared to read the Bible in Hebrew; prereq 3202 or #; offered when feasible)

5970. DIRECTED READINGS. (Cr ar; prereq 3013, #, Δ, CLA approval)
Special problems for advanced students.

Sumerian (Sum)

5011-5012. ELEMENTARY SUMERIAN. (4 cr per qtr; prereq advanced undergrad with 2 yrs other foreign language or grad student; offered alt yrs)
Introduction to Sumerian writing and grammar. Readings from classical Sumerian literary and historical texts.

CLASSICAL AND INDO-IRANIAN LINGUISTICS

Grk 5715, 5716, 5718; Lat 5715, 5717, 5733, 5735
(For course descriptions see Greek and Latin under CLASSICAL LANGUAGES, LITERATURES, AND CULTURES above.)

See South Asian and Middle Eastern Languages and Cultures for descriptions of the following courses:

Per 5900. READINGS IN AN IRANIAN LANGUAGE

SALC 5090. INSTRUCTION IN SOUTH ASIAN LANGUAGES

Skt 5131-5132-5133. BEGINNING SANSKRIT

Skt 5161-5162-5163. ADVANCED SANSKRIT

Skt 5201-5202-5203. INTERMEDIATE SANSKRIT

Skt 5320. READINGS IN PHILOSOPHICAL TEXTS

Skt 5710. TOPICS IN SANSKRIT LANGUAGE AND LITERATURE

Skt 8990. RESEARCH

Representative courses of interest offered by Classical and Near Eastern Studies faculty through other departments:

Engl 5712; Hist 5061, 5062, 5063 (Ancient Greece); Hist 5276, 5756-5757 (Modern Greece); Phil 5005.

Graduate Programs

Classics

See Classical and Near Eastern Studies.

Clinical Laboratory Science (CLS)

Professor: Richard D. Brunning; Jaroslav Cervenka; Agustin P. Dalmaso; John H. Eckfeldt; J. Roger Edson; Stanley L. Erlandsen; Patricia Ferrieri; Alexandra H. Filipovich; Leonard Greenberg; John H. Kersey; Tucker W. LeBien; Patrick J. Manning; J. Jeffrey McCullough; Harry T. Orr; Herbert F. Polesky; Daniel A. Vallera

Associate Professor: Helen M. Hallgren, *director of graduate studies*; Fred S. Apple; Robert J. Boudreau; Douglas J. Christie; Karen Kani; R. Scott McIvor; Miriam Segall; William R. Swaim; Michael Y. Tsai; Carol L. Wells; Michael J. Wilson; Walid Yasmineh

Assistant Professor: Craig E. Litz; Karen G. Lofsness; Ronald C. McGlennen; Keith Willard

Senior Research Associate: Robert D. Nelson

Please read the *General Information* section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.S. (Plan A only).

Curriculum—Graduate work in clinical laboratory science offers students with basic science or medical technology backgrounds the opportunity to gain competence in a specialized area of laboratory medicine. It provides training in the research, supervisory, and teaching aspects of the field. Students pursue investigative work in one of six specialty areas: chemistry, genetics, hematology, immunohematology, immunology, and microbiology.

Prerequisites for Admission—A bachelor's degree in a basic science or in medical technology, including standard college courses in organic/inorganic chemistry, biochemistry, quantitative analysis, physics, and mathematics, is required. Previous laboratory experience is desirable.

Special Application Requirements—Applicants must forward to the Department of Laboratory Medicine and Pathology three letters of recommendation, an autobiographical outline that includes a statement of career goals, and scores from the General Test of the Graduate Record Examination. A minimum score of 550 on

the Test of English as a Foreign Language (TOEFL) is required for applicants whose native language is not English. Students may be admitted any quarter.

Degree Requirements—Students are encouraged to file their program after completing 9 to 15 graduate credits. At least 25 credits are required in the specialty area; at least 9 credits are required in a single supporting program, or 8 credits in related fields outside the major. Students must pass a final oral examination for defense of the thesis.

Language Requirement—None.

For Further Information and Applications—Contact the Clinical Laboratory Science Program, Department of Laboratory Medicine and Pathology, University of Minnesota Medical School, Box 198 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (612/625-9171).

CLS 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

5064s. INTRODUCTION TO CLINICAL IMMUNOHEMATOLOGY. (3 cr; prereq MicB 5235) Christie, Hallgren
Fundamental principles of blood grouping, antibody identification, compatibility testing, serology, and immunology. Lecture.

5065s. INTRODUCTION TO CLINICAL IMMUNOHEMATOLOGY: LABORATORY. (2 cr; prereq MicB 5235)
Exercises illustrating basic techniques in blood grouping, antibody identification, compatibility testing, and detection of antibodies by serological and immunological methods.

5077f. HEMATOLOGY I: BASIC TECHNIQUES. (3 cr, §MedT 5077; prereq Δ) Lofsness
Theory and application of basic principles and techniques in clinical hematology. Lecture and lab.

5078w. HEMATOLOGY II: HEMOSTASIS/ INSTRUMENTATION. (3 cr, §MedT 5078; prereq 5077 or MedT 5077, Δ)
Theory and application of basic principles and techniques. Lecture and lab.

5103f. PRINCIPLES OF DIAGNOSTIC MICROBIOLOGY. (5 cr, §MedT 5102; prereq MdBc 3103, 5232 or #) Wells

5112w. INTRODUCTION TO CLINICAL CHEMISTRY. (3 cr, §MedT 5112; prereq Chem 3100, Chem 3101, MdBc 5300, MdBc 5301, Phl 3051, MedT 5011, Δ)

Lecture course on basic concepts and techniques in clinical chemistry. Quality control; approaches to methods comparison; spectrophotometry, fluorometry, and chromatography techniques such as electrophoresis, ion exchange, and thin layer gas chromatography. Section on principles of automation includes work with Auto-analyzers.

5113s. PRINCIPLES OF CLINICAL CHEMISTRY. (3 cr, §MedT 5113; prereq 5112 or MedT 5112, Δ)

Lecture course on measurement and physiological relevance of various serum constituents. Electrolytes, proteins, enzymes, steroids, lipids, toxicology, and RIA.

5120. SEMINAR: CLINICAL LABORATORY SCIENCE. (1 cr [may be repeated for cr])

Review and discussion of current literature; presentation and discussion of research carried on in department.

5125. PRACTICUM TEACHING. (1-3 cr, §MedT 5125)

Supervised experience in teaching, development of skills in effective use of instructional materials, tests, and measurements.

5128. ELEMENTS OF LABORATORY ADMINISTRATION. (3 cr, §MedT 5128) Karni

Introduction to lab administration. Leadership styles, employee selection and evaluation, communications, motivation, morale, discipline, job descriptions, record keeping, budgets, cost accounting, purchasing, product evaluation, lab safety, labor relations, and government regulations.

5135. ADVANCED CLINICAL MICROBIOLOGY. (1-5 cr, §MedT 5135; prereq #)

Observation, study, and practice in special problems, advanced techniques, and methodology in clinical microbiology.

5140. TECHNIQUES FOR TEACHING. (3 cr, §MedT 5140) Karni

Development of objectives, classroom activities, and evaluation criteria for medical technology education.

5155. ADVANCED CLINICAL HEMATOLOGY. (5 cr [may be repeated for cr], §MedT 5155; prereq #)

Observation, study, and practice in special problems, advanced techniques, and methodology in clinical hematology.

5165. ADVANCED CLINICAL IMMUNOHEMATOLOGY. (5 cr [may be repeated for cr], §MedT 5165; prereq #)

Observation, study, and practice in special problems, advanced techniques, and methodology in clinical immunohematology.

5175. ADVANCED CLINICAL CHEMISTRY. (5 cr [may be repeated for cr], §MedT 5175; prereq #)

Observation, study, and practice in special problems, advanced techniques, and methodology in clinical chemistry.

5180f, w, s, su. ADVANCED CHEMISTRY. (1-5 cr; prereq #) Staff

5195f. INTRODUCTION TO COMPUTERS IN LABORATORY MEDICINE AND PATHOLOGY. (1-5 cr; prereq #) Connelly

Readings, discussions, seminars, and programming assignments to introduce students to current and anticipated uses of computers as part of health care delivery systems.

5196s. COMPUTER METHODOLOGY IN THE DELIVERY OF HEALTH CARE I: PHYSIOLOGICAL MONITORING AND TESTING. (3 cr, §HInf 5433; prereq HInf 5432 or #) Finkelstein

Role of the computer in monitoring and testing patients; hardware and software requirements for processing clinically significant signals; comparison and evaluation of currently available systems.

5197f. COMPUTER METHODOLOGY IN THE DELIVERY OF HEALTH CARE II: INTRODUCTION TO MEDICAL DECISION-MAKING TECHNIQUES. (3 cr, §HInf 5434; prereq HInf 5432, PubH 5452 or #) Connelly, Rich

Introduction to biometrical concepts and techniques used to support the medical decision-making process, including test efficacy, decision analysis, Bayes theorem, and multivariate analysis. Current studies of the medical problem-solving process, and computer-based medical decision support systems.

5198w. COMPUTER METHODOLOGY IN THE DELIVERY OF HEALTH CARE III: OPERATIONS RESEARCH AND CONTROL SYSTEMS FOR HOSPITALS. (3 cr, §HInf 5435; prereq HInf 5432 or #) Potthoff

Health information systems for inpatient, outpatient, and research use, including status of current systems, costs and benefits, and legal/ethical considerations. System 2000 and other database management systems for clinical research used for class problems.

5272f. IMMUNOHEMATOLOGY I: IMMUNOLOGY AND HEMATOLOGY IN IMMUNOHEMATOLOGY. (3 cr) Polesky

Immunology and HLA; principles of inheritance and molecular genetics; review hematopoiesis; structure, function, and disorders of red and white blood cells and platelets.

5273w. IMMUNOHEMATOLOGY II: BLOOD GROUP SYSTEMS. (3 cr) Polesky

Biochemistry, genetics, antigens, antibodies, serology, and clinical significance of blood group systems. Neutrophil and platelet antigens and antibodies. Parentage testing.

5274s. IMMUNOHEMATOLOGY III:

TRANSFUSION MEDICINE. (3 cr) Polesky
Donor selection, collection, processing; apheresis; component preparation; indications for use of blood components; transfusion in selected clinical conditions; transplantation and transfusion; hemolytic disease of the newborn and Rh immune globulin; transfusion reactions; transfusion transmitted viruses.

Graduate Programs

5280f, 5281w, 5282s. ADVANCED IMMUNO-HEMATOLOGY PRACTICUM I, II, III. (2 cr per qtr; prereq #)

Component preparation; collection and processing blood from donors; testing for transfusion transmitted viruses; HLA methods; parentage testing; advanced serological techniques and problem solving. Educational methods; exposure to management in blood center and transfusion service.

5346f. COMPUTER APPLICATIONS IN HEALTH CARE. (4 cr, §HInf 5430; prereq health professional or student in health care discipline) Finkelstein

Current applications of computers and associated provider roles in health care areas in hospitals and communities.

5765f. HEMATOLOGY. (4 cr; prereq #) Lofsness
Blood and blood forming organs; blood and bone marrow from the standpoint of diagnosis and prognosis.

5768f, w, s, su. ADVANCED HEMATOLOGY. (Cr ar; prereq #) Brunning

5864f, w, s. RESEARCH SEMINAR. (1 cr; prereq #) Staff

5865f, w, s. DEPARTMENTAL SEMINAR. (1 cr; prereq #) Staff

8105. PRINCIPLES OF DIAGNOSTIC ENZYMOLOGY. (3 cr; prereq 5101, 5102 or #; offered when feasible) Yasmineh

Enzymes of diagnostic interest; their biological and biochemical aspects, and their usefulness in understanding the etiology of disease and its diagnosis, treatment, and prevention.

8176. ADVANCED TOPICS IN CLINICAL CHEMISTRY. (3 cr; prereq #; offered when feasible)
Use of statistics, predictive value of tests, new concepts in methodology and automation, principles and advantages of kinetic and equilibrium assays.

8236f, w, s, su. RESEARCH ON CLINICAL LABORATORY PROBLEMS. (1-10 cr) Staff

8240. EDUCATIONAL ADMINISTRATION IN MEDICAL TECHNOLOGY. (3 cr; prereq #) Karni
Responsibilities of administration to students, faculty, and educational community. Topics include curriculum planning, accreditation, staffing, student selection, finances. Sample administrative problems and decisions used as practice vehicles.

Cognitive Science (CgSc)

Professor: Paul W. Fox (psychology); Jeanette K. Gundel (linguistics); Keith Gunderson (philosophy); Paul Johnson (information and decision sciences); Michael B. Kac (linguistics); Gordon E. Legge (psychology); Charles A. Nelson (child development); J. Bruce Overmier (psychology); Herbert L. Pick, Jr. (child development); C. Wade Savage (philosophy); Gerald M. Siegel (communication disorders); James R. Slagle (computer science); Albert Yonas (child development)

Associate Professor: Charles R. Fletcher (psychology), *director of graduate studies;* Patricia J. Bauer (child development); Maria L. Gini (computer science); Daniel J. Kersten (psychology); David S. Knopman (neurology); Mary Jo Nissen (psychology); Maria D. Sera (child development); Joseph P. Stemberger (linguistics); Paulus W. van den Broek (educational psychology)

Course of Study—Minor in cognitive science, applicable to master's (M.A. and M.S.) and doctoral programs.

Curriculum—Cognitive science is a field of inquiry at the interface of cognitive psychology, computer science, linguistics, neuroscience, and philosophy. Cognitive science is concerned with the acquisition, representation, and use of knowledge by humans and machines. The curriculum provides students with a broad foundation in psychological, philosophical, and computational approaches to the study of cognition.

Prerequisites for Admission—Admission to the cognitive science graduate minor is contingent upon prior admission to a master's or doctoral degree-granting program within the Graduate School. Admission to the minor program is limited and only by permission of the director of graduate studies in cognitive science. Applications for admission to the minor are due November 1; students are admitted effective winter quarter.

Minor Requirements—Students seeking to complete the cognitive science minor at either the M.A./M.S. or Ph.D. level are required to take those of the following core courses that are outside their major department: CgSci 8000, CSci 5511, and Psy 5015. In addition, CgSci 8001 (a three-quarter proseminar) is required for the Ph.D. minor. The minor program at the M.A./M.S. level requires a minimum of 12 graduate-level quarter credits; the minor at the Ph.D. level requires 21 credits. Additional credits beyond the required courses must be taken in courses selected from the list of elective courses. Credits from courses in the student's major department, however, do not count toward the minor.

Language Requirement—None specific to the minor program.

For Further Information and Applications—Contact Professor Charles R. Fletcher, Center for Research in Learning, Perception, and Cognition, University of Minnesota, 205 Elliott Hall, 75 East River Road, Minneapolis, MN 55455 (612/625-6096 or 612/625-9092).

Core Courses

CgSc 8000. PHILOSOPHY OF COGNITIVE SCIENCE. (4 cr; prereq #) Savage
Philosophical framework for analyzing cognitive sciences. Recent developments in metaphysics and epistemology. Nature of scientific theories, methodologies of cognitive sciences, relations among cognitive sciences, relation of cognitive science to epistemology and various philosophical problems.

CgSc 8001. PROSEMINAR IN COGNITIVE SCIENCE. (1 cr per qtr for 3 qtrs; prereq admission to cog sci grad minor) Fletcher
Survey of major topics in cognitive science, including theoretical assumptions, methods, and samples of current research.

CgSc 8360. SEMINAR: TOPICS IN COGNITIVE SCIENCE. (1-4 cr; prereq admission to cog sci grad minor or #)
Lectures and in-depth discussion.

CSci 5511. ARTIFICIAL INTELLIGENCE I. (4 cr; prereq 3322 or #; informal lab)

Psy 5015. COGNITIVE PROCESSES. (4 cr; prereq 3011 or 3051 or 5014 except for honors sequence students and grads)

Elective Courses—Cognition

Anth 5114. STRUCTURAL ANTHROPOLOGY

Anth 5132. SYMBOLIC ANTHROPOLOGY

CPsy 5343. COGNITIVE DEVELOPMENT

CPsy 8343. ADVANCED COGNITIVE DEVELOPMENT I

CPsy 8347. ADVANCED COGNITIVE DEVELOPMENT II

Psy 5014. PSYCHOLOGY OF HUMAN LEARNING AND MEMORY

Psy 8970. SEMINAR: SPECIAL AREAS OF PSYCHOLOGY AND RELATED SCIENCES
(Some of these seminars are acceptable for the minor, including the Seminar in Computer Models of Cognitive Processes and the Seminar in Cognitive Neuropsychology. Students should consult with the director of graduate studies in cognitive science to determine whether a particular seminar is acceptable.)

Elective Courses—Philosophy

Phil 5615. MINDS, BODIES, AND MACHINES

Phil 8180. SEMINAR: PHILOSOPHY OF LANGUAGE

Elective Courses—Perception

CPsy 5341. PERCEPTUAL DEVELOPMENT

CPsy 8341. ADVANCED PERCEPTUAL DEVELOPMENT

Psy 5031. PERCEPTION

Elective Courses—Language

Anth 5161. CULTURAL SEMANTICS

CPsy 5345. LANGUAGE DEVELOPMENT

CPsy 8345. ADVANCED LANGUAGE DEVELOPMENT

Ling 5001. INTRODUCTION TO LINGUISTICS

Ling 8820. TOPICS IN LANGUAGE AND COGNITION

Psy 5054. PSYCHOLOGY OF LANGUAGE

Psy 8056. SEMINAR: PSYCHOLOGY OF LANGUAGE

Elective Courses—Applications

CSci 5512. ARTIFICIAL INTELLIGENCE II
(Some of these seminars are acceptable for the minor. Students should consult with the director of graduate studies in cognitive science to determine whether a particular seminar is acceptable.)

Psy 5051. PSYCHOLOGY OF HUMAN-MACHINE INTERACTION

Psy 8201. SOCIAL COGNITION

Communication Disorders (CDIs)

Professor: Charles E. Speaks, chair; Patricia A. Broen, director of graduate studies; Robert H. Brookshire; Julia M. Davis; Robert H. Margolis; Richard R. Martin (on leave); Karlind T. Moller; David A. Nelson; Joe E. Reichle; Gerald M. Siegel; Clark D. Starr; Dianne J. Van Tasell

Associate Professor: Arlene E. Carney; Samuel K. Haroldson; Joseph P. Stemberger

Adjunct Associate Professor: David A. Preves

Assistant Professor: Timothy N. Doyle; Robert S. Schlauch; Jennifer A. Windsor

Visiting Assistant Professor: Leslie E. Glaze

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Graduate Programs

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Emphases in the master's program are speech-language pathology and audiology. Emphases in the doctoral program are speech-language pathology, speech science, audiology, and hearing science.

Prerequisites for Admission—There are no specific academic prerequisites. Prospective students generally have completed an undergraduate degree or coursework in the field, but individuals from other academic areas are welcome. Students entering the M.A. program with minimal background in communication disorders should expect their program to extend beyond the usual two years.

Special Application Requirements—Three letters of recommendation evaluating the applicant's scholarship (at least two from professorial-rank faculty), a complete set of transcripts (in addition to that required by the Graduate School), and Graduate Record Examination scores are required. Deadline for application to the master's program is February 1; late applications are considered only if space is available. Master's students ordinarily begin graduate study during fall or summer terms.

Master's Degree Requirements—Students who complete the master's degree with emphasis in speech-language pathology or audiology are eligible for clinical certification by the American Speech-Language-Hearing Association. A complete list of degree program requirements may be obtained from the director of graduate studies. An oral final examination is required for Plan A and Plan B students.

Doctoral Degree Requirements—Programs are designed by the student and the adviser to develop skills in research and scholarship. Required courses are EPsy 8260, 8261, and 8262.

Language Requirement—None.

For Further Information and Applications—Contact the Department of Communication Disorders, University of Minnesota, 115 Shevlin Hall, 164 Pillsbury

Drive S.E., Minneapolis, MN 55455 (612/624-3322; fax 612/624-7586).

CDIs 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

CDIs 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

CDIs 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5101. COMMUNICATION PROBLEMS OF CHILDREN. (3 cr; prereq non-Speech and Hearing Science major; offered alt yrs) S Doyle, staff
Problems of children with impaired communication due to delayed language development, hearing loss, articulation disorders, voice disorders, stuttering, cleft palate (oral-facial anomalies), and neuromuscular disorders. Emphasis on providing information about these disorders and their effects on speech and language development.

5102. COMMUNICATION PROBLEMS OF ADULTS. (3 cr; prereq non-Speech and Hearing Science major; offered alt yrs) Haroldson, Starr
Problems of hearing, speech, language, and voice in adults for persons interested in human communication. Information basic to the communicatively impaired adult. Implications for familial, social, academic, and vocational adjustments to living.

5103. COMMUNICATION DISORDERS AND CULTURAL DIVERSITY. (4 cr) Siegel
Children in public schools are increasingly from diverse cultural backgrounds. Influence of culture on communication disorders; role of speech-language clinician in serving diverse populations.

5301. INTRODUCTION TO ACOUSTICS. (5 cr) Speaks
Elements of acoustics necessary to understand quantitative aspects of speech and hearing science, speech-language pathology, and audiology. Nature of sound, sound transmission, units of measurement, acoustic characteristics of speech, and elementary electronics.

5302. ANATOMY AND PHYSIOLOGY OF THE SPEECH AND HEARING MECHANISMS. (4 cr) Gross
anatomy, physiology, and function of structures related to phonation, articulation, and audition.

5303. PHONETICS LABORATORY. (2 cr) Broen
Phonetic analysis of speech, the IPA classification system and articulatory correlates of English phonemes. Lab transcription of isolated sounds, words, and connected speech.

5304. SPEECH SCIENCE. (4 cr; prereq 5301, 5302, 5303 or #) Speaks
Acoustic characteristics of speech. Consideration of theories of speech production and speech perception, and critical review of classical and current research in production and perception. Introduction to techniques for analysis and synthesis of speech.

5305. LANGUAGE ACQUISITION. (4 cr) Windsor
Theory and experimental research dealing with language development.

5306. HEARING SCIENCE. (4 cr; prereq 5301, 5302 or #) Schlauch
Fundamental concepts in normal audition. Psychoacoustic methods; sensitivity and acuity; loudness, pitch, timbre, distortion, aural harmonics; masking, adaptation; the auditory reflex; binaural phenomena, localization.

5502. STUTTERING. (4 cr) Haroldson
Description, nature, and treatment of stuttering in children and adults. Students are involved at various levels in therapeutic and research activities.

5504. NORMAL AND DISORDERED CHILD PHONOLOGY. (4 cr; prereq 5302, 5303 or #) Broen
Theory and research relating to normal and disordered phonological development. Emphasis on assessment and treatment of phonological disorders.

5507. CLEFT PALATE, ORAL-FACIAL ANOMALIES AND SPEECH. (4 cr; prereq 5304, 5504 or #) Starr, Moller
Relationships between oral-facial structures and speech. Emphasis on speech problems associated with dental and palatal anomalies and on their clinical management. Observations of clinical activities.

5508. VOICE DISORDERS. (4 cr; prereq 5304 or #) Starr, Haroldson
Physical and physiological bases of normal voice production reviewed. Voice disorders (pitch, loudness, quality); their symptomatology, etiology, and clinical management. Laryngectomy and other organic disorders emphasized.

5509. MOTOR SPEECH DISORDERS. (4 cr; prereq 5304 or ¶5304)
Nature, assessment, and treatment of motor speech disorders in adult and pediatric populations.

5606. LANGUAGE ASSESSMENT, INTERVENTION; EARLY STAGES. (4 cr; prereq 5305 or #) Reichle
Analysis of communication disorders in preschool-age children. Emphasis on assessment and management of language disorders observed in children with developmental disabilities as well as intellectually normal children.

5607. LANGUAGE ASSESSMENT, INTERVENTION; LATER STAGES. (4 cr; prereq 5305 or #) Windsor
Analysis of language disorders in school-age children. Emphasis on assessment and intervention.

5608. LANGUAGE ASSESSMENT, INTERVENTION; ADULTS. (4 cr; prereq 5302 or #) Brookshire
Analysis of language disorders in adolescent and adult populations. Emphasis on assessment and intervention strategies applicable to aphasia and other neurogenic disorders.

5611. AUGMENTATIVE SYSTEMS OF COMMUNICATION. (4 cr) Reichle
Review of equipment and instructional procedures used to establish communication board and signing skills in severely handicapped populations.

5701. HEARING LOSS AND AUDIOMETRY. (5 cr; prereq 5301, 5302 or #) Schlauch
Basic orientation to audiology. Overview of hearing disorders: audiometric and medical correlates, medical and surgical management, effects on communication and psychosocial adjustment. Introduction to basic audiometry: pure-tone audiometry, speech audiometry, screening, acoustic immittance. Lab participation required.

5702. ADVANCED AUDIOMETRY. (5 cr; prereq 5701 or #) Schlauch
Advanced audiometric procedures, including speech discrimination testing, pediatric testing, detection and evaluation of pseudohypacusis. Behavioral diagnostic procedures for determining site of lesion, along with auditory pathologies that these procedures are designed to detect. Lab participation required.

5703. COMMUNICATION PROBLEMS OF THE HEARING-IMPAIRED. (5 cr; prereq 5701 or #) Carlstrom, Carney, Van Deusen, Van Tasell
Effects of hearing loss on development of language, perception and production of speech, and psychosocial adjustment. Techniques for habilitation and rehabilitation of hearing-impaired children and adults, including use of amplification, speechreading, and auditory training. Basic instruction in finger spelling and elements of manual communication.

5704. NOISE AND HUMANKIND. (4 cr; prereq 5301 or #)
Temporary and permanent effects of steady, intermittent, and impulse noise on hearing and health. Annoyance and community noise. Noise measurement, reduction, and control; ear defenders and their limitations. Hearing conservation programs; preemployment testing and monitoring audiometry.

5705. OBJECTIVE MEASURES OF AUDITORY FUNCTION. (3 cr; prereq 5701 or #; offered alt yrs) Margolis
Advanced techniques for clinical physiological evaluation of the auditory system. Major emphasis on acoustic immittance and auditory evoked potentials, with some discussion of electronystagmography, galvanic skin response, and electrocardiac response. Lab participation required.

5706. HEARING AIDS. (4 cr; prereq 5701 or #) Van Tasell
Electroacoustic characteristics of personal hearing aids and group amplification systems. Acoustical principles of earmold design and modification. Methods for selecting amplification for hearing-impaired children and adults.

5707. AUDIOLOGY IN EDUCATIONAL SETTINGS. (3 cr; prereq 5703 or #; offered alt yrs) Carlstrom
Audiological services for hearing-impaired school children. Selection and maintenance of group amplification equipment. Acoustical evaluation of classrooms. Legal educational rights of hearing-impaired children. In-service training of other professionals who work with hearing-impaired school children.

Graduate Programs

5900. TOPICS IN COMMUNICATION DISORDERS. (1-4 cr)

5970. DIRECTED STUDIES. (Cr ar [may be repeated for cr]; prereq #) Staff
Directed readings and preparation of reports on selected topics.

8305. LABORATORY INSTRUMENTATION. (2 or 4 cr; prereq 5301 or #) Schlauch, Speaks, Van Tasell
Two-credit course includes basic theoretical and practical information; 4-credit course also includes application of basic principles to the calibration and evaluation of audiometric equipment. M.A. students in speech pathology must enroll for 2 credits; in audiology, for 4 credits. Doctoral students from any department may enroll for either 2 or 4 credits. Lab participation required.

8502. SEMINAR: STUTTERING. (3 cr; prereq 5502 or #) Siegel
Theoretical explanations of stuttering; research data and methodologies subserving the respective theories. Students independently design and, when feasible, execute research studies that derive from, and are consistent with, a particular theory of stuttering.

8504. SEMINAR: NORMAL AND DISORDERED CHILD PHONOLOGY. (3 cr; prereq 5504 or #) Broen
Advanced study and independent research.

8507. SEMINAR: CLEFT PALATE. (3 cr; prereq 5507 or #) Starr, Moller
Research on communication problems of persons with cleft palates.

8508. SEMINAR: VOICE. (3 cr; prereq 5508 or #) Starr
Advanced study and independent research.

8520, 8521. CLINICAL EDUCATION IN SPEECH-LANGUAGE PATHOLOGY. (1-6 cr [may be repeated for cr]; prereq grad major in comm dis) Staff

8590. SEMINAR: CURRENT ISSUES IN SPEECH-LANGUAGE PATHOLOGY. (3 cr) Stemberger, staff
Significant problem areas in speech-language pathology; relation to other rehabilitation programs and personnel. Class projects involving in-depth exploration of a specific problem.

8605, 8606, 8607. SEMINAR: LANGUAGE DISORDERS. (3 cr per qtr; prereq 5305 or #) Broen, Reichle, Siegel, Windsor
Advanced study and independent research.

8608. SEMINAR: APHASIA. (3 cr; prereq 5608 or #) Brookshire
Review of principal theoretical instruments for evaluation and methods of clinical management of acquired aphasia and related disorders. Independent investigation of parameters determinative of aphasic behavior.

8715, 8716, 8717, 8718. SEMINAR: HEARING. (3 cr per qtr) Carney, Schlauch, Van Tasell
Major experimental research in psychophysiological and psychoacoustical nature of hearing. Critical analysis of theory, experimental method, and treatment of data.

8720, 8721. CLINICAL EDUCATION IN AUDIOLOGY. (1-6 cr [may be repeated for cr]; prereq grad major in comm dis) Staff

8990. RESEARCH. (Cr ar [may be repeated for cr]) Staff
Open to graduate students doing research.

Comparative Literature (CLit)

Professor: Peter E. Firchow (English); Harvey B. Sarles (comparative literature); Jochen Schulte-Sasse (comparative literature; German); Nicholas Spadaccini (Spanish and Portuguese)

Associate Professor: John W. Mowitz (comparative literature)

Assistant Professor: Peter Canning (comparative literature); Keya Ganguly (comparative literature); Prabhakara Jha (comparative literature)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan B only) and Ph.D.

Curriculum—The major portion of coursework for degrees in comparative literature is offered by the literature and language departments. Approval may also be given, however, to take graduate courses in such areas as anthropology, art, architecture, history, music, philosophy, and sociology. In all cases, students should consult with their adviser concerning course selections.

Prerequisites for Admission—Although most students in the program have undergraduate majors in language or literature, applicants with other undergraduate backgrounds are considered.

Special Application Requirements—It is strongly recommended that applicants submit scores from the Graduate Record Examination. Admission is in fall quarter only.

Degree and Language Requirements—Consult the director of graduate studies for degree and language requirements.

For Further Information and Applications—Contact the Department of Cultural Studies and Comparative Literature, University of Minnesota, 350 Folwell Hall, 9 Pleasant Street S.E., Minneapolis, MN 55455 (612/624-8099; fax 612/626-0228).

CLit 8666. DOCTORAL PRE-THESIS CREDITS.

(max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

CLit 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5147. TEACHING AS DIALOGUE. (4 cr) Sarles
Nature of teaching and of the teacher. Teaching authority; dynamics of Socratic dialogue and relation of teacher to students, to oneself; in present, toward students' futures.

5165. PERSPECTIVES IN HUMAN BEHAVIOR.

(4 cr) Sarles
Comparative basis for studying different disciplines, especially in behavioral sciences. Uses in-depth interviews of disciplinary practitioners to demonstrate nature of similarities, differences, and complementarities: integration and coherence vs. independence of disciplinary unities.

5221. BASIC CONCEPTS OF CINEMA. (4 cr; offered alt yrs) Mowitt

Tools and knowledge necessary to situate film in historical context, define major parameters of film theory, and introduce basic concepts of film analysis. Comparative study of French, English, and American theories.

5331, 5332. THE EUROPEAN NOVEL: 1750-1950.

(4 cr per qtr; prereq reading knowledge of French or German; offered alt yrs) Schulte-Sasse
Development of the novel as an artistic genre; social and intellectual-historical factors. *5331*: 1750-1850, with emphasis on England, France, and Germany; includes the novels of Sterne, Rousseau, Goethe, Stendhal, Scott, Balzac, and E. T. A. Hoffman. *5332*: 1850-1950, with emphasis on England, France, Germany, and Spain; includes the novels of Dickens, Flaubert, Dostoevsky, Tolstoy, Zola, Joyce, Hesse, Mann, Unamuno, Cela, and Lawrence.

5452. GENRE THEORY. (4 cr; prereq reading knowledge of French or German or Spanish or #; offered when feasible)

5555. INTRODUCTION TO SEMIOTICS. (4 cr; offered when feasible) Canning, Sarles

5701. THE CONCEPT OF MODERNITY. (4 cr; prereq reading knowledge of German or French or Spanish or #; offered alt yrs) Canning
Concept of modernity as it unfolds in 19th century in works of Poe, Baudelaire, Nietzsche, Dostoevsky, and others and as reflected by contemporary theorists of language and literature.

5711. SOCIOCRITICISM. (4 cr; prereq 3xxx lit course or #) Jha

Introduction to sociological theories of literary discourse. Theoreticians such as Goldmann, Foucault, Bakhtin; application of theory to practice in readings of specific texts.

5910. TOPICS IN COMPARATIVE LITERATURE.

(3-6 cr; prereq reading knowledge of French or German or Spanish or #) Staff
Topics vary and include: English and American literature in China; John Donne's Renaissance background; Joyce, Proust, and Mann; literature and ideas; medieval Latin literary texts; myth and ritual: the past redefined; the romantic novel; translation: theory and practice; the vanguard in Paris, 1900-1930.

5970. DIRECTED READING IN COMPARATIVE LITERATURE. (1-4 cr; prereq #, Δ, CLA approval) Staff

8001-8002-8003-8004†. SEMINAR IN COMPARATIVE LITERATURE. (4/4/4/1 cr)

Canning, Jha, Schulte-Sasse
8001, 8002, 8003: Guided research in selected areas with attention to methods applicable in the study of comparative literature. *8004*: Individual tutorial under direction of faculty member for project paper of previous three quarters.

8125. ON DISCOURSE AND LANGUAGE. (4 cr; offered alt yrs) Sarles

Language as rhetorical, discursive, and dynamic phenomenon. What is a rhetorical grammar? What is relation of language to human nature and question of nature in general sense? How language relates to human body, tone-of-voice phenomena.

8251. THEORIES OF NARRATIVE: MODELS, TRADITIONS, TEXTS. (4 cr; offered alt yrs) Schulte-Sasse

In light of selected narrative texts, comparison of narratologies that emerge from different representational perspectives and literary traditions.

8910-8920-8930. ADVANCED COMPARATIVE LITERATURE SEMINAR. (4 cr; prereq 8001, 8002, 8003 or #) Staff

Advanced seminar emphasizing the practical applications of specific methodologies and theories to a determined area. Topics vary.

8962. MODERNISM AND FEMINISM. (4 cr)

Different paths that recognizable modernist and feminist discourses take in common project of negating and rewriting the past. Implications of these discourses' (at times explosive) confrontation for understanding of fictional as well as theoretical texts.

8970. DIRECTED READING IN COMPARATIVE LITERATURE. (1-4 cr; prereq grad student in comparative literature, Δ) Staff

Comparative Studies in Discourse and Society (CSDS)

Professor: Jackson P. Hershbell (Classical and Near Eastern studies); Richard D. Leppert (cultural studies and comparative literature); Bruce Lincoln (cultural studies and comparative literature); Jochen Schulte-Sasse (German); Hernán Vidal (Spanish and Portuguese)

Associate Professor: John Archer (cultural studies and comparative literature), *director of graduate studies;* Rita Copeland (English); Maria Damon (English); William W. Malandra (Classical and Near Eastern studies); Ellen Messer-Davidow (English); Roger P. Miller (geography); John W. Mowitz (cultural studies and comparative literature; English); Gianna Pomata (history); Paula Rabinowitz (English); Gary C. Thomas (cultural studies and comparative literature)

Assistant Professor: Lisette E. Josephides (anthropology); Katherine M. Solomonson (architecture)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan B only) and Ph.D.

Curriculum—The curriculum emphasizes small seminars and directed research. The core requirement is a three-quarter research seminar, a practicum that develops critical and analytic skills and introduces current theoretical perspectives with the study of historic problems. The majority of courses are offered on a nonrecurring basis and are closely related to current faculty research. For listings, students should consult the quarterly *Class Schedule* and fliers available in the main office. In all cases, students should consult their advisers and the director of graduate studies concerning course selections.

Prerequisites for Admission—Applicants to the master's program are required to have a bachelor of arts degree in a humanities or social science discipline or other relevant field. Applicants to the doctoral program must have a master of arts degree or demonstrate evidence of adequate background and competence. Because the program involves broad, often interdisciplinary, courses of study and a variety of emphases, the graduate admissions committee carefully reviews each applicant's background in terms of

analytical skills, knowledge of subject matter, experience, and language preparation.

Special Application Requirements—Scores from the General (Aptitude) Test of the Graduate Record Examination are required. The deadline for financial aid application is January 15 preceding the academic year for which aid is sought. Applications for admission are considered only at the January 15 deadline, except in certain cases for students already enrolled in a graduate degree program at the University of Minnesota. Consult the director of graduate studies for application forms and requirements.

Master's Degree Requirements—The master's degree requires 44 quarter credits. All master's students are required to take the three-quarter research seminar. The remaining credits are divided between seminars in the program and electives in other departments, chosen in consultation with the adviser and the director of graduate studies. Written and oral final examinations are required.

Doctoral Degree Requirements—The doctoral degree requires an additional 36 credits beyond the master's degree. All doctoral students are required to take the three-quarter research seminar. The remaining credits are divided between seminars in the program and electives in other departments, chosen in consultation with the adviser and the director of graduate studies.

Language Requirements—Students must obtain a reading knowledge of one language other than English for the master's degree and of two languages other than English for the doctoral degree, appropriate to individual research interests.

Minor Requirements for Students Majoring in Other Fields—Minor field requirements are 16 credits for the master's program and 20 credits for the doctoral program. All minors must include at least two courses from the three-quarter research seminar sequence.

For Further Information and

Applications—Contact the Comparative Studies in Discourse and Society Program, University of Minnesota, 350 Folwell Hall, 9 Pleasant Street S.E., Minneapolis, MN 55455 (612/625-5358; e-mail csds@maroon.tc.umn.edu).

CSDS 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

CSDS 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5711. INTERPRETATION OF MYTH. (4 cr, §Hum 5711, §RelS 5111; prereq jr or sr or grad student) Structure and function of myths. Myth as social charter, ideological system, literary form. Readings in classic theories of myth and primary sources from India, Iran, Mesopotamia, Greece, Africa, North and South America.

5910. TOPICS IN COMPARATIVE STUDIES IN DISCOURSE AND SOCIETY. (4 cr; prereq jr or sr or grad student) Themes in comparative, sociohistorical analysis of discursive practices. Individually or team taught. Topics vary quarterly.

5970. DIRECTED STUDIES. (Cr ar; prereq grad student, #) Guided individual reading or study.

8001, 8002, 8003. BASIC RESEARCH SEMINAR IN COMPARATIVE STUDIES IN DISCOURSE AND SOCIETY. (4 cr per qtr; prereq grad student, Δ) Year-long practicum focusing on such issues as interrelations of center and periphery in production and reception of discourse; role of discourse in struggles over social boundaries; power and formation of cultural constituencies. Theoretical readings and case studies.

8404. INTERNATIONAL HIERARCHY. (3 cr, §Pol 8404; prereq pol sci or CSDS grad student or #) Duvall Asymmetric structures and processes of international relations; systematic conditions and implications of informal empire and structures of dependency and hegemony.

8910. ADVANCED TOPICS IN THE COMPARATIVE STUDY OF DISCOURSE AND SOCIETY. (4 cr; prereq grad student) Themes in comparative, sociohistorical analysis of discursive practices. Individually or team taught. Topics vary quarterly.

8970. DIRECTED STUDIES. (Cr ar; prereq grad student, #) Guided individual reading or study.

Other courses eligible for CSDS credit that are offered by the Department of Cultural Studies and Comparative Literature and are listed in the Related Courses section of this bulletin.

CSCL 5102. CULTURAL POLITICS

CSCL 5152. CLASSIFICATION, HIERARCHY, AND SOCIAL BORDERS

CSCL 5154. THEORETICAL CONSTRUCTIONS OF SPACE

CSCL 5178. THE POLITICAL DISCOURSE OF CHANGE

CSCL 5256. SUBURBIA

CSCL 5301. SOCIETY, IDEOLOGY, AND THE PRODUCTION OF ART

CSCL 5302. AESTHETICS, IDEOLOGY, VALUATION OF ART

CSCL 5392. THE IDEOLOGY OF THE MASTER NARRATIVE

CSCL 5398. PHENOMENOLOGY AND ETHNOGRAPHY

CSCL 5751. BASIC CONCEPTS OF CINEMA

CSCL 5835. RICHARD WAGNER'S *DER RING DES NIBELUNGEN*: MUSIC, MYTH, AND POLITICS

CSCL 5910. TOPICS IN CULTURAL STUDIES AND COMPARATIVE LITERATURE

Computer and Information Sciences (CSci)

Professor: Ahmed Sameh, *head*; Marvin L. Stein, *director of graduate studies*; Gordon B. Davis; David H. Du; David W. Fox; Laël C. Gatewood; Paul E. Johnson; Michael B. Kac; Richard Y. Kain; K. S. P. Kumar; E. Bruce Lee; Linda R. Petzold; Marian B. Pour-El; J. Ben Rosen; Youcef Saad; Eugene B. Shragowitz; James R. Slagle; Hans F. Weinberger

Associate Professor: Frederic N. Bailey; Daniel L. Boley; John V. Carlis; Ding-Zhu Du; Krzysztof S. Frankowski; Maria Gini; Larry G. Hutchinson; Ravi Janardan; Larry L. Kinney; Vipin Kumar; J. David Naumann; Arthur L. Norberg; Haesun Park; Ting-Chuen Pong; Gerald E. Sobelman; Jaideep Srivastava; Clark D. Thomborson¹; Anand R. Tripathi; Wei-Tek Tsai

Assistant Professor: Phillip J. Barry; Vladimir Cherkassky; Anthony T. Chronopoulos; Shantanu Dutt; Daniel J. Kersten; Joseph A. Konstan; Gyungho Lee; Zhiyuan Li; David J. Lilja; Matthew T. O'Keefe; Nikolaos P. Papanikolopoulos; John T. Riedl; Shashi Shekhar; Bapiraju Vinnakota

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A, Plan B, and coursework only) and Ph.D.

¹ University of Minnesota, Duluth

Graduate Programs

Curriculum—The faculty of the Department of Computer Science conducts research in a broad spectrum of the computer sciences and interdisciplinary fields. Graduate students may pursue research and study with faculty on topics such as theory of computation and algorithms, numerical algorithms and software for supercomputer and parallel machines, languages and compilers, systems, artificial intelligence, computer and system design, computer-aided design, software engineering, and history of computing. In addition, students may choose a course of study that combines a portion of one of these major areas with an entirely different field.

Graduate students have access to today's most powerful supercomputers through the Minnesota Supercomputer Center. In addition, Computer and Information Services provides an integrated computing environment ranging from microcomputers to workstations to large mainframe computing equipment. The Department of Computer Science also provides computing facilities through its various laboratories, such as the Instructional Laboratory, the Software Engineering Laboratory, the Artificial Intelligence Laboratory, the High Performance and Computing Laboratory, and the Distributed Systems Laboratory.

Prerequisites for Admission—A degree in any major with a substantial background in mathematics and basic core computer science is required; a computer science major is preferred. Applicants with an inadequate background must remove any deficiencies before beginning their degree program.

Special Application Requirements—Scores from the General (Aptitude) Test of the Graduate Record Examination (GRE) are required. As of fall quarter 1994, the Subject Test is optional, although highly recommended, especially for those seeking financial assistance. If taken, it should be in the undergraduate major field or, if it is not offered in that field, in computer science, mathematics, or engineering. Before applying for the M.S. coursework-only

program, students must have the equivalent of six months full-time computer-related industrial experience in the United States, but they need not take the GRE.

Master's Degree Requirements—In addition to general Graduate School requirements, all master's students must demonstrate competence in the basic material through a final oral examination.

Doctoral Degree Requirements—Doctoral students must take the written preliminary examination no later than two years after entering the program.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Computer Science, University of Minnesota, 4-192 Electrical Engineering/Computer Science Building, 200 Union Street S.E., Minneapolis, MN 55455 (612/625-4002).

CSci 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

CSci 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

CSci 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5001. THEORY AND APPLICATION OF LINEAR PROGRAMMING ALGORITHMS. (4 cr; prereq 5301 or #; informal lab)

Basic solutions to linear systems; inequalities; convex polyhedral sets; linear programming formulation and optimality conditions; theoretical and computational aspects of simplex algorithm; postoptimal analysis; duality. Revised simplex and numerically stable methods, upper-bounded problems; commercially available LP systems; methods for large, sparse systems. Interior methods for LP.

5002. COMPUTATIONAL METHODS FOR NONLINEAR PROGRAMMING. (4 cr; prereq 5001 or #; informal lab; offered alt yrs)

Convex functions and domains; nonlinear optimality conditions and duality; unconstrained minimization methods; convergence rates; minimization methods for linear and nonlinear constraints; penalty functions; acceleration of convergence; nonconvex problems. Comparison of available nonlinear programming software. Parallel methods for optimization.

5101. INTRODUCTION TO THE ORGANIZATION OF COMPUTER SYSTEMS. (4 cr; §3107, §3327; prereq non-CSci major, 3121 or 3316 or #)

Organization of hardware and software systems that support computer programming and program execution. Symbolic assembly language to study mapping of application programs and data into underlying hardware. Ideas illustrated in assembly language (currently Motorola 680x0).

5102. STRUCTURE AND PROGRAMMING OF SOFTWARE SYSTEMS. (4 cr; prereq 3327, 5101 or #; informal lab)

Extension of basic machine architecture and principles of system programming; closed subroutines; parameter passing mechanisms; macros and conditional assembly input-output; assembly linking and loading; dynamic resource allocation; introduction to operating systems, job control language, and processes.

5104. SYSTEM SIMULATION: LANGUAGES AND TECHNIQUES. (4 cr; prereq 3327 or 5101, Stat 3091 or #; informal lab; offered alt yrs)

Methodologies relevant to system modeling and simulation. Application of stochastic process, Markov chains, and queuing theory to developing system models and designing simulation experiments. Data collection and statistical analysis of output. Fundamentals of discrete event-based simulations using digital computers. Simulation languages, both process- and event-oriented, including SIMULA and SIMPAS. Applications of these techniques to job shops, operations research, and modeling of computer and communications systems.

5106. STRUCTURE OF HIGHER LEVEL LANGUAGES. (4 cr; prereq 5102, 3322 or #; does not carry grad cr for CSci majors; informal lab)

Formal definition of the syntax and semantics of programming languages; semantics both by means of interpreters and by using the axiomatic approach. Concepts underlying programming languages and their implementations in a selected group of languages. Program description at compilation time and execution time.

5107. COMPUTER GRAPHICS I. (4 cr; prereq 3322, 3327 or #; informal lab)

Definition of interactive computer graphics, its goals and problems. Model system. Data structures for computer graphics, picture structure, and transformations. Structures of graphical programming languages. Interaction handling. Raster graphics.

5110. USER INTERFACES AND PROGRAMMING WITH X. (4 cr; prereq 3322, 3327 or #; informal lab)

Design, programming, and evaluation of interactive applications with emphasis on X window system. Software structure of window systems and toolkits, prototyping and interface construction tools, design and implementation of application interfaces, models of human-computer interaction, and interface evaluation.

5113. INTRODUCTION TO OBJECT-ORIENTED PROGRAMMING USING C++. (4 cr; prereq C language programming equiv to 3113; does not carry grad cr for CSci majors)

Object-oriented programming; inheritance, including polymorphism and multiple inheritance; container classes and iterators; operator overloading, user-defined implicit conversions, constructors, destructors, and templates.

5117. COMPUTER GRAPHICS II. (4 cr; prereq 5107 or #; informal lab)

Introduction to vector geometry. Three-dimensional modeling and viewing transformations. Perspective view generation and 3D clipping. Introduction to curves and surfaces. Hidden line and hidden surface removal. Realistic Image generation. Advanced display system architectures. Modeling of 3D graphics programming.

5121. ALGORITHMS AND DATA STRUCTURES II. (4 cr, §3322; prereq non-CSci major, 3321)

Fundamental paradigms for algorithm design with supporting data structures. Complexity, correctness analysis, and lower bound theory. Implementation of selected algorithms and data structures using C++ language.

5122. ADVANCED DATA STRUCTURES. (4 cr; prereq 3322 or 5121 or #; informal lab)

Internal and external sorting. Symbol tables. Optimal binary search trees. AVL trees. B-trees. Tries. Hashing. Files and indexes, ISAM, multilists, inverted files, cellular partitions, differential files.

5151-5152. INTRODUCTION TO PARALLEL COMPUTING I-II. (4 cr per qtr; prereq 3121 or 3322)

Programming techniques, algorithms, data structures. Evaluation of algorithm quality. Effectiveness and scalability. *5151*: Basic concepts and algorithms for parallel computation. *5152*: Parallel algorithms for variety of problems.

5180. SOFTWARE ENGINEERING I. (4 cr; prereq 5106; informal lab)

Emphasis on abstractions as vehicle for analysis, design, and testing and on modules as vehicle for implementation. Software life cycle and project databases. PSL/PSA. Actor model of computation, process, and data modeling. Specification language MSG. Use of abstractions in functional, architectural, and module design. Test case selection and reliability assessment. Systematic coding: invariants and representation functions.

5181. SOFTWARE ENGINEERING II. (5 cr; prereq 5180; scheduled lab)

Requirements analysis. Project planning and management. Design reviews, software testing, validation strategies. Maintenance. Student groups specify, design, implement, and test partial software systems. Emphasis on application of general software development methods and principles from 5180.

5199f, w.s. PROBLEMS IN LANGUAGES AND SYSTEMS. (1-4 cr [may be repeated for cr]; prereq #)

Special courses or individual study arranged with faculty member.

Graduate Programs

5201. COMPUTER ARCHITECTURE. (4 cr; prereq 3311, 3327; does not carry grad cr for CSci majors; informal lab)

Elementary computer architecture, gates and digital logic, register transfers and micro-operations, processor studies of existing systems.

5205. PARALLEL COMPUTER ARCHITECTURE. (4 cr; prereq 5201 or #; offered alt yrs)

Parallel computer system analysis and design; organizational dependence on computations to be performed; primary components of parallel architectures (processors, control units, memories, interconnection networks); implemented paradigm of pipelined and vector processors, array processors, and multiprocessors.

5211. DATA COMMUNICATIONS AND COMPUTER NETWORKS. (4 cr; prereq 5102 or #; informal lab)

Network classification and services. Hardware components: multiplexors, concentrators, communications media. Network protocols and architectures. Research areas.

5280. COMPUTER-AIDED DESIGN I. (4 cr; prereq experience with data structures; informal lab)

CAD for digital systems with emphasis on VLSI. Hardware description languages: synthesis, simulation, test generation.

5281. COMPUTER-AIDED DESIGN OF VLSI. (4 cr; prereq experience with data structures; informal lab)

CAD for digital systems with emphasis on VLSI. Physical design: partitioning, placement and routing, design rule checks, electrical rule checks. Inherent complexity of algorithms. Analysis of best known algorithms.

5299f,w,s. PROBLEMS IN MACHINE DESIGN.

(1-4 cr [may be repeated for cr]; prereq #)
Special courses or individual study arranged with faculty member.

5301. NUMERICAL COMPUTATION. (4 cr; prereq Math 3261 or #; knowledge of Pascal or FORTRAN assumed; informal lab)

Floating point arithmetic and rounding errors. Iterative methods. Numerical solution of nonlinear equations. Newton's method. Direct methods for linear systems of equations. Gaussian elimination. Factorization methods. Interpolation and approximation. Numerical integration and differentiation. Introduction to numerical solution of ordinary differential equations.

5302. ANALYSIS OF NUMERICAL ALGORITHMS. (4 cr; prereq 5301 or #)

Norms, condition numbers, and error analysis. Convergence rates for iterative methods. Numerical approximation methods. Least squares. Fast Fourier transform. Spline interpolation. Gaussian quadratures. Computation of eigenvalues and eigenvectors. Stability and error analysis of methods for ordinary differential equations.

5304. COMPUTATIONAL ASPECTS OF MATRIX THEORY. (4 cr; prereq 5302 or #; informal lab)

Direct and iterative solution of large linear systems. Decomposition methods. Computation of eigenvalues and eigenvectors. Singular value decomposition. Linpack and other software packages. Methods for sparse and large structured matrices.

5305. NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS. (4 cr; prereq 5302 or #; informal lab)

Initial value problem. Convergence and stability. Efficient implementation. Error estimation and step size control. Comparison of recent software packages. Two-point boundary value problems. Collocation and finite element methods.

5306. NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS. (4 cr; prereq 5302, differential equations or advanced calculus)

Fundamentals of partial differential equations (PDEs). Finite difference and finite element discretization methods. Numerical treatment of parabolic, hyperbolic, and elliptic problems. Convergence, stability, and consistency. Iterative methods. Programming techniques and use of FORTRAN packages.

5307. NUMERICAL ALGORITHMS FOR PARALLEL COMPUTERS. (4 cr; prereq CLA or upper div IT CSci major or grad student, 5301, 5302 or #)

Basic concepts of vectorization and parallelization. Parallel matrix multiplication. Parallel factorization for dense linear systems (LU, QR). Parallel solutions of triangular and banded systems. Parallel methods for eigenvalue problem. Parallel methods for sparse linear problems.

5314. INTRODUCTION TO SPARSE MATRIX TECHNIQUES. (4 cr; prereq 5304, programming exper equiv to 3105 or 3321; offered alt yrs)

Sources of sparse matrices. Reducing profile: reverse Cuthill McKee, general methods, elimination trees, fill-in. Reducing fill: minimum degree, nested dissection. Pivoting strategies and storage schemes. Iterative methods: matrix splittings, Jacobi, relaxation, preconditioning.

5399f,w,s. PROBLEMS IN NUMERICAL ANALYSIS. (1-4 cr [may be repeated for cr]; prereq #)
Special courses or individual study arranged with faculty member.

5400. INTRODUCTION TO AUTOMATA THEORY. (4 cr; prereq 3311, 3321 or #; does not carry grad cr for CSci majors; informal lab)

Turing machines, computable functions, unsolvability of the halting problem, recursive functions. Finite state models: equivalence, minimization, properties, decision questions, characterizations. Regular expressions. Survey of other automata.

5499f,w,s. PROBLEMS IN COMPUTATIONAL THEORY OR LOGIC. (1-4 cr [may be repeated for cr]; prereq #)

Special courses or individual study arranged with faculty member.

5502. INTRODUCTION TO OPERATING

SYSTEMS. (4 cr; prereq 3322, 5102 or #; informal lab)
Definition and historical development of operating systems. Abstractions and implementations of features common to most systems. Concurrency and related control problems. Resource allocation. Storage allocation. Process manager and the kernel of an operating system. Sharing. Capability-based addressing. Performance measurement and analysis.

5504. INTRODUCTION TO COMPILERS. (4 cr; prereq 5106 or #; informal lab)

Lexical scanning together with preprocessing and macroexpansion, symbol tables, parsing, intermediate text generation, semantic processing, error detection and correction. Students design and implement a front end for a compiler.

5505. INTRODUCTION TO COMPILERS. (4 cr; prereq 5504 or #)

Higher-level language L, machine language loaders, linkage editors; mapping L onto machine language, code generation techniques; derivation of an intermediate language and implementation of code generators (from intermediate onto machine language). Students write back-end of compiler.

5511. ARTIFICIAL INTELLIGENCE I. (4 cr; prereq 3322 or #; informal lab)

Introduction to ideas, issues, and applications of artificial intelligence. Knowledge representation, problem solving, search, inference techniques, theorem proving. Expert systems. Artificial intelligence programming languages.

5512. ARTIFICIAL INTELLIGENCE II. (4 cr; prereq 5511 or #; informal lab)

Techniques of artificial intelligence to solve complex problems. Natural language processing and speech recognition. Machine perception and integrated robots. Planning. Machine learning. Expert systems.

5521. PATTERN RECOGNITION. (4 cr; prereq 5301, Stat 3091 or #; informal lab)

Definition of problems of pattern recognition, feature selection, measurement techniques, etc. Classification methods; statistical decision theory, nonstatistical techniques. Automatic feature selection. Syntactic pattern recognition. The relationship between mathematical pattern recognition and artificial intelligence. Applications.

5531. ARTIFICIAL INTELLIGENCE PROGRAMMING TECHNIQUES. (4 cr; prereq 5511 or #; informal lab; offered alt yrs)

Languages and programming techniques for problems in artificial intelligence. Lisp and Prolog. Production system and frame-based languages. High level tools. Implementation of knowledge representation structures and inference operations. Applications in expert systems.

5551. INTRODUCTION TO INTELLIGENT ROBOTIC SYSTEMS. (4 cr; prereq 5511 or #)

Fundamentals of robot manipulator operations. Sensing techniques and their basic principles. Real-time programming issues as applied to control of robots. Robot programming and planning.

5561. COMPUTER VISION. (4 cr; prereq 5511 or #)

Representational and computational tools. Matching. Edge detection. Shape from shading, motion, stereo. Texture. Object recognition. Introduction to applications.

5571. EXPERT SYSTEMS. (4 cr; prereq 5511 or #)

Aspects of artificial intelligence representations and inferencing mechanisms as applied to expert systems. Students develop small expert system.

5599. PROBLEMS: ARTIFICIAL INTELLIGENCE.

(1-4 cr [may be repeated for cr]; prereq #)
Special courses or individual study arranged with faculty member.

5702. THE PRINCIPLES OF DATABASE SYSTEMS. (4 cr; prereq 5122 or #; informal lab)

Fundamental concepts. Conceptual data organization. Data models. Data manipulation languages. Database design. Security and integrity. Performance evaluation. Query optimization. Distributed database systems.

5703. DATABASE SYSTEM DESIGN. (4 cr; prereq 5702 or #; informal lab)

Application of database concepts in design and development of database systems and applications. Design of current commercial as well as research-oriented database systems. Techniques of using database systems for applications.

5799. PROBLEMS: INFORMATION SCIENCE.

(1-4 cr per qtr [may be repeated for cr]; prereq #)
Special courses or individual study arranged with faculty member.

5863. COMPUTER SYSTEMS PERFORMANCE ANALYSIS. (3 cr, §EE 5863; prereq grad IT major, 5201 or EE 5858 or #; offered alt yrs)

Tools and techniques for measuring and analyzing computer hardware, software, and system performance. Benchmark programs, measurement tools, performance metrics. Presenting data, summarizing measured data, comparing system performance. Deterministic and probabilistic simulation techniques, random number generation and testing. Bottleneck analysis.

8101. ADVANCED OPERATING SYSTEMS. (3 cr; prereq 5211, 5502)

Multiprocessor and distributed system architectures. Interprocess communication models and primitives. Information protection: access control list and capability-based systems. Secure communication protocols. Dynamic linking and sharing. Naming, synchronization, and mutual exclusion in distributed systems. Recovery principles. Network file systems.

8102. OPERATING SYSTEMS THEORY. (3 cr; prereq 5104, 5502)

Computer system modeling and performance evaluation. Queuing network models and analysis methods. Multiprocessor and distributed system control algorithms: synchronization, mutual exclusion protocols, resource management, deadlocks, scheduling, load balancing. Security models; security problems in distributed systems.

Graduate Programs

8103. DISTRIBUTED AND PARALLEL PROGRAMMING. (3 cr; prereq 5502, 8101)

Concurrent programming constructs. Formal models of concurrent systems. Problem mapping to distributed and parallel architectures. Synchronous algorithms. Termination detection problem. Distributed and parallel algorithms for graph problems. Common knowledge in distributed systems. Reliable communication and consensus protocols.

8305. ADVANCED COMPUTATIONAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS. (3 cr; prereq 5305)

Boundary value problems, includes conditioning, shooting, multiple shooting and finite difference methods, solving linear and nonlinear equations, and mesh selection. Differential-algebraic equations, includes solvability, index, order and stability for numerical methods, applications, and software.

8307. ADVANCED PARALLEL NUMERICAL METHODS. (3 cr; prereq 5301, 5307 or 5152; offered alt yrs)

Parallel algorithms for scientific computing. Partial differential equations: relaxation, SOR, SSOR, ADI, multigrid algorithms. Fast Poisson solvers. Sparse linear algebra. Conjugate gradient methods. Gaussian elimination. Domain decomposition.

8314. ITERATIVE METHODS FOR LINEAR SYSTEMS. (3 cr; prereq 5304; offered alt yrs)

Iterative methods for large sparse matrices, matrices too big to keep in memory. Jacobi, Gauss-Siedel, relaxation methods. Chebyshev acceleration. Conjugate gradient method: basic theory, convergence. Connection with Lanczos tridiagonalization. Extensions to non-symmetric matrices. Preconditioning techniques. Supercomputer implementation.

8320. NUMERICAL SOLUTION OF LINEAR LEAST SQUARES PROBLEMS. (3 cr; prereq 5304 or #; offered alt yrs)

Linear least squares. Post decomposition. Weighting and constrained least squares. Modified least squares. Signal and image processing applications.

8401-8402. ALGORITHMS—TECHNIQUES AND THEORY. (3 cr per qtr; prereq 5121, 5400 or #; offered alt yrs)

Searching, polynomial manipulation, graph algorithms, parallel computations, linear pattern matching, computationally related problems, hard problems, abstract complexity, miscellaneous techniques.

8403-8404. THEORY OF COMPUTATION. (3 cr per qtr; prereq 5400 or equiv or #; offered alt yrs)

Models of computation. Computability and unsolvability. Computational complexity. Speed-up theorems. Hierarchy theorems. Intractable problems (e.g., NP-complete, PSPACE-complete, provably intractable). Relativized problems. Advanced topics.

8505. OPTIMIZATION IN COMPILERS. (3 cr; prereq 5504 or #)

Automatic collection of global information encompassing structure of the program; usage information for the variables; representation in terms of a program graph. Specific optimizations: elimination of common subexpressions; backward movement of code; strength reduction. Minimization of loads and stores. Optimal global assignment of registers.

8521. NEUROCOMPUTING AND NEURAL NETWORKS. (3 cr; prereq 5511)

Learning laws, associative networks, mapping networks, backpropagation, overfitting and generalization, complexity of learning, self-organizing maps; current topics such as optimization via boltzman networks, spatio-temporal networks, physiological networks, efficient implementations on parallel computers.

8551. ARTIFICIAL INTELLIGENCE TECHNIQUES IN ROBOTICS. (3 cr; prereq 5512 or #; informal lab)

Representation of physical world and reasoning over world models. Complex modeling, representation of physical properties, uncertainty. Qualitative and quantitative reasoning techniques. Use of knowledge bases, reasoning about space, reasoning with geometry, reasoning with time. Program synthesis, plan formation, error recovery.

8561. READINGS IN COMPUTATIONAL VISION. (3 cr; prereq 5561 or #; offered alt yrs)

Classic papers and recent results relating to computational models of vision and other perceptual systems.

8571. READINGS IN EXPERT SYSTEMS. (3 cr; prereq 5571 or #; offered alt yrs)

Classic papers and recent results relating to expert systems and computational models of expert problem solving.

8581. READINGS IN PARALLEL SYMBOLIC COMPUTING. (3 cr; prereq 5512 or #; offered alt yrs)

Exploiting parallelism in symbolic applications with special emphasis on problems related to artificial intelligence. Parallel search, parallel execution of expert systems. Parallel algorithms for natural language, vision, neural networks.

8701. ADVANCED TOPICS IN DATABASE SYSTEMS. (3 cr; prereq 5702 or #)

In-depth coverage of active research. Physical and logical database design, semantic data models, database computers, query optimization, performance evaluation, distributed database systems, and new database applications.

8760. PLAN B PROJECT. (3 cr [may be taken once to satisfy Plan B master's requirement, may appear on master's program, but may not be applied toward 20 cr minimum in major field]; prereq CSci MS student, #; S-N only)

Project topic(s) arranged between student and adviser. Written report(s).

Note—All of the following seminars may be presented as either lectures or as individually assigned readings in the current literature. The amount of credit earned is arranged with the faculty member. Seminars may be repeated for credit when topics change.

- 8199. SEMINAR: LANGUAGES AND SYSTEMS.** (1-3 cr; prereq #)
- 8299. SEMINAR: MACHINE DESIGN.** (1-3 cr; prereq #)
- 8399. SEMINAR: NUMERICAL ANALYSIS.** (1-3 cr; prereq #)
- 8499. SEMINAR: COMPUTATIONAL THEORY AND LOGIC.** (1-3 cr; prereq #)
- 8599. SEMINAR: ARTIFICIAL INTELLIGENCE.** (1-3 cr; prereq #)
- 8699. SEMINAR: CONTROL SCIENCE.** (1-3 cr; prereq #)
- 8799. SEMINAR: INFORMATION SCIENCE.** (1-3 cr; prereq #)

Other Acceptable Courses

In addition to the courses offered by the Department of Computer Science that are listed above, the following courses, taught by members of the graduate faculty in computer science, may be applied to the major.

- EE 5852-5853. COMPUTER ORGANIZATION AND DESIGN I-II**
- Math 5162-5163-5164. MATHEMATICAL LOGIC**
- Math 8140-8141-8142. APPLIED LOGIC**
- Math 8181-8182-8183. FORMAL LANGUAGES AND AUTOMATA**
- Math 8190-8191-8192. TOPICS IN LOGIC**
- Psy 5036. VISION: COMPUTATIONAL THEORY TO NEURAL SYSTEMS**

Conflict Management

Professor: Mario F. Bognanno (industrial relations); Eugene Borgida (psychology); Paul V. Ellefson (forest resources); Steven D. Penrod (law); Marshall S. Poole (speech-communication)

Assistant Professor: Mark S. Umbreit (social work)

Course of Study—Minor in conflict management, applicable to master's (M.A. and M.S.) and doctoral programs.

Curriculum—Conflict management is a recently recognized and rapidly advancing area of inquiry that is concerned with the

study of the origin, process, and management of conflict interactions among individuals, groups, organizations, and systems, and the impact of these interactions. It is an interdisciplinary effort with roots in economics, family studies, industrial relations, law, political science, primary communication, psychology, public policy, social work, and other departments.

Prerequisites for Admission—Admission to the graduate minor in conflict management is contingent upon prior admission to a master's or doctoral degree-granting program within the Graduate School.

Special Application Requirements—None.

Minor Requirements—The minimum number of graduate-level quarter credits for the minor at the master's level is 11 and at the doctoral level is 21. The program for an individual student is developed in consultation between the student, the major adviser, and the director of graduate studies in conflict management. A sequence of three required core seminars in conflict management theory and practice is chosen, one each from the following pairs: SW 5026 or Spch 5407; IR 5002 or PA 5114; and IR 8027 or Law 5833.

Language Requirements—None specific to the minor program.

For Further Information and Applications—Contact the director of graduate studies, Graduate Minor in Conflict Management, Conflict and Change Center, University of Minnesota, Humphrey Center, 301 19th Avenue South, Minneapolis, MN 55455 (612/625-0362).

Core Courses

IR 5002. Systems of Conflict and Dispute Resolution

IR 8027. Dispute Resolution Practices: Mediation, Fact Finding, and Arbitration

Law 5833. Alternative Dispute Resolution (*see Law School Bulletin for complete description*)

PA 5114. Conflict Management: Theory and Practice

Spch 5407. Communication and Interpersonal Conflict

SW 5026. Mediation and Conflict Resolution

Graduate Programs

Elective Courses

The following is an illustrative, not exhaustive, list of potential elective courses. With the permission of the director of graduate studies, students may elect courses other than those listed below in fulfillment of the degree requirements. (See the Law School Bulletin for complete descriptions of the Law courses listed below.)

- Anth 5117. Natural Resources Anthropology**
Anth 5152. Anthropology of Social Movements
Anth 5157. The Political Discourse of Social Change
Econ 5107H. Honors Course: Game Theory and Its Applications
Econ 8117, 8118. Noncooperative Game Theory
EPsy 5154. Organizational Development and Change
EPsy 8150. Psychology of Conflict Resolution
FR 5241. Political and Administrative Processes For Natural Resource Administration
IntR 5930. Peace Studies: The Gender Variable
IR 8007. Collective Bargaining: Private and Public Sectors
IR 8017. Labor Movements in a Changing World
IR 8024. Organization Design and Change
IR 8032. International Comparative Labor Relations
IR 8037. Labor-Management Negotiations
Jour 8651. Seminar: Mass Media and Social Change
Law 5203. Labor Law
Law 5236. American Indian Law
Law 5820. Labor Arbitration
MBA 8010. Management and Organization Behavior
Mgmt 8021. Organization Design and Development
Mgmt 8050. Innovation and Change
Mgmt 8201. Business, Government and Society
PA 5001. Social Movements, Politics and Public Policy
Phil 5770. Ethical Issues in Biomedicine
Pol 5885. International Peace and Violence
Pol 8402. Conflict Dynamics and Security
Psy 5702. Individual Behavior in Organizations
PubH 5727. Health Leadership and Effecting Change
Rhet 5165. Studies in Organizational Communication, Conflict, and Change
Soc 5211. Social Processes in Small Group Settings
Soc 5311. Sociology of Conflict
Soc 5411. Formal Organizations

Spch 8421. Seminar: Communication and Negotiation

SW 8350. Planned Social Change

VoEd 5762. Management of Conflict

Conservation Biology (CBio)

Regents' Professor: Margaret B. Davis (ecology, evolution, and behavior)

Professor: Dean E. Abrahamson (public affairs); Peter A. Abrams (ecology, evolution, and behavior); Franklin H. Barnwell (ecology, evolution, and behavior); Marvin E. Bauer (forest resources); Elmer C. Birney (Bell Museum of Natural History; ecology, evolution, and behavior); Kenneth N. Brooks (forest resources); Dwight A. Brown (geography); Kendall W. Corbin (ecology, evolution, and behavior); William P. Cunningham (genetics and cell biology); James W. Curtsinger (ecology, evolution, and behavior); Edward J. Cushing (ecology, evolution, and behavior); Gary E. Duke (veterinary biology); Donald P. Geesaman (public affairs); Luther P. Gerlach (anthropology); Hans M. Gregersen (forest resources); D. Frank McKinney (Bell Museum of Natural History); L. David Mech (fisheries and wildlife); Patrice A. Morrow (ecology, evolution, and behavior); Richard E. Phillips (ecology, evolution, and behavior); Philip J. Regal (Bell Museum of Natural History); Donald B. Siniff (ecology, evolution, and behavior); Anthony M. Starfield (civil and mineral engineering; ecology, evolution, and behavior); John R. Tester (ecology, evolution, and behavior)

Associate Professor: Francesca J. Cuthbert (fisheries and wildlife), *director of graduate studies;* David A. Andow (entomology); Charles R. Blinn (forest resources); Ralph W. Holzenthal (entomology); Peter A. Jordan (fisheries and wildlife); Anne R. D. Kapuscinski (fisheries and wildlife); James R. Kitts (fisheries and wildlife); James A. Perry (forest resources); Patrick T. Redig (veterinary biology); Ruth G. Shaw (ecology, evolution, and behavior); J. L. David Smith (fisheries and wildlife); Robert M. Zink (Bell Museum of Natural History)

Adjunct Associate Professor: Mary G. Henry (fisheries and wildlife); Ronald L. Tilson (fisheries and wildlife)

Assistant Professor: Glenn R. Furnier (forest resources); Susan M. Galatowitsch (horticulture); Barbara J. Kanninen (public affairs); Linda L. Kinkel (plant pathology); Bruce C. Vondracek (fisheries and wildlife)

Adjunct Assistant Professor: David E. Andersen (fisheries and wildlife)

Research Associate: Allen L. Lundgren (forest resources)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—The conservation biology program has two complementary aims leading to a unique interdisciplinary

program. The first is to provide students with sound graduate training in the biological sciences relevant to the conservation of plants, animals, and ecosystems globally.

The second is to expose students to the social, political, and economic sciences that relate to both the recognition and solution of conservation problems. The overall objective of the program is to prepare students to develop solutions or approaches to these problems that are scientifically and environmentally sound and likely to be acted upon or implemented by existing social and political structures.

Prerequisites for Admission—A B.S. degree in biology or a closely related field is preferred. Applicants with a baccalaureate degree in another field may be accepted, but are required to make up selected courses in biology. In general, Ph.D. applicants holding a baccalaureate degree are expected first to complete a master's degree.

Special Application Requirements—A statement of career goals and three letters of recommendation evaluating the applicant's potential for graduate study are required. The Graduate Record Examination General Test is required. The deadline for application is January 15; earlier application is encouraged for individuals seeking financial aid. Typically students are admitted only in fall quarter.

Master's Degree Requirements—All master's students must complete a minimum of 44 credits in the biological and social aspects of conservation biology. For Plan A students, 16 of these credits are thesis credits; Plan B students take 16 credits that include credits arranged for Plan B papers.

Doctoral Degree Requirements—Students complete a total of 68 graduate credit hours. Ph.D. candidates take the core courses and are expected to show competency in both the biological and social sciences. With their advisory committee, students develop a program that emphasizes the ecological and social aspects of conservation biology. Thesis research may require proficiency in

supporting areas (e.g., statistics, computing, communications).

Language Requirements—None.

For Further Information, Applications, and a List of Courses—Contact the director of graduate studies, Conservation Biology Program, Department of Fisheries and Wildlife, University of Minnesota, 200 Hodson Hall, 1980 Folwell Avenue, St. Paul, MN 55108 (612/624-3600).

CBio 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

CBio 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

CBio 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

8001. CONSERVATION BIOLOGY SEMINAR. (1 cr) Presentations by students, faculty, and visiting specialists.

Control Science and Dynamical Systems (CSDy)

Regents' Professor: Daniel D. Joseph (aerospace engineering and mechanics)

Professor: Allen R. Tannenbaum (electrical engineering), *co-director:* Donald G. Aronson (mathematics); Fredric N. Bailey (electrical engineering); David P. Fan (genetics and cell biology); William Garrard (aerospace engineering); Robert T. Holt (political science); Mostafa Kaveh (electrical engineering); John C. Kieffer (electrical engineering); K. S. P. Kumar (electrical engineering); E. Bruce Lee (electrical engineering); Walter Littman (mathematics); Richard P. McGehee (mathematics); Katsuhiko Ogata (mechanical engineering); Linda R. Petzold (computer science); J. Ben Rosen (computer science); George R. Sell (mathematics); Yasutaka Sibuya (mathematics); Marvin L. Stein (computer science); William H. Warner (aerospace engineering and mechanics)

Associate Professor: Tryphon T. Georgiou (electrical engineering), *co-director:* Daniel Boley (computer science); Max Donath (mechanical engineering); Dale F. Enns (aerospace engineering and mechanics); Maria Gini (computer science); Larry L. Kinney (electrical engineering); Kim A. Stelson (mechanical engineering); Ahmed H. Tewfik (electrical engineering)

Assistant Professor: Gary J. Balas (aerospace engineering and mechanics), *director of graduate studies:* Prodromos Daoutidis (chemical engineering and materials science); Nikolaos P. Papanikolopoulos (computer science); Thomas A. Posbergh (aerospace engineering and mechanics); Andrew R. Teel (electrical engineering); Yiyuan Zhao (aerospace engineering and mechanics)

Graduate Programs

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—Ph.D.

Curriculum—Student programs must emphasize modeling—mathematical and physical analyses of control and/or dynamical systems, with some computational or numerical expertise—and two areas selected from the following three: control theory for deterministic processes; stability theory and general analysis of dynamical systems; stochastic processes and information theory.

Prerequisites for Admission—Applicants must have completed a master's degree in one of the related fields of engineering, computer science, mathematics, statistics, or physics. Master's degrees with an emphasis in control science and/or dynamical systems can be earned in any of these programs at Minnesota. An applicant with a master's degree in another area whose scientific, mathematical, and/or engineering background is adequate to pursue the program also is considered. A high level of proficiency in mathematics is necessary to successfully complete the Ph.D. program. Applicants are strongly encouraged to obtain a faculty adviser before formally applying to the program.

Special Application Requirements—Three letters of recommendation evaluating the applicant's scholarship and a complete set of transcripts are required. At least one letter of recommendation must be from a faculty member familiar with the applicant's previous graduate work. Because faculty are drawn from a number of disciplines and students' programs can reflect a variety of emphases, it is important for applicants to clearly specify career goals and program emphasis desired in their application materials.

Doctoral Degree Requirements—Programs are designed by the student and the adviser. Coursework is normally selected from those courses in science, mathematics,

engineering, and related fields that are relevant to the field of control science and dynamical systems. The written preliminary examination covers three of the four areas of emphasis (see Curriculum above). Normally students can prepare for this examination by completing three 8xxx or suitably advanced courses in three of the four areas. In addition, students normally take substantial coursework in advanced mathematics.

Language Requirements—For emphases other than mathematics, one foreign language. For the emphasis in mathematics, a second foreign language or a special project.

For Further Information and Applications—Contact the Control Science and Dynamical Systems Center, University of Minnesota, 107 Akerman Hall, 110 Union Street S.E., Minneapolis, MN 55455 (612/625-1801; e-mail moore@aem.umn.edu).

CSDy 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

CSDy 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

8899. SEMINAR IN CONTROL AND DYNAMICAL SYSTEMS. (1-3 cr [may be repeated for cr]; prereq #: S-N only)
Current research, advanced topics. Arranged with instructor.

Curriculum and Instruction

Professor: Barbara M. Taylor, *chair*; Frances P. Lawrenz, *director of graduate studies*; Marian O. Bagley; Richard W. Beach; Carol A. Carrier; John J. Cogan; William E. Gardner; Michael F. Graves; Harlan S. Hansen; Ilene B. Harris; Peggy A. House; Robert L. Jackson; Roger T. Johnson; Judith Lambrecht; Dale L. Lange; Darrell R. Lewis; John C. Manning; Dianne L. Monson; Thomas R. Post; S. Jay Samuels; James E. Stochl; Howard Y. Williams

Associate Professor: Eugene M. Anderson; Patricia G. Avery; J. Michael Bennett; Harlan G. Copeland; Margaret K. DiBlasio; Fred N. Finley; Kerry J. Freedman; Patricia A. Heller; Simon R. Hooper; Helen L. Jorstad; Robert E. Orton; R. Michael Paige; Rosemarie J. Park; Gregory C. Sales; Constance L. Walker

Assistant Professor: Darcia F. Narvaez; Margaret Y. Phinney; Diane J. Tedick; Susan M. Watts

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan B only) in education (emphasis in curriculum and instruction), art education, elementary education, and mathematics education; Ph.D. in education (emphasis in curriculum and instruction); and Certificate of Specialist in Education.

Curriculum—Majors for the master's degree in art education, education, elementary education, and mathematics education are administered by the Department of Curriculum and Instruction, under the direction of a single director of graduate studies. The education major with emphasis in curriculum and instruction is divided into the following concentration areas: curriculum studies; English education; instructional systems; reading education; science education; second languages and cultures education; and social studies education.

For the Ph.D. degree in education with emphasis in curriculum and instruction, concentrations include art education, communications education (children's literature, English education, language arts, and reading), curriculum and instruction (curriculum studies, early childhood education, instructional systems), elementary education, mathematics education, science education, second languages education, and social science education.

The specialist certificate is offered in curriculum supervision and mathematics education.

Prerequisites for Admission—Prerequisites vary among areas of emphasis or concentration. Generally a bachelor's degree with licensure fulfills the requirement. For some areas, however, there is no equivalent undergraduate program. In that case, 15 to 20 credits of work at the undergraduate level determined acceptable by advisers and the director of graduate studies are adequate. Some areas require a minimum of one year of teaching experience.

Special Application Requirements—

Scores from the Graduate Record Examination are required. Master's and doctoral applications are reviewed by the department on specific dates in the fall, winter, and spring quarters.

Master's Degree Requirements—Students must complete requirements in the areas common to all emphasis areas, in behavioral and humanistic studies, in multicultural education, and in preparation for research. A final oral examination is required.

Doctoral Degree Requirements—

Requirements include core courses and coursework in the concentration. Students must show competency in methodology; social, historical, and philosophical foundations; and psychological foundations.

Specialist Certificate Requirements—

Students complete coursework in an area of emphasis and related studies. An internship, a project, and final examination are required.

Language Requirements—For the master's degree and specialist certificate, none. For the doctoral degree, some concentrations require at least one foreign language.

Minor Requirements for Students

Majoring in Other Fields—Requirements are designed according to individual student needs.

For Further Information and Applications—

Contact the Department of Curriculum and Instruction, University of Minnesota, 125 Peik Hall, 159 Pillsbury Drive S.E., Minneapolis, MN 55455 (612/625-2545).

Educ 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Educ 8888. THESIS CREDITS: DOCTORAL. (36 cr required for Ph.D.)
Section 2. Curriculum and Instruction

Curriculum and Instruction (CI)

5008. THEORY AND PRACTICE OF TEACHING ART IN ELEMENTARY SCHOOLS. (4 cr, §ArEd 5308) DiBlasio, Freedman

Art concepts, skills, and processes appropriate for elementary school, methods of art instruction, and children's production of and responses to art.

Graduate Programs

5045. ADVANCED CONTEMPORARY CRAFTS.

(4 cr, §ArEd 5020; prereq 3045 or ArEd 3020 or #)
In-depth experiences in craft techniques, including ceramics, fibers, jewelry, and metal design, with emphasis on design analysis, understanding of materials, and mastery of processes.

5049. ART MEDIA TECHNIQUES. (3-6 cr [max 12 cr], §ArEd 5001) DiBlasio, Freedman
Lectures, demonstrations, discussions, critique sessions on processes in creativity; handling specific media; each offering focuses on a single topic.

5052. INTRODUCTION TO ART THERAPY. (3 cr, §ArEd 5201)
History and current conceptions and practices.

5055. MULTICULTURAL ART EDUCATION. (3 cr, §ArEd 5316; offered when feasible) Freedman

5058. ISSUES IN ART EDUCATION. (1-12 cr, §ArEd 3800)
Issues and trends, current practices, and recent research.

5060. ART PROBLEMS FOR EXCEPTIONAL LEARNERS. (4 cr, §ArEd 5305; offered when feasible)

5065. IMPROVING ART PROGRAMS IN THE SCHOOLS. (4 cr, §ArEd 5386; prereq tchg exper or #; offered when feasible) DiBlasio, Freedman

5069. CURRICULUM INNOVATIONS IN ART EDUCATION. (4 cr, §ArEd 5302) DiBlasio
Study and analysis of innovations, evaluation of materials for teaching units and projects.

5070. HISTORY OF AMERICAN ART EDUCATION. (3 cr, §ArEd 5310; offered alt yrs) Freedman
Development of art as subject matter in curriculum; relation to traditions in art and in schooling; comparison of change within social, political, and economic contexts.

5074. INTERNATIONAL ART EDUCATION. (3 cr, §ArEd 5318; offered when feasible) Freedman

5078. APPLICATION OF AESTHETIC THEORY IN EDUCATION. (3 cr, §ArEd 5389; offered alt yrs) DiBlasio
Contemporary theories of art; their psychological and philosophical foundations. Open to teachers, supervisors, and administrators concerned with art in general education at all levels.

5080. INTERNSHIP IN ART EDUCATION. (3-9 cr, §ArEd 5600; prereq #) DiBlasio, Freedman
Professional assignment for degree candidates under joint supervision of departments and cooperating agency.

5085. PRACTICUM IN ART EDUCATION. (3-9 cr, §ArEd 5605; prereq #) DiBlasio, Freedman
Independent project under direction; gathering data, developing proposals, experimenting with evaluating innovative practices.

5086. STUDENT TEACHING IN ART EDUCATION. (3 or 6 or 12 cr, §ArEd 3600; prereq ¶3184, 5110 or Elem 3101 or SeEd 3150, 5150)
Observation of, participation in, and supervisory experiences with various types and levels of art classes.

5090. PROFESSIONAL PROBLEMS IN ART EDUCATION. (3 cr, §ArEd 5900; prereq MEd student or #)
Independent study for MEd candidates; integrates learning from art education, art, and education.

5100. ELEMENTARY SCHOOL CURRICULUM. (3 cr, §Elem 5100; prereq 5110 or Elem 3101)
Selection and organization of subject matter for courses; methods, problems, and findings of research by subjects.

5101. WORKSHOP: PROGRAMS AND PROCEDURES OF CURRICULUM DEVELOPMENT IN ELEMENTARY SCHOOLS. (1-3 cr, §Elem 5101; prereq elem school tchg exper, #; S-N only)
Leadership in procedures; operational processes; major considerations in planning and organizing; interpersonal relationships, and evaluation of improvement programs.

5102. PREPARATION OF CURRICULUM MATERIALS FOR ELEMENTARY SCHOOLS. (3 cr, §Elem 5102; prereq 5130 or CISy 5600 or Elem 5100 or SeEd 5113)
Selecting and organizing units, courses of study, curriculum guides and writing materials, individually and in groups.

5110. INTRODUCTION TO ELEMENTARY SCHOOL TEACHING. (3 cr, §Elem 3101, §Elem 5000; prereq ¶5183, elem educ major or CLA music educ major or □)
Curriculum, organization, instruction, management, and professional decision making.

5113. CLASSROOM MANAGEMENT IN THE ELEMENTARY SCHOOL. (3 cr, §Elem 5145, §SeEd 5145; prereq tchg or admin exper or #) Hansen
For teachers, administrators, and support staff working in elementary school programs: focus on management of student behavior, instruction as it relates to student behavior, and teacher organizational tasks in the classroom.

5130. INTRODUCTION TO CURRICULUM STUDIES. (3 cr, §CISy 5600)
Definitions of curriculum; historical and current issues; principles and theories of curriculum; alternative models and methods of design and evaluation.

5133. CURRICULUM PLANNING AND DESIGN. (3 cr, §CISy 5605)
Theoretical and practical bases of interdisciplinary curriculum design; models for developing interdisciplinary approaches to curriculum design and implementation; evaluation of interdisciplinary curricula.

5136. HISTORY OF CURRICULUM IN THE UNITED STATES. (4 cr, §CISy 5607)

Survey of formation of public school subjects and curriculum theory in United States from their European roots and early development in 19th century to contemporary issues of reform discussed in relation to the past. Social, political, and economic implications of curriculum history.

5137. THE MULTICULTURAL GENDER-FAIR CURRICULUM. (4 cr, §Elem 5225, §SeEd 5225)

Avery, Walker
Planning for development and implementation of multicultural and gender-fair perspective in elementary and secondary classrooms. Individual teacher goals, professional issues, and resources and teaching strategies for successfully exploring new perspectives.

5138. CLASSROOM COMMUNICATION: MULTICULTURAL AND MORAL PERSPECTIVES. (4 cr; prereq MEd or grad student or #)

Factors that lead to effective communication in ethnically diverse classrooms, preschool through adult. Communication techniques and classroom structures that have cultural and moral implications. Students expand their intercultural communication skills through tutoring and in-class practice.

5145. CURRICULUM TOPICS. (1-4 cr [max 6 cr], §CISy 5100; offered when feasible)

5149. AMERICA'S SCHOOLS IN THE 20TH CENTURY. (3 cr, §CISy 5370, §EdPA 5370; prereq educ or grad student or #)

Analysis and interpretation of events and issues that shaped America's schools in 20th century; current education reform proposals and their antecedents.

5150. SECONDARY SCHOOL TEACHING. (3 cr, §SeEd 5250; prereq educ or CLA music educ student or #, ¶5185 or regis in approved program area practicum)

Curricular, instructional, managerial, leadership, and professional functions.

5153. THEMATIC INSTRUCTION FOR MIDDLE SCHOOLS. (2 cr, §AdEd 5191, §Educ 5191, §Elem 5191, §SeEd 5291)

Logical and contextual relationships among mathematics, science, and social studies as taught in middle schools.

5155. CLASSROOM INSTRUCTION. (3 cr, §CISy 5902; prereq MEd or grad student)

Identifying goals, selecting instructional strategies, and developing assessment procedures for contemporary K-12 students. Incorporates issues related to multicultural education and reflective teaching.

5156. TECHNIQUES OF INSTRUCTION. (3 cr, §SeEd 5132)

Cross-departmental course for developing competencies; application of current psychological research to classroom instruction, defining objectives in terms of achievable student competencies.

5160. SUPERVISION OF ELEMENTARY, SECONDARY, AND POSTSECONDARY INSTRUCTION. (3 cr, §CISy 5800; prereq 5130 or CISy 5600) Anderson

Achievement of appropriate teaching expectations focusing on problems of personnel responsible for their improvement.

5161. SUPERVISORY STRATEGIES. (3 cr, §Elem 5109; prereq #: offered when feasible)

5162. PEER COACHING FOR TEACHERS. (1-3 cr, §CISy 5801; prereq grad or MEd student)

Teachers coaching teachers: acquiring concepts, skills, and dispositions for observing classroom instruction and providing feedback.

5170. CLASSROOM MANAGEMENT IN THE SECONDARY SCHOOLS. (3 cr, §Elem 5145, §SeEd 5145)

For teachers, administrators, and support staff working in secondary school programs: focus on management of student behavior, instruction as it relates to student behavior, and teacher organizational tasks in the classroom.

5172. TEACHING STUDENTS WITH LEARNING DIFFICULTIES. (3 cr, §Elem 5107) Park, Watts

Diagnosis of pupil difficulty; development and prevention; tests as aids to teaching; following up a testing program; socioemotional problems associated with learning difficulties.

5178. SEMINAR IN TEACHER LEADERSHIP. (1-3 cr; prereq grad student or #)

Networking with other teachers for final project in Teacher Leadership Program.

5180. CLINICAL EXPERIENCE IN ELEMENTARY SCHOOL TEACHING. (12 cr, §Elem 5212)

Supervised classroom teaching.

5183. APPLYING INSTRUCTIONAL METHODS IN THE ELEMENTARY SCHOOL. (2 cr per qtr [max 4 cr], §Elem 5211)

Supervised experience in elementary school classrooms.

5185. ORIENTATION IN THE SECONDARY SCHOOLS. (0-2 cr, §SeEd 5251; prereq ¶5150 or ¶SeEd 5250)

Supervised observation in classroom and related school activities.

5187. PRACTICUM: IMPROVEMENT OF TEACHING IN ELEMENTARY OR PRE-KINDERGARTEN SCHOOLS. (3 cr, §Elem 5602; prereq MEd student in elem educ or in early childhood educ)

Elementary school classroom teaching project for improving specific teaching skills; planned by student and approved and directed by student's adviser as part of M.Ed. program.

5190. DIRECTED INDIVIDUAL STUDY IN CURRICULUM AND INSTRUCTION. (1-6 cr [max 6 cr], §CISy 5509; prereq #)

Production and evaluation of curricular materials; review and analysis of literature concerning issues or problems; assessment of curriculum processes.

Graduate Programs

5195. DIRECTED STUDY IN ELEMENTARY AND SECONDARY EDUCATION. (Cr ar [max 6 cr], §SeEd 5351; prereq educ or grad student; S-N optional)

Individual or group work on curricular, instructional, or evaluation problems.

5250. CURRENT TRENDS IN EARLY CHILDHOOD EDUCATION. (3 cr, §Elem 5376;

prereq tchg exper in kindergarten or primary or #) Hansen

Continuing needs of children in our changing culture; current practices and recent research.

5251. EARLY CHILDHOOD EDUCATION: MATERIALS AND RESOURCES. (3 cr, §Elem 5377;

prereq 5250 or Elem 3376 or Elem 3377) Hansen
Experience in the selection and use of commercial and teacher-made educational materials and media common to teaching in early childhood education programs.

5252. CONTEMPORARY PROGRAMS FOR YOUNG CHILDREN. (1-3 cr [max 3 cr], §Elem 5378;

prereq MEd student in early childhood educ)
Growth and development aspects of preschool children in light of need for curriculum intervention programs; current trends, program evaluation, and recent research.

5253. COGNITIVE AND CREATIVE LEARNING IN EARLY CHILDHOOD EDUCATION. (3 cr, §Elem

3379, §Elem 5379; prereq CPsy 1301 or CPsy 5301)
Development approach to planning cognitive, language, and creative curriculum.

5281. STUDENT TEACHING IN THE NURSERY SCHOOL. (3-6 cr, §Elem 3604; prereq approval of

major adviser and director of student tchg)
Supervised teaching.

5310. MICROCOMPUTER USES IN THE ELEMENTARY CLASSROOM. (3 cr, §CISy 5206, §Elem 5140) Stochl

Using microcomputers to enhance instruction across curriculum.

5315. USING LOGO IN THE CLASSROOM. (3 cr, §Elem 5141, §MthE 5173; prereq 5360 or CISy 5003 or equiv)

Using LOGO in elementary and middle grades to develop skills in thinking, planning, and logic; applying fundamental mechanics and philosophy of LOGO using turtle graphics; developing classroom materials.

5330. INTRODUCTION TO INSTRUCTIONAL SYSTEMS. (1 cr, §CISy 5000; offered when feasible)

5331. INSTRUCTIONAL SYSTEMS: TRENDS AND ISSUES. (1-3 cr [max 9 cr], §CISy 5100, §VoEd 5101; offered when feasible)

5335. INTRODUCTION TO INSTRUCTIONAL SYSTEMS AND TECHNOLOGY. (3 cr, §CISy 5151)

Historical foundations, contemporary issues, and research base of instructional systems.

5336. A SYSTEMATIC APPROACH TO DESIGNING INSTRUCTION. (3 cr, §CISy 5201)

Instructional materials design in accordance with systems principles including design of a specific unit of courseware.

5337. PRINCIPLES AND PROCEDURES IN DESIGNING INSTRUCTION. (4 cr, §CISy 5209)

Major models of instructional development; generic components; design models; review of instructional design and learning environments.

5351. COMPUTER-BASED TOOLS FOR TEACHERS. (3 cr, §CISy 5208)

Use of technology for material generation, record keeping, and classroom management tasks in K-12 classrooms.

5355. INTRODUCTORY EDUCATIONAL TECHNOLOGY METHODS. (1-6 cr [no more than 3 cr may be applied to CISy concentration within the educ MA and PhD programs], §CISy 5080)

Techniques for evaluating and selecting hardware and software to meet instructional needs. Strategies and techniques for integrating educational technology to meet curricular goals and objectives.

5356. ADVANCED EDUCATION TECHNOLOGY METHODS. (1-6 cr [no more than 3 cr may be applied to IS concentration within the educ MA and PhD programs], §CISy 5090; prereq 5355 or 5360 or CISy 5003 or CISy 5080 or #)

Current educational technology systems, selection of hardware and software, and strategies for integration of technology into variety of curricular areas. Development and implementation of plans for integration of technology in classroom instruction.

5360. INTRODUCTION TO COMPUTERS AND THEIR USES. (1 cr, §CISy 5003; S-N only)

Computer technology in instruction; hardware, software, terminology, word processing, instructional applications. For students with no background in computing.

5361. INTRODUCTION TO MULTIMEDIA. (1 cr, §CISy 5004; offered when feasible)

5362. INTRODUCTION TO INSTRUCTIONAL COMPUTER PROGRAMMING. (3 cr, §CISy 5006;

prereq 5360 or CISy 5003 or #; A-F only) Hooper
Designing computer-based instruction. Students need not have a mathematics or science background.

5363. COMPUTER-BASED INSTRUCTION: INTRODUCTION TO DESIGN. (3 cr, §CISy 5205; prereq 5362 or CISy 5006 or #)

Computer uses in education and training; models for designing computer-based instruction with emphasis on interface design.

5364. COMPUTER-BASED INSTRUCTION: DESIGN AND DEVELOPMENT. (3 cr, §CISy 5212; prereq 5362 or CISy 5205 or #; offered when feasible)

5365. COMPUTER-BASED GAMES AND SIMULATIONS. (3 cr, §CISy 5216; prereq 5364 or CISy 5212 or #)

Design, implementation, and evaluation of instructional computer-based games and simulations.

5366. COMPUTER-BASED INSTRUCTIONAL GAMES. (3 cr, §CISy 5218; prereq 5364 or CISy 5212 or #)

Design, implementation, and evaluation of instructional computer-based games.

5367. INTERACTIVE VIDEO INSTRUCTION. (4 cr, §CISy 5207; prereq 5361, 5336 or 5337 or 5363 or CISy 5004, CISy 5201 or CISy 5205 or CISy 5209 or #) Multimedia technologies; design and development of interactive instruction.

5390. DIRECTED INDIVIDUAL STUDY IN CURRICULUM AND INSTRUCTION. (1-6 cr [max 6 cr], §CISy 5509; prereq #)

Production and evaluation of curricular materials; review and analysis of literature concerning issues or problems; assessment of curriculum processes.

5400. SURVEY OF CHILDREN'S LITERATURE. (3 cr, §Elem 5210; prereq educ student or #) Techniques of and materials for teaching with children's literature in elementary schools.

5401. LITERATURE FOR THE ELEMENTARY SCHOOL. (3 cr, §Elem 5300) Monson
Evaluative survey of books for children; research related to children's reading interests; selection of literature.

5402. SURVEY OF SPECIAL COLLECTIONS IN CHILDREN'S LITERATURE. (3 cr, §Elem 5305; prereq 5401 or #) Monson
Content and accessibility of collections that relate the creation of books; emphasis on possibilities and methods for interpreting content of collections to children.

5403. CREATIVE WRITING FOR AND BY CHILDREN. (3 cr [max 6 cr], §Elem 5318; prereq 3400 or 3420 or Elem 3300 or Elem 3316 or elem tchg exper or #) Monson
Language arts in elementary school for experienced teachers, supervisors, graduate students, and college instructors; emphasis on creative aspects of writing of children's literature and children's own writing.

5410. TEACHING READING IN THE ELEMENTARY SCHOOL. (3 cr, §Elem 5331; prereq 9 cr educ) Manning, Taylor, Watts
Objectives, materials, and teaching procedures; current practices and curricula; class and individual projects.

5411. READING DIFFICULTIES: ASSESSMENT AND INSTRUCTION. (3 cr, §Elem 5334; prereq 5410 or 5450 or Elem 5331 or SeEd 5344) Manning, Taylor
Causes, prevention, and correction; remedial practices useful to the classroom teacher, school counselor, and reading specialist.

5412. DIAGNOSIS OF READING DIFFICULTIES. (3 cr, §Elem 5335; prereq 5411 or Elem 5334) Taylor
Relationship to psychological factors and clinical remedial correction.

5413. TEACHING STUDENTS WITH READING DIFFICULTIES. (3 cr, §Elem 5336; prereq 5172 or 5411 or Elem 5334 or Elem 5107) Taylor
Assessment and tutoring of individual children who have difficulty in school learning.

5414. BEGINNING READING INSTRUCTION. (3 cr, §Elem 5337; prereq 3410 or Elem 3331 or elem teacher or #) Manning

For teachers and specialists interested in initial teaching procedures; compares alternative methods of beginning instruction; emphasis on readiness programs, test-grouping patterns, language factors, and intensive instruction procedures to prevent reading failure.

5415. TEACHING READING IN THE INTERMEDIATE GRADES. (3 cr, §Elem 5338; prereq 3410 or Elem 3331 or elem tchg exper or #) Taylor, Watts

For teachers and specialists interested in problems of teaching reading beyond the decoding stage; emphasis on comprehension strategies, basic study skills, reading in the content areas, and use of literature in reading program.

5416. WORKSHOP: CURRICULUM IMPLEMENTATION IN ELEMENTARY SCHOOL READING. (1-9 cr [max 9 cr], §Elem 5339; prereq elem tchg exper or #; offered when feasible) Manning, Taylor, Watts

5420. TEACHING WRITING IN THE ELEMENTARY SCHOOL. (3 cr, §Elem 5315; prereq postbac or MED or grad student) Monson, Phinney
Theory and research on writing process, applications to development of elementary school writing curriculum.

5425. TEACHING LANGUAGE ARTS IN THE ELEMENTARY SCHOOL. (3 cr, §Elem 5316; prereq 3420 or Elem 3316 or elem tchg exper) Monson, Phinney
Improvement of instruction, study of trends in English education.

5440. TEACHING LITERATURE IN SECONDARY SCHOOLS. (3 cr, §SeEd 5321) Beach
Current theory and methods of instruction; research and response to literature and reading; adolescent literature; growth assessment; curriculum design and evaluation.

5441. LITERATURE FOR ADOLESCENTS. (3 cr, §SeEd 5320) Beach
Reading and analysis of fiction and nonfiction; methods for critically assessing quality and appeal. Appropriate for secondary English and social studies teachers and librarians.

5450. TEACHING READING IN CONTENT AREAS. (3-5 cr, §SeEd 5344) Graves
Methods of accommodating to student abilities and facilitating reading in regular content classes.

5451. SECONDARY REMEDIAL READING INSTRUCTION. (3 cr, §SeEd 5175; prereq 5410 or 5450 or Elem 5331 or SeEd 5344) Graves
Principles and techniques for developing and conducting programs for secondary students seriously deficient in reading skills.

Graduate Programs

5460. TEACHING WRITING IN SECONDARY SCHOOLS AND COLLEGES. (3-5 cr, §SeEd 5322)

Beach

Historical and contemporary context; analysis of composing processes; prewriting and revision; audience analysis; comprehension and coherence; selected problems in assigning and evaluating writing.

5461. DIAGNOSING AND ASSESSING WRITING IN SECONDARY SCHOOLS. (3 cr, §SeEd 5323;

prereq educ jr or sr or grad student) Beach

Application of theory and research on composition instruction to analysis of diagnosis of writing samples; evaluation of writing using written or conference feedback; large group writing assessment using different rating scales; development of assignments and curriculum materials for writing instruction.

5470. CLASSROOM RESEARCH IN LITERARY EDUCATION. (3 cr, §SeEd 5176) Graves

Review and analysis of current studies; design and analyses for school-based research.

5471. PERSPECTIVES ON ENGLISH STUDIES IN SCHOOLS. (3 cr, §SeEd 5194)

Nature, development, future direction; evaluation of the "given-ness" of English studies in the context of widespread ambiguities of tradition, class, culture.

5472. TEACHING FILM AND TELEVISION. (3 cr, §SeEd 5326) Beach

Current theory and methods of teaching critical response to film and television; techniques, genres, history, economics; integration and use of short film and Super-8 filmmaking with English and social studies teaching in the classroom.

5473. LANGUAGE, CULTURE, AND EDUCATION. (4 cr, §SeEd 5404, §Spch 5404)

Psychological and social-psychological perspectives for study of language-communication; dimensions of language variation (dialects, codes, registers); implications for program development and instructional practices.

5480. SCHOOL-RELATED PROJECTS IN ENGLISH EDUCATION AND READING. (1-6 cr [max 6 cr], §SeEd 5659; prereq MEd student in English educ)

Individual or group work on curricular, instructional, or evaluation problems and projects applicable to school situations.

5485. DIRECTED EXPERIENCES IN TEACHING ENGLISH. (6-12 cr, §SeEd 3621; prereq 5475 or SeEd 5350)

5491. CURRENT DEVELOPMENTS IN ENGLISH EDUCATION. (1-6 cr [max 12 cr], §SeEd 5350; offered when feasible)

5500. TEACHING SCIENCE IN THE

ELEMENTARY SCHOOL. (3 cr, §Elem 5346; prereq postbac in elem educ or #; offered when feasible) Finley, Heller, Johnson, Lawrenz

5501. WORKSHOP: CURRICULUM IMPLEMENTATION IN ELEMENTARY SCHOOL SCIENCE. (1-3 cr [max 12 cr], §Elem 5347; prereq elem tchg exper; offered when feasible) Finley, Heller, Johnson, Lawrenz

5502. WORKSHOP: OUTDOOR SCIENCE EDUCATION. (3 cr, §Elem 5348; prereq elem tchg

exper) Johnson

Classroom and fieldwork activities dealing with models, materials, and methods in the outdoor setting; consideration of broad topics such as ecological relationships, cyclic processes and change as well as more specific topics such as rocks and minerals, plants and animals, and stargazing.

5503. ELEMENTARY SCHOOL SCIENCE: CURRICULUM AND SUPERVISION. (3 cr, §Elem

5349; prereq elem tchg exper or #; offered when feasible) Finley, Heller, Johnson, Lawrenz

5504. ELEMENTARY SCHOOL SCIENCE: MATERIALS AND RESOURCES. (3 cr, §Elem 5350;

prereq elem tchg exper or #) Finley, Heller, Johnson, Lawrenz

Experiences in the use of educational materials and media common to the teaching of modern elementary school science.

5505. INTEGRATING SCIENCE AND HEALTH EDUCATION. (3 cr, §Elem 5351; prereq educ or grad

student or #)

Techniques of and backgrounds for integrating instruction of science and health.

5506. TEACHING HEALTH IN THE ELEMENTARY SCHOOLS. (1 cr, §Elem 5213; prereq elem postbac student or #)

Techniques of and materials for teaching health at elementary level.

5507. TEACHING GEOLOGY IN ELEMENTARY SCHOOLS. (3 cr, §Elem 5352; prereq admission to an educ grad prog or #; offered when feasible)

5530. SCIENCE EDUCATION FOR THE MIDDLE SCHOOL. (3 cr, §SeEd 5700; prereq science educ

student or #)

Planning science education.

5531. TEACHING SECONDARY SCHOOL SCIENCE: A CONSTRUCTIVIST APPROACH.

(4 cr, §SeEd 5702; prereq 5530, 5580 or SeEd 5700, SeEd 5701, ¶CI 5581 or ¶SeEd 5703, postbac science educ student or #) Finley, Heller, Lawrenz

Science teaching methods.

5532. CURRENT DEVELOPMENTS IN SECONDARY SCHOOL SCIENCE TEACHING.

(3 cr, §SeEd 5390; prereq MA or MEd or PhD student in educ or #) Finley, Heller, Lawrenz

Curricula, methods, materials of instruction, evaluation.

5533. STUDIES IN SCIENCE EDUCATION. (3 cr, §SeEd 5397; prereq 8500 or SeEd 8887, MEd student, #)

Improvement of science teaching through application of research findings.

5534. FOUNDATIONS OF SCIENCE EDUCATION. (3 cr, §SeEd 5706; prereq MA or MEd or PhD student in educ)

Analyzes present practice in light of historical and philosophical foundations of science education.

5535. SCIENCE EDUCATION ASSESSMENT. (3 cr, §SeEd 5398; prereq science educ grad student or #)

Lawrenz
Strategies for specifying science education outcomes and techniques for assessment.

5536. INTERACTIONS OF SCIENCE AND MATHEMATICS. (3 cr, §MthE 5174, §SeEd 5274; prereq math educ or science educ student or #)

Unifying concepts and central themes common to mathematics and physical science. Fundamental concepts and principles, problem solving in interdisciplinary environment, and lab activities for junior and senior high school classes.

5537. WORKSHOP: SCIENCE EDUCATION. (1-12 cr [max 12 cr], §SeEd 5394; prereq MA or MEd or PhD student in educ or #)

Analysis of issues, materials, and instructional techniques related to current topics of relevance to secondary school and college science teachers; each offering to focus on a single topic for varying credit.

5572. SEMINAR: REFLECTING ON CLINICAL EXPERIENCE IN SCIENCE TEACHING. (3 cr, §SeEd 5705; prereq 5531, 5581 or SeEd 5702, SeEd 5703, ¶CI 5582 or ¶SeEd 5704, #)

Reflections and issues.

5580. APPLYING SCIENCE EDUCATION. (3 cr, §SeEd 5701; prereq ¶5530 or ¶SeEd 5700, science educ student or #)

Teaching science education in middle school.

5581. APPLYING SCIENCE METHODS IN HIGH SCHOOLS. (4 cr, §SeEd 5703; prereq 5530, 5580 or SeEd 5700, SeEd 5701, ¶CI 5331 or ¶SeEd 5702, postbac student or #) Finley, Heller, Lawrenz

Practicum in conducting, analyzing, and reflecting on science teaching in secondary schools.

5582. CLINICAL EXPERIENCE IN SCIENCE TEACHING. (6 or 12 cr, §SeEd 5704; prereq 5531, 5581, ¶5572 or SeEd 5702, SeEd 5703, ¶SeEd 5705, #) Finley, Heller, Lawrenz

Supervised clinical experiences in secondary school science teaching.

5583. SCHOOL-BASED PROJECTS IN SCIENCE EDUCATION. (1-12 cr [max 12 cr], §SeEd 5395; prereq MEd student in science educ)

Individual or group work on curricular, instructional, or evaluation problems and projects applicable to school situations.

5619. TEACHING SECOND LANGUAGES AND CULTURES IN ELEMENTARY SCHOOLS. (4 cr, §Elem 5319) Jorstad

Methods and materials; developing oral and written communication; consideration of alternatives in program format; preparation of materials; global awareness and cross-cultural experience; assessing children's language; children's literature, games, songs, developing units and lessons.

5620. SECOND LANGUAGES AND YOUNG CHILDREN: LIKE CHILD'S PLAY. (4 cr, §Elem 5321)

Current approaches to teaching second languages to young children; emphasizes innovative curricular models. How young children acquire language; effects of bilingualism on child development. Rationales, advantages, and pedagogical theories of program models, from full immersion to programs that emphasize cultural understanding. Visits to actual classrooms and with bilingual and immigrant families.

5631. SECOND LANGUAGE CURRICULUM. (3 cr per qtr [total 9 cr], §SeEd 5801; prereq postbac student) Jorstad, Tedick, Walker

Course spans one academic year; component of teacher education program. Nature of school and second language curriculum; variety of curricular orientations and their implications for instruction and evaluation.

5632. SECOND LANGUAGE INSTRUCTION. (3 cr per qtr [total 9 cr], §SeEd 5802; prereq postbac student) Jorstad, Tedick, Walker

Course spans one academic year; component of teacher education program. Developing skills for selecting, organizing, and providing effective second language learning opportunities through observation, practice, and reflection.

5633. SECOND LANGUAGE RESEARCH. (2 cr per qtr [max 6 cr], §SeEd 5803; prereq graduate of SLC postbac licensure, 6 cr after licensure) Jorstad, Tedick, Walker

Classroom-based examination of teaching and student learning over academic year.

5640. FOUNDATIONS OF BILINGUAL EDUCATION. (4 cr, §SeEd 5216) Walker
Development of bilingual schooling in the United States; history, social and political impact, implications of congressional and judicial decisions related to language minority populations, current policy as it affects programs serving populations with limited English proficiency.

5641. PROGRAMS AND CURRICULA IN BILINGUAL EDUCATION. (4 cr, §SeEd 5217)
Current curricular strategies for instructing language minority students in United States and selected international settings; analysis of styles by program and individual student learning goals; materials for instruction and content focusing on non-English language curriculum; typologies and models of instructional programs; operational variables affecting curricular patterns and program goals.

5642. ASSESSMENT OF LEARNERS WITH LIMITED ENGLISH PROFICIENCY. (4 cr, §SeEd 5218) Walker

Social, political, and educational context of assessment of students with limited English proficiency; evaluation vs. research and implications for bilingual schooling, curriculum development, and materials selection; existing methods for assessing language proficiency and academic achievement.

Graduate Programs

5645. SCHOOLING OUTCOMES FOR A MULTIETHNIC SOCIETY. (4 cr, §SeEd 5221)

Analysis of schooling experiences for students of African-American, Hispanic, Asian, and American Indian backgrounds. Changing perspectives concerning ethnic student achievement, research on factors influencing school achievement, and prospects for change.

5650. SECOND LANGUAGE AND CULTURES EDUCATION: INTRODUCTION AND OVERVIEW. (4 cr, §SeEd 5186)

Curricula and instruction in various settings: elementary, secondary, open, free, suburban, and center city schools; bilingual programs, colleges, community colleges, universities, and adult programs including teacher preparation.

5652. TEACHING CULTURE: THEORY AND APPLICATION. (4 cr, §SeEd 5122; prereq postbac or grad student) Paige, Walker

Analysis of concept; related factors and materials for classroom use; culture shock; empathy; culture conflict, awareness, learning.

5654. PARENT INVOLVEMENT IN SECOND LANGUAGE PROGRAMS. (3 cr, §SeEd 5220; offered alt yr) Walker

Nature of parent and community involvement; role of family and community in education of language minority children; actualizing parent potential and participation in classrooms and schools.

5655. TECHNOLOGY IN SECOND LANGUAGE LEARNING AND TEACHING. (4 cr, §SeEd 5184)

Role of new technology in second language learning; analysis of applications to delivery of instruction and curriculum; planning for research on use of technology in language acquisition.

5656. READING AND WRITING IN A SECOND LANGUAGE. (4 cr, §SeEd 5219)

Reading comprehension and composing processes in a second language; relationship between first and second language comprehension and composing processes, between reading and writing, and between culture and reading comprehension and writing; politics of literacy; assessment of second language literacy.

5657. SPEAKING AND LISTENING IN A SECOND LANGUAGE. (4 cr, §SeEd 5385) Jorstad

Theories and methods of teaching language as communication in oral and aural modes; planning student interaction; classroom organization for learning and acquisition. Students complete reflective analyses of lessons.

5658. SECOND LANGUAGE TESTING, ASSESSMENT, AND EVALUATION. (4 cr, §SeEd 5382) Jorstad, Tedick

Language proficiency assessment, English as a second language, bilingual education; oral interviews; testing communicative abilities; standardized language measures; building test items; evaluating programs; aptitude and attitude measurement.

5660. SPECIAL TOPICS IN THE TEACHING OF SECOND LANGUAGES AND CULTURES. (1-10 cr [max 10 cr], §SeEd 5191) Jorstad, Lange, Paige, Tedick, Walker

Related specifically to the needs of the in-service teacher; topics, location, and duration is highly flexible.

5662. CRITICAL ISSUES IN SECOND LANGUAGE CURRICULUM. (4 cr, §SeEd 5189) Lange, Tedick

Development of competencies in curriculum and materials construction; application to lessons, units, modules, courses, levels of instruction in ongoing programs of second language acquisition in schools.

5669. SCHOOL AND PROFESSIONAL-BASED EXPERIENCES IN SECOND LANGUAGES AND CULTURES. (1-12 cr [max 12 cr], §SeEd 5185; prereq MEd student)

Opportunity for teachers to work together on curricular, instructional, or evaluation problems; internship experiences; participation in professional activities.

5680. PRACTICUM: TEACHING SECOND LANGUAGES AND CULTURES IN ELEMENTARY SCHOOLS. (3 cr, §Elem 5320; prereq 5619 or Elem 5319, §CI 5619 or ¶Elem 5319, #; S-N only) Jorstad

Minimum of three hours weekly of supervised teaching and observation in elementary schools.

5684. CLINICAL EXPERIENCES IN SECOND LANGUAGES. (4 cr per qtr [total 12 cr], §SeEd 5804; prereq postbac student)

Course spans one academic year; component of teacher education program. Teaching and learning experience in both elementary and secondary second language classrooms.

5690. DIRECTED STUDY IN SECOND LANGUAGES AND CULTURES. (Cr ar [max 6 cr], §SeEd 5351; prereq educ or grad student; S-N optional) Individual or group work on curricular, instructional, or evaluation problems.

5700. TEACHING SOCIAL STUDIES IN THE ELEMENTARY SCHOOL. (3 cr, §Elem 5361; prereq 5110 or Elem 3101 or equiv, postbac student) Avery, Cogan

Content and organization of social studies programs; programs of understanding, improving the learning situation, and effective use of materials.

5730. SOCIAL STUDIES FOR THE IN-SERVICE ELEMENTARY/MIDDLE SCHOOL TEACHER. (3 cr, §Elem 5361; prereq 5110 or Elem 3101, postbac student) Avery, Cogan

Content and organization of social studies programs; programs of understanding, improving the learning situation, and effective use of materials.

5740. INTRODUCTION TO SOCIAL STUDIES EDUCATION. (4 cr, §SeEd 5152; prereq postbac student)

Analysis of teaching strategies and contemporary curriculum materials in the social studies; techniques of instruction useful in inquiry; strategies of analysis; classroom behavior and evaluation; required of all M.A., M.Ed., and Ph.D. candidates.

5741. ADVANCED METHODS FOR TEACHING THE SOCIAL STUDIES. (4 cr, §SeEd 5150; prereq postbac student)

Advanced methods for social studies teachers; prerequisite to other graduate-level courses in social studies education.

5742. THE SOCIAL SCIENCES AND THE SOCIAL STUDIES. (3 cr per qtr [max 6 cr], §SeEd 5153; prereq postbac student) Avery

Issues, materials, and instructional techniques related to current topics of particular relevance to social studies teachers.

5746. TEACHING ABOUT THE NEWSPAPER IN THE CLASSROOM. (1-3 cr [max 4 cr], §Elem 5227, §SeEd 5227) Avery

Institution of the newspaper; articulation of series of useful instructional strategies, curriculum development techniques, and teaching materials.

5747. GLOBAL EDUCATION: CONTENT AND PRACTICE. (3 cr, §Elem 5164, §SeEd 5164; offered alt yrs) Avery, Cogan

To help classroom teachers and administrators assess current methods and materials and select appropriate evaluation instruments by examination of existing content and methods in global education.

5760. SOCIAL STUDIES FOR THE IN-SERVICE MIDDLE/SECONDARY SCHOOL TEACHER. (3 cr, §SeEd 5152; prereq in-service teacher or #)

Analysis of teaching strategies and contemporary curriculum materials in the social studies; techniques of instruction useful in inquiry; strategies of analysis; classroom behavior and evaluation; required of all M.A., M.Ed., and Ph.D. candidates.

5763. ECONOMICS EDUCATION PROGRAMS.

(1-3 cr, §SeEd 5167; prereq Econ 1002 or equiv or #) Conceptual framework of economic education through analyzing its research, objectives, philosophy, scope, and curricular sequence.

5764. SOCIAL STUDIES INQUIRY PROJECT.

(1-6 cr [max 6 cr], §SeEd 5151; prereq #) Avery Provides opportunity to work individually or in teams on curricular, instructional, or evaluation problems within the school.

5780. PRACTICUM: SECONDARY SOCIAL STUDIES EDUCATION. (1-7 cr [max 7 cr], §SeEd 3152; prereq educ student, Δ for postbac students)

Pre-student-teaching experience for developing teacher competencies; supervised observation and participation in classroom and related school activities.

5782. STUDENT TEACHING IN SECONDARY SOCIAL STUDIES. (3-15 cr [max 15 cr], §SeEd 3641; prereq SeEd 3350, postbac student)

5821. TEACHING MATHEMATICS IN THE ELEMENTARY SCHOOL. (3 cr, §Elem 3391; prereq 5110 or Elem 3100, Elem 3101, Math 1005, Math 1006) Principles of learning pertinent to modern program of mathematics in primary and elementary grades; objectives, content, philosophy, instructional materials, and methods of instruction and evaluation.

8075. SEMINAR: ART EDUCATION. (1 cr, §ArEd 8306) DiBlasio, Freedman
Reports, evaluation of problems, recent literature.

8079. RESEARCH IN ART EDUCATION. (3 cr, §ArEd 8300) DiBlasio, Freedman
Research techniques.

8099. PROBLEMS: ART EDUCATION. (Cr ar, §ArEd 8900; prereq #) DiBlasio, Freedman
Independent projects under staff guidance may include advanced studio practice or technical problems requiring experimental or library research.

8130. CURRICULUM AND INSTRUCTION CORE: CRITICAL EXAMINATION OF CURRICULAR CONTEXTS. (3 cr, §CISy 8100; prereq PhD student or #) Lange
Impact of aesthetic, historical, social, political, and cultural forces on current curriculum contexts. Seminar.

8131. CURRICULUM AND INSTRUCTION CORE: TEACHING THEORY AND RESEARCH. (3 cr, §CISy 8102; prereq PhD student or #)
Overview of research on teaching: historical perspective, modern empirical procedures and findings, and implications of research for practice and for future investigation.

8132. CURRICULUM AND INSTRUCTION CORE: RESEARCH METHODS IN CURRICULUM AND INSTRUCTION. (3 cr, §CISy 8103; prereq PhD student or #; A-F only)
Purposes, approaches, and assumptions related to methods of educational research, such as descriptives correlational, case-study, experimental, ethnographic, and developmental. Seminar.

8133. SEMINAR IN TEACHING IN COLLEGES OF EDUCATION. (3 cr, §CISy 8201; prereq doctoral student or #, ¶8134)
Goals, instructional strategies, and evaluation procedures.

8134. PRACTICUM IN TEACHING IN COLLEGES OF EDUCATION. (1 cr, §CISy 8202; prereq 8133 or CISy 8201, doctoral student or #)
Supervised teaching in education course at University of Minnesota or at another college or university.

8135. CURRICULUM STUDIES SEMINAR. (4 cr, §CISy 8416)
Problems and issues in curriculum theory and research.

8136. CURRICULUM REFORM AND SOCIAL CHANGE. (2 cr [max 4 cr], §CISy 8600; prereq 5100 or 5130 or CISy 5600 or Elem 5100 or #)
Implications for curriculum of social change, institutional arrangements, and educational reform movements; influence of curriculum on change and implementation issues related to school reform; processes of curriculum implementation and supervision.

8140. CURRICULUM IMPLEMENTATION AND LEADERSHIP. (4 cr, §CISy 8610)
Enactment of curriculum in various institutional and cultural settings; methods and processes of implementation; several types of curriculum packages and various populations; leadership strategies for curriculum specialists.

Graduate Programs

8147. THE DOMAIN OF CURRICULUM THEORY AND RESEARCH: ALTERNATIVE PARADIGMS AND RESEARCH METHODS. (4 cr, §CISy 8620)

Assessment of inquiry traditions, research methods, and exemplar studies in empirical-analytic, deliberative, and reconceptualist traditions of curriculum. Includes survey of quantitative and qualitative research methods and other inquiry as applied to curriculum questions.

8190. PROBLEMS: IMPROVEMENT OF INSTRUCTION. (Cr ar, §Elem 8991; prereq #)

For students qualified to make intensive studies of problems related to school supervision.

8191. CURRICULUM LEADERSHIP: INTERNSHIP. (1-4 cr, §CISy 8700)

Curriculum planning, design, development, implementation, and evaluation. Leadership practice in clinical setting.

8195. PROBLEMS: SECONDARY SCHOOL SUPERVISION. (Cr ar, §CISy 8800, prereq Δ)

Individual problems on improvement of instruction.

8198. PROBLEMS: TEACHER EDUCATION. (3-9 cr, §AdEd 8284; prereq Educ 8284, #)

Research in supervision, organization, and administration; lab experiences at elementary and secondary levels.

8199.* PROBLEMS: CURRICULUM STUDIES.

(3-9 cr, §CISy 8501; prereq PhD student)
Individual empirical investigation.

8290. PROBLEMS: TEACHING KINDERGARTEN.

(3 cr, §Elem 8976; prereq #) Hansen
Opportunity for in-depth study or research related to self-selected interest areas in kindergarten education.

8340. INSTRUCTIONAL SYSTEMS RESEARCH AND THEORY. (3 cr, §CISy 8305, §SeEd 8305; prereq MA or PhD student)

Planning instructional system research.

8341. DESIGNING INSTRUCTIONAL MATERIALS: RESEARCH AND THEORY. (3 cr, §CISy 8307; prereq 5337 or CISy 5209, MA or PhD student)

Theory and practice; conventional group instruction; individualized instruction, or instruction using new media for self-instruction.

8361. ADVANCED COURSEWARE AND DESIGN: ISSUES. (3 cr, §CISy 8411; prereq 5365 or 5366 or CISy 5216 or CISy 5218 or #; offered when feasible)

8370. ADVANCED DESIGNS IN COURSEWARE: VIDEO. (3 cr, §CISy 8412; prereq 5367 or CISy 5207 or #; offered when feasible)

8390.* PROBLEMS: INSTRUCTIONAL SYSTEMS.

(Cr ar, §CISy 8501; prereq #)
Individual empirical investigation.

8391. INSTRUCTIONAL SYSTEMS SEMINAR. (2 cr [max 6 cr], §CISy 8416; prereq #; offered alt yrs)

Problems and issues in instructional theory and research.

8400. RESEARCH IN SPECIAL COLLECTIONS OF CHILDREN'S LITERATURE. (1-3 cr [max 6 cr], §Elem 8300) Monson

Comparative study of national and international special collections of original manuscripts, artwork, first editions, and other bases for collecting children's books; research in University Library's Special Collections or other accessible collection.

8411. RESEARCH FOUNDATIONS FOR READING INSTRUCTION. (3 cr, §Elem 8331; prereq 5410 or #;

offered alt yrs) Manning
Critical review and analysis of classical research studies in the psychology, pedagogy, and sociology of reading; criteria for appraising research findings; educational implications.

8412. RECENT RESEARCH IN READING. (3 cr, §Elem 8332; prereq #) Taylor, Watts

Critical analysis of methodology and findings of current research; appraising research methods, population limitations, and educational implications.

8413. SEMINAR: READING RESEARCH AND INSTRUCTION. (1-3 cr [max 9 cr], §Elem 8333; prereq #) Graves, Watts

Problems of research at all levels; topics vary according to offering; presentation of proposed designs and current studies.

8420. RESEARCH IN ENGLISH COMPOSITION IN ELEMENTARY SCHOOLS. (3 cr, §Elem 8316; prereq 5425 or Elem 5316 or equiv) Monson, Phinney

Review of theory and research in the teaching and learning of writing; future research directions determined by current classroom practices.

8425. RESEARCH ON DEVELOPMENT IN SPELLING, HANDWRITING, AND LISTENING.

(3 cr, §Elem 8317; prereq 5425 or Elem 5316)
Review of findings with implications for the classroom teacher; evaluation criteria and needed research.

8470. INTRODUCTION TO RESEARCH IN ENGLISH EDUCATION AND READING. (4 cr, §SeEd 8892)

8471. ADVANCED TOPICS IN ENGLISH EDUCATION AND READING. (1-9 cr [max 9 cr], §SeEd 8893; prereq #) Beach
Selected special topics with implications for curriculum development and change.

8492. READINGS IN ENGLISH EDUCATION AND READING. (1-3 cr, §SeEd 8895) Beach, Graves, Kegler

Readings in secondary school English curriculum and instruction.

8493. PROBLEMS: TEACHING ENGLISH AND READING. (Cr ar, §Elem 8916, §Elem 8931, §SeEd 8896) Beach, Graves, Kegler

For those qualified to undertake individual research.

8500. RESEARCH FOUNDATIONS OF SCIENCE EDUCATION. (3 cr, §Elem 8346, §SeEd 8887) Finley, Heller, Lawrenz

Implications for the improvement of instruction in junior and senior high schools.

8501. THE ELEMENTARY SCHOOL SCIENCE PROGRAM: ARTICULATION AND COORDINATION. (3 cr, §Elem 8347; prereq 5504, 8500; offered when feasible) Finley, Heller, Johnson, Lawrenz

8570. SEMINAR: RESEARCH IN SCIENCE EDUCATION. (3 cr [max 9 cr], §SeEd 8899; prereq MA or PhD student or #) Finley, Heller, Johnson, Lawrenz
Problems of science instruction, kindergarten through college; opportunity to discuss needed research, develop proposals, and design models for empirical research.

8590. PROBLEMS: CURRICULUM CONSTRUCTION IN SCIENCE EDUCATION. (Cr ar, §SeEd 8871; prereq #; offered when feasible) Finley, Heller, Lawrenz

8630. RESEARCH IN SECOND LANGUAGES AND CULTURES EDUCATION. (4 cr, §SeEd 8188) Jorstad, Lange
Identification and retrieval of information; preparation of research proposals, papers, and theses; examination of empirical research models; discussion of needed research; designing an individual study.

8631-8632-8633. RESEARCH SEMINAR: SECOND LANGUAGES AND CULTURES EDUCATION. (3 cr per qtr [max 9 cr], §SeEd 8387; prereq 8630 or SeEd 8188) Jorstad, Lange, Paige, Tedick, Walker
Three-quarter seminar. Students select a problem; design an appropriate study; collect and analyze data; summarize results; prepare and submit a manuscript designed for publication; cooperate in critical review of projects.

8640. SECOND LANGUAGE TEACHING IN THE CLASSROOM: THEORY AND APPLICATIONS. (4 cr, §SeEd 8187) Lange
Variables affecting second language learning in classrooms: attitudes, motivation, learner, teacher, environment, materials, learning models, methods; research contribution to understanding second language learning; bilingual education.

8650. SEMINAR: SPECIAL TOPICS IN SECOND LANGUAGES AND CULTURES RESEARCH. (1-4 cr)

8694. PROBLEMS: SECOND LANGUAGES AND CULTURES EDUCATION. (Cr ar [max 8 cr], §SeEd 8894) Jorstad, Lange, Tedick, Walker
Individual research.

8698. READINGS IN SECOND LANGUAGES AND CULTURES EDUCATION. (1-4 cr, §SeEd 8898) Jorstad, Lange, Tedick, Walker
Readings in development, research, curriculum, instruction, evaluation, culture, teacher education as needed by student.

8740. SEMINAR: TRENDS AND ISSUES IN SOCIAL STUDIES EDUCATION. (3 cr, §Elem 83363; prereq Elem 3361 or Elem 5361, Elem 8362 or #) Avery, Cogan
Development of proposals and design models for empirical research; problems of social studies instruction for grade levels K-6.

8742. SEMINAR: RESEARCH IN SOCIAL STUDIES EDUCATION. (3 cr, §Elem 8362, §SeEd 8362; prereq M.A. or Ph.D. student or #, 5740 or SeEd 5152, SeEd 8104; offered when feasible) Avery

8750. PROBLEMS: SOCIAL STUDIES EDUCATION. (3-9 cr [max 9 cr], §Elem 8961, §SeEd 8801; prereq 5741, 5740 or SeEd 5150, SeEd 5152, SeEd 5156, SeEd 8104 or #) Avery
Individual research.

Mathematics Education (MthE)

5040. TEACHING MATHEMATICS: ADVANCED TOPICS. (3 cr; prereq math ed or grad student or #)
Pedagogy, content, and instructional strategies for teaching trigonometry, analysis, calculus, probability, statistics, discrete mathematics. Content and issues relevant to advanced mathematics curriculum. Instructional materials and appropriate technology.

5081. TEACHING SECONDARY SCHOOL ARITHMETIC. (3 cr; prereq math educ major or minor, Math 5081 or ¶5081 or #)
Survey of concepts, principles, and processes of secondary school pre-algebra curriculum; learning difficulties, teaching strategies and alternatives; mathematical foundations of pre-algebra topics.

5082. TEACHING ALGEBRA. (3 cr, §5020; prereq math educ major or minor, Math 5082 or ¶5082 or #)
Survey of concepts, principles, and processes of secondary school curriculum; learning difficulties, teaching strategies and alternatives; mathematical foundations of algebra topics.

5083. TEACHING GEOMETRY. (3 cr; prereq math educ major or minor, Math 5083 or ¶5083 or #)
Survey of concepts, principles, and processes of secondary school geometry curriculum; learning difficulties, teaching strategies and alternatives; mathematical foundations of geometry topics.

5101. WORKSHOP: ELEMENTARY SCHOOL MATHEMATICS. (1-12 cr [max 12 cr]; not open to majors in math educ)
Modern trends, methods, and materials used to convey mathematical ideas.

5102. WORKSHOP: MATHEMATICS EDUCATION. (1-12 cr [max 12 cr])
Issues, materials, and instructional techniques focusing on a single current topic of particular relevance to secondary school and college mathematics teachers.

5150. TOPICS IN RECREATIONAL MATHEMATICS. (3 cr; prereq educ or grad student or #)
Survey including magic squares; palindromes, repunits, repdigits from number theory; geometric dissections, topological recreations, cryptarithms; uses as problem-solving modes in mathematics classrooms.

Graduate Programs

5152. GEOMETRY FOR PRIMARY GRADES.

(1-3 cr [3 max cr]; prereq educ or grad student or #)
Geometric content and pedagogy. Levels of geometric thought, formation of spatial abilities; early childhood concepts from topology, transformational geometry, Euclidean geometry, and applications; dimensional models, construction, planal tessellations.

5153. GEOMETRY IN THE INTERMEDIATE GRADES.

(1-3 cr [3 max cr]; prereq educ or grad student or #)
Instructional approaches and physical materials relating to teaching of informal and intuitive geometric concepts in intermediate and middle school grades. Fundamental concepts of measurements and geometric relationships in 1, 2, and 3 dimensions, measurement systems, estimation, geometric figures and their properties, transformations and symmetry, congruence and similarity.

5170. TEACHING PROBLEM SOLVING, REASONING, AND PROOF.

(3 cr; prereq math ed or grad student or #)
Fundamental concepts and principles. Emphasis on activities and applications for junior and senior high classes. Pedagogical experiences to prepare teachers.

5171. TEACHING PROBABILITY AND STATISTICS.

(3 cr, §SeEd 5274; prereq postbac educ student or #; at least 1 math course in probability or statistics or combinatorics recommended)
Fundamental concepts and principles. Emphasis on activities and applications for junior and senior high classes. Pedagogical experiences to prepare teachers to integrate quantitative literacy in classrooms.

5172. HISTORICAL TOPICS IN THE MATHEMATICS CLASSROOM.

(3 cr; prereq math ed or grad student or #)
History of school mathematics content and methodology. Cross-cultural contributions in development of mathematical ideas; development of lessons, activities, and materials for school use.

5173. LOGO IN THE MATHEMATICS CLASSROOM.

(3 cr, §Elem 5141; prereq CISy 5003 or equiv, math ed or grad student or #)
Using LOGO in mathematics classroom to develop skills in thinking, planning, and problem solving; LOGO philosophy and use of microworlds; using advanced features and turtle graphics; developing classroom materials.

5174. INTERACTIONS OF SCIENCE AND MATHEMATICS.

(3 cr, §SeEd 5274; prereq math educ student or science educ student or #)
Unifying concepts and central themes common to mathematics and physical science. Fundamental concepts and principles, problem solving in interdisciplinary environment, and lab activities for junior and senior high school classes.

5301. INSTRUCTIONAL LEADERSHIP IN ELEMENTARY SCHOOL MATHEMATICS.

(3 cr; not open to majors in math educ; prereq #; offered when feasible)

5311. TEACHING AND SUPERVISION OF MATHEMATICS IN THE ELEMENTARY SCHOOL.

(3 cr; prereq Elem 3391 or #)
Present practices and trends in methods, evaluation, and diagnosis; objectives, psychology, and philosophy related to improvement of instruction.

5312. TEACHING AND SUPERVISION OF MATHEMATICS IN THE SECONDARY SCHOOL.

(3 cr; prereq mathematics tchg exper or #)
Methods, materials, and curriculum development; principles of learning; review of research; preparation and evaluation of tests, units, and materials of instruction.

5313. TEACHING AND SUPERVISION OF MATHEMATICS IN THE MIDDLE SCHOOL.

(4 cr; prereq elem or secondary licensure; offered when feasible)

5321. MATERIALS LABORATORY FOR ELEMENTARY SCHOOL MATHEMATICS INSTRUCTION.

(3 cr; prereq 5311 or Elem 3391 or #)
Printed and programmed materials, audio-visual aids, community resources; lab projects and techniques of using mathematical devices and instruments.

5322. MATERIALS LABORATORY FOR SECONDARY SCHOOL MATHEMATICS INSTRUCTION.

(3 cr; prereq 5312 or #)
Sources and types of materials, lab projects and techniques of using mathematics devices and instruments, visual aids, and community resources.

5331. CURRENT DEVELOPMENTS IN ELEMENTARY SCHOOL MATHEMATICS INSTRUCTION.

(3 cr; prereq 5311 or #)
Contemporary literature, trends, and experimentation with content; criteria for program evaluation.

5332. CURRENT TRENDS AND ISSUES IN SECONDARY SCHOOL MATHEMATICS INSTRUCTION.

(3 cr; prereq 5312 or #)
Recent developments in mathematics curriculum and instructional alternatives, issues in teaching and learning; providing for special student needs; program planning and evaluation.

5345. MATHEMATICS FOR GIFTED CHILDREN.

(3 cr; prereq 5311 or Elem 3391 or #; offered when feasible)

5355. MATHEMATICS FOR SLOW LEARNING CHILDREN.

(3 cr; prereq 5311 or Elem 3391 or #)
Units of instruction emphasizing mathematical concepts essential for vocational competence; experimental materials and methods designed to improve performance of low achievers.

5366. TECHNOLOGY-ASSISTED MATHEMATICS INSTRUCTION.

(3 cr; prereq math ed or grad student, CISy 5006 or equiv or #)
Computers, programmable and graphing calculators, and video as instructional tools in mathematics; design and evaluation of technology-based mathematics lessons; effect of technology on mathematics curriculum; managing technology in the classroom.

5630. CLINICAL EXPERIENCES IN TEACHING GEOMETRY. (2 cr; 5620, ¶5030, math educ student or #)
Observation and participation in geometry classrooms. Supervised microteaching and peer teaching. Development of observational, classroom management, and communication skills.

5680. PRACTICUM IN MATHEMATICS EDUCATION. (3-9 cr [max 9 cr]; prereq #)
Supervised experience in teaching or related work in school.

5980. DIRECTED STUDIES IN MATHEMATICS EDUCATION. (3-9 cr [max 9 cr]; prereq #)
Survey of recent literature; design and preparation of reports on special problems.

8500. THEORY AND CLASSICAL RESEARCH IN MATHEMATICS EDUCATION. (3 cr; prereq 5311 or 5312 or #)
Critical review of research and relevant theoretical formulations; criteria for appraising research methods, educational implications.

8570. RESEARCH IN MATHEMATICS EDUCATION. (4 cr; prereq 8500 or #; offered when feasible)

8590. SEMINAR: MATHEMATICS EDUCATION. (Cr ar [max 8 cr]; prereq #)
Problems of mathematics instruction at levels of kindergarten through junior college; opportunity to develop proposals and design models for empirical research.

8680. INTERNSHIP: MATHEMATICS EDUCATION. (Cr ar)
Participation in supervision, instruction, curriculum development, or research to gain in-service experience in a leadership role; includes a seminar; related project; required for the specialist certificate in mathematics education.

8980. PROBLEMS: MATHEMATICS EDUCATION. (Cr ar; prereq 8500 or 8570)
Surveying the most recent literature, designing and preparing research reports on special problems.

Dentistry

Professor: Richard P. Elzay, *dean*; Robert A. Vickers, *director of graduate studies*; Dwight L. Anderson; M. Bashir Bakdash; Carl L. Bandt; David O. Born; Jaroslav Cervenka; Anthony J. DiAngelis; William H. Douglas; Mohamed E. N. ElDeeb; Richard J. Goodkind; Mark C. Herzberg; Myer S. Leonard; William F. Liljemark; Leslie V. Martens; Karlind T. Moller; Bruce L. Pihlstrom; Charles F. Schachtele; Burton L. Shapiro; Quenton T. Smith; T. Michael Speidel; Michael J. Till

Clinical Professor: Richard R. Bevis; Frank W. Worms

Associate Professor: Gary C. Anderson; James L. Baker; Muriel J. Bebeau; Ralph DeLong; Mahmoud E. ElDeeb; James R. Friction; Kenneth M. Hargreaves; James E. Hinrichs; Ramesh K. Kuba; Thomas D. Larson; Kathleen J. Newell; Maria R. Pintado; Eric L. Schiffman; John K. Schulte; Larry F. Wolff; Omar A. Zidan

Clinical Associate Professor: Gerald D. Cavanaugh

Assistant Professor: John P. Conry; Pamela R. Erickson; James R. Holtan; Bryan S. Michalowicz; Nelson L. Rhodus; Chester J. Schultz, Jr.

Clinical Assistant Professor: Daniel E. Gatto

Senior Psychologist: Kate M. Hathaway

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.S. (Plan A only).

Curriculum—Advanced educational programs for the M.S. degree (and for clinical specialties) in the School of Dentistry include endodontics, oral pathology, oral and maxillofacial surgery, orthodontics, pediatric dentistry, periodontics, prosthodontics, and general practice residencies and programs. Other clinical and postdoctoral programs include temporomandibular disorders and craniofacial pain, operative dentistry, caries research, oral and maxillofacial radiology, geriatric dentistry, primary dental care, and the Dentist Scientist Award.

The Dentist Scientist Award (DSA), which is supported by a grant from the National Institutes of Health, provides for Ph.D. training in basic sciences and advanced education in a clinical specialty of dentistry. Individual awards are competitive. Information regarding the DSA may be obtained from the principal investigator, Dr. Mark Herzberg, or the director of graduate studies.

Clinical Instruments—The School of Dentistry Dental Clinics maintain a centralized instrument usage and sterilization system that provides clinical instrumentation and related services for graduate students. Usage fees, where applicable, are listed in the quarterly *Class Schedule*.

Prerequisites for Admission—A D.D.S. degree (or its foreign equivalent) from an accredited school of dentistry, with a B average or better or with academic standing in the top fourth of the applicant's graduating class is required.

Graduate Programs

Master's Degree Requirements—Programs are designed by the individual areas of specialization in the major subject within the Graduate School's minimum credit and distribution requirements. Students may elect to take a minor or related fields in nonclinical fields in consultation with their adviser. A final oral examination is required.

Language Requirements—Proficiency in a language in addition to English is required for individuals specializing in oral pathology.

Minor Requirements for Students

Majoring in Other Fields—Graduate study related to dentistry and leading to the M.S. and Ph.D. degrees may also be pursued through majors in such allied sciences as anatomy, biochemistry, microbiology, oral biology, pathobiology, pharmacology, and physiology. A Ph.D. program in one of the above fields with a minor in dentistry is offered to qualified dental graduates.

For Further Information and

Applications—Contact the director of graduate studies or the main office, School of Dentistry, University of Minnesota, 15-238 Moos Health Sciences Tower, 515 Delaware Street S.E., Minneapolis, MN 55455 (612/625-9982).

Dent 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Dentistry (Dent)

5945. GERIATRIC HOSPITAL DENTISTRY. (Cr ar) Martens

Care of elderly, medically compromised patient; diagnosis and treatment of complex patient dental medical cases with medical assessment team. Resident, under supervision of faculty, provides consultation, treatment planning, and treatment on elderly patients with Dental General Practice Residents.

5950, 5951, 5952, 5953. ADVANCED GENERAL DENTISTRY SEMINAR I, II, III, IV. (Cr ar) Born
Clinical seminars with emphasis on treatment planning, case presentation, techniques and materials, comprehensive oral health care and maintenance, and issues in practice management. Correlated with concurrent clinical experiences.

5960, 5961, 5962, 5963. ADVANCED GENERAL DENTISTRY CLINIC I, II, III, IV, V, VI, VII, VIII. (Cr ar) Martens

Comprehensive oral health care delivered in variety of settings, emphasizing complex restorative care, coordinating care with dental and medical specialists, special needs patients, and advanced techniques.

5970, 5971, 5972, 5973. GENERAL PRACTICE SEMINAR I, II, III, IV. (Cr ar) Martens

A sequence of lectures, discussions, and seminars on topics related to current dental practice. Correlated with clinical experiences.

5974, 5975, 5976, 5977. GENERAL PRACTICE CLINICAL ADMINISTRATION I, II, III, IV. (Cr ar) Martens

Field experience in hospital dental clinic administration for residents.

5980, 5981, 5982, 5983, 5984, 5985, 5986, 5987. GENERAL PRACTICE CLINIC I, II, III, IV, V, VI, VII, VIII. (Cr ar) Martens

A series of planned experiences in the clinical disciplines of dentistry, with emphasis on patient care.

5989. ADVANCED CLINICAL GERIATRIC DENTISTRY. (Cr ar; prereq #) Martens

Practical clinical experience in examination, diagnosis, treatment planning, and treatment of older adult patients in the dental clinic at the Amherst H. Wilder Senior Health Center. Extensive case history reports reflecting the total social, psychological, and physical aspects of the patient as well as oral health status prepared and presented.

5990. FIELD EXPERIENCE: ADMINISTRATION IN A MULTIDISCIPLINARY HEALTH CENTER. (Cr ar; prereq #) Martens

Administrative and management concerns related to development of dental service in multidisciplinary care facility for older adults. Field placement at the Amherst W. Wilder Senior Health Center and affiliated residencies.

5992-5993-5994. ORAL HEALTH SERVICES FOR OLDER ADULTS. (Cr ar; prereq #) Born

A series of seminars for graduate students on broad variety of topics related to aging, oral health of older adults, and delivery of oral health services to older adults. Readings, discussions, and design of research project.

8126. TEACHING AND EVALUATION IN DENTISTRY I. (3 cr; prereq #)

Application of educational and psychological principles to professional dental education. Theoretical principles of behavioral and cognitive psychology applied to topics appropriate to dental education. Students apply these principles to concrete instructional situations in their own areas of interest and become familiar with instructional practice in both traditional and new instructional settings.

8127. TEACHING AND EVALUATION IN DENTISTRY II. (3 cr; prereq 8126)

Application of evaluation and measurement theory to higher education, specifically dental education. Objectives for teaching and evaluation, construction of tests and measurement instruments, analysis of tests, interpretation of test results, principles of marking.

8129. TOPICS AND PROBLEMS IN DENTAL EDUCATION. (Cr ar; prereq #)

Independent study arranged for individual student to pursue advanced work in student learning, instructional development, curriculum planning, student testing and evaluation, and academic administration, where these areas and their interfaces are applied directly to professional dental education. Provides opportunity for applying and extending concepts learned in 8126, 8127.

8400. CRANIOMANDIBULAR DISORDERS: SELECTED TOPICS. (3 cr) Schulte

Seminar on current issues in diagnosis and treatment of craniomandibular disorders.

8440. TMJ AND CRANIOFACIAL PAIN: ADVANCED THEORY AND PRINCIPLES. (3 cr; prereq #) Friction, staff

Nature and pathophysiology of disorders causing chronic pain in TMJ and craniofacial regions; advanced principles and theory on assessment, diagnosis, and interdisciplinary management.

8441. SEMINARS IN TMJ AND CRANIOFACIAL PAIN. (1 cr; prereq #) Friction, staff

Advanced topics on theories and application of recently developed techniques of data collection, diagnostic strategies, and management for TMJ and craniofacial pain.

8442. ADVANCED CLINICAL TMJ AND CRANIOFACIAL PAIN. (1-4 cr; prereq #) Friction, staff

Interdisciplinary study of patients with TMJ and craniofacial pain using techniques of assessment currently being researched; background and clinical knowledge of patient synthesized with respect to current literature on management; management program is developed, discussed with faculty, and implemented; effects of treatment and compliance reviewed at each follow-up appointment.

8443. CURRENT LITERATURE IN TMJ AND CRANIOFACIAL PAIN. (1 cr; prereq #) Friction, staff
Review of current literature in TMJ and craniofacial pain and how it relates to past literature, theories on pain, and philosophies of management.

Endodontics (Endo)

5300f, 5301w, 5302s, 5303su, 5304f, 5305w, 5306s. ADVANCED CLINICAL ENDODONTICS. (Cr ar) M E ElDeeb

Diagnosis and treatment of clinical cases. Students are assigned complex cases and explore new and unique techniques.

5310f, 5311w, 5312s, 5313su, 5314f, 5315w, 5316s.

ENDODONTIC EMERGENCY PROBLEMS. (1 cr per qtr) M E ElDeeb

Each student is assigned a one-week period (8 hours per day) and is responsible for all emergencies in the Endodontic Clinic during this time.

5330f, 5331w, 5332s, 5333su, 5334f, 5335w, 5336s.

REVIEW OF CASES. (1 cr per qtr) M E ElDeeb

Students present cases for review by endodontic faculty and other graduate students.

8004su. RESEARCH IN ENDODONTICS. (Cr ar) M E ElDeeb

Organized literature review in area of specific interest of student, selection of thesis project, and completion of research and thesis.

8310f, 8311w, 8312s, 8313su, 8314f, 8315w, 8316s.

SEMINAR: ENDODONTICS. (2 cr per qtr) M E ElDeeb

Review of current literature, research, and clinical cases. Sessions assigned to student.

8320f, 8321w, 8322s. ADVANCED ENDODONTIC LECTURES. (1 cr per qtr) M E ElDeeb

Pulpal and periapical pathology, diagnosis, and treatment planning in endodontics.

8335. ENDODONTIC-PERIODONTIC SEMINAR.

(1 cr) M E ElDeeb

Discussions of endodontic-periodontic problems for all graduate dental students.

Oral Biology (OBio)

See the separate major heading Oral Biology later in this bulletin.

Oral and Maxillofacial Surgery (OSur)

5257. AMBULATORY GENERAL ANESTHESIA.

(1 cr) Gatto, Swift

A clinical rotation involving experience in outpatient management and using intravenous sedation and general anesthesia.

5276. MEDICINE FOR THE ORAL SURGEON.

(2 cr; prereq participation in oral surgery residency program) Swift

Six-week rotation at Mt. Sinai Hospital on medical service under direction of University's Internal Medicine Department. Rotation involves workup and admission and daily management of patients on medical service.

5277. PHYSICAL DIAGNOSIS FOR ORAL

SURGERY RESIDENTS. (1 cr; prereq participation in oral surgery residency program) Swift

Six-week didactic course coupled with evaluation of patients at University Hospital under direction of Department of Medicine and its faculty.

8250. ADVANCED ORAL AND MAXILLOFACIAL SURGERY. (Cr ar) Swift

Assigned clinics in University Hospitals and Veterans Administration Medical Center, Hennepin County Medical Center, and School of Dentistry.

Graduate Programs

8251. SEMINAR: ORAL SURGERY. (1 cr) Swift
Oral surgical subjects.

8253. PROBLEMS IN ORAL AND MAXILLOFACIAL SURGERY. (Cr ar) Swift
Current literature review; experience in surgical techniques.

8254. TOPICS. (1 cr) Swift
Surgical orthodontic techniques and seminar.

8255. GENERAL SURGERY. (Cr ar) Staff
Clinical rotation on general surgical service at University Hospitals. Seminars, clinics, and operating room experience.

Oral Pathology (OPat)

5017. ORAL PATHOLOGY CLINIC. (Cr ar) Vickers
Resident participates in management of Oral Pathology Clinic patients at the School of Dentistry and serves as oral pathology consultant with designated staff in school's screening facilities.

8001. RESEARCH IN ORAL PATHOLOGY. (Cr ar) Gorlin, Vickers

8004. HISTOPATHOLOGY. (2 cr) Vickers
Weekly presentation of currently encountered diagnostic material. Evaluation and interpretation by trainees of individual and representative material. Additional diagnostic information, such as clinical and radiologic information, is collated as an introduction to the individual problem of diagnosis when possible. Cases chosen in advance and made available for individual study.

8006. CURRENT LITERATURE REVIEW. (1 cr) Gorlin, Vickers
Seminars on a variety of research problems, topics, and areas of special interest between graduate students and oral pathology faculty. Students expected to determine both subjects for discussion and nature of discussions.

8007. SPECIAL ORAL PATHOLOGY. (2 cr) Staff
Review of the clinical, radiographic, and treatment aspects of oral disease and oral manifestations of systemic disease. For residents and graduate students in disciplines other than oral pathology.

8008. CLINICAL ORAL PATHOLOGY CONFERENCE. (1 cr) Gorlin, Sedano, Vickers
Weekly "rounds" of patient presentation by division staff of dental school and health sciences center. Symptomatology, diagnosis, prognosis, and treatment.

8011. SURGICAL ORAL PATHOLOGY. (Cr ar) Vickers
Residents and graduate students participate as staff assistants in diagnosis of oral diseases. Histopathologic, frozen section, clinical, cytologic, cytogenetic, microbiologic, hematologic, radiologic, and other diagnostic means are used.

8012. HUMAN AND MEDICAL CYTOGENETICS. (4 cr) Cervenka

Methodology of tissue culture, identification of chromosomes, chromosomal structure, phylogenetic evolution of chromosomes, sex chromatin analysis, use of cell hybridization, chromosomes in human cancer, action of mutagenic agents, and genetic counseling in autosomal and sex chromosome syndromes. Mechanism of chromosomal aberrations. Procedures of genetic counseling and prenatal cytogenetics.

8300f. HUMAN DEVELOPMENT GENETICS I. (2 cr; prereq GCB 3022, BioC 5970, Path 5101 or #)
Genetic and genetic-environmental interactions in development of normal and abnormal human traits. Genetic control of prenatal and postnatal differentiation at the cellular tissue level. Morphological and functional (behavioral) human traits, especially those affecting the face and oral structures.

Oral Radiology (ORad)

8300. ADVANCED ORAL ROENTGENOGRAPHIC INTERPRETATION. (2 cr; prereq #) Kuba
Theory, principles, and practice of roentgenographic interpretation of intraoral and extraoral roentgenograms. Normal roentgenographic anatomy and roentgenographic evidence of the presence of pathology and anomalies integrated with relevant anatomical, pathological, clinical, and statistical data in establishing differential, provisional and final diagnoses, prognoses, treatment plans, and treatment.

Orthodontics (Otho)

5001, 5002, 5003, 5004. CLINICAL ORTHODONTICS. (Cr ar) Speidel, staff
Students assigned patients for complete management of orthodontic and orthodontically related occlusal problems under direct staff supervision.

8001. RESEARCH IN ORTHODONTICS. (Cr ar) Speidel, Viazis, staff

8200, 8201, 8202, 8203. GROWTH AND DEVELOPMENT. (Cr ar) Speidel, staff
Head growth, development, osteology, and myology. Both normal and abnormal morphology and function, with emphasis on cephalometric methods.

8204, 8205, 8206, 8207. ORTHODONTIC DIAGNOSIS AND TREATMENT PLANNING. (Cr ar) Speidel, staff
Etiology, treatment, and prognosis of clinical orthodontic patients.

8208, 8209, 8210, 8211. ORTHODONTIC SEMINAR. (Cr ar) Speidel, staff
Current literature, research, implications.

8217w, 8218s, 8219su. TOPICS IN ORTHODONTICS. (Cr ar) Speidel, staff

Pediatric Dentistry (Pedo)**5414. ADVANCED CLINICAL PEDODONTICS.**

(Cr ar) Staff

Assignment of patients for treatment of difficult or unusual pedodontic problems under direct faculty supervision.

8001. RESEARCH IN PEDIATRIC DENTISTRY.

(Cr ar) Staff

8290, 8291. HOSPITAL PEDODONTICS I, II. (Cr ar) Staff

Faculty-supervised diagnosis and treatment of pedodontic problems at Hennepin County Medical Center. Participation on a rotation basis in seminars in pediatrics and anesthesia. Preoperative and postoperative seminar discussion and evaluation of treatment plans.

8292. PEDODONTIC LITERATURE. (Cr ar) Staff

In-depth literature review and seminar discussion of specific pedodontic topics.

8293. ADVANCED PEDODONTIC TECHNIQUES.

(Cr ar) Staff

Description of and exercises in advanced pedodontic skills and techniques.

8294. PEDODONTIC DIAGNOSIS AND**TREATMENT PLANNING. (Cr ar) Staff**

Systematic approach to diagnosis of and treatment planning for various pedodontic problems.

8295. INDEPENDENT PEDODONTIC STUDY.

(Cr ar) Staff

Preparation of a position paper on assigned topic, including review of pertinent literature.

8298. INTERDISCIPLINARY CARE OF THE CLEFT PALATE PATIENT. (1 cr)

Comprehensive surgical, dental, and speech and hearing evaluation and management of patients with cleft lip and palate.

Periodontics (Pero)**5222. DENTISTRY AND SYSTEMIC HEALTH****CARE. (1 cr; prereq Dent grad student) Hinrichs**

Seminar for improving dentist's knowledge about treating medically compromised patients. Cardiac murmurs, coagulation, diabetes mellitus, organ transplants, hypertension, radiation and chemotherapy for oncology patients, and control of transmittable diseases.

8000f,w,s,su. ADVANCED CLINICAL**PERIODONTOLOGY. (Cr ar) Hinrichs**

Clinical training in examination, diagnosis, treatment planning, and various phases of prevention and treatment of patients with periodontal disease.

8100f,w,s,su. RESEARCH IN PERIODONTOLOGY.

(Cr ar) Bandt, staff

Opportunity to take part in various phases of periodontal research being conducted in labs and clinic.

8200f,w,s,su. CLINICAL SEMINARS IN**PERIODONTOLOGY. (Cr ar) Hinrichs, Pihlstrom,**

Schaffer

Clinical cases are discussed from a diagnostic, treatment planning, and therapeutic viewpoint.

8220. TOPICS IN CONSCIOUS SEDATION. (2 cr;

prereq Dent grad student) Hinrichs

Seminar for evaluating current literature. Patient selection and evaluation; approaches in oral, inhalation, and intravenous sedation; and management of medical emergencies for dental patients.

8250w,s. SUPPORTING STRUCTURES OF THE**TEETH. (Cr ar) Schaffer**

Gingival tissues, cementum, periodontal ligament, and alveolar bone discussed from a histological, physiological, and pathological point of view.

8300f,w,s,su. SEMINAR: PERIODONTOLOGY.

(Cr ar) Pihlstrom

Discussion of assigned weekly literature reviews. Preparation of assigned formal literature reviews.

8305s. PERIODONTIC-PROSTHODONTIC**SEMINAR. (1 cr; offered alt yrs) Hinrichs**

Discussions of periodontal-prosthetic problems for all graduate dental students.

8335. DENTAL IMPLANTOLOGY: A**MULTIDISCIPLINARY OFFERING. (2 cr; prereq**

dent grad major)

Theories and techniques associated with implants in managing partially or completely edentulous patients; contributions from periodontology, prosthodontics, and oral-maxillofacial surgery.

8400. ANATOMY OF NORMAL AND OBSERVED**PERIODONTIUM. (2 cr; offered alt yrs) Pihlstrom,**

Schaffer

8450. BACTERIOLOGY AND IMMUNOLOGY OF**PERIODONTAL DISEASES. (1 cr) Wolff****Prosthodontics (Pros)****8003. ADVANCED TECHNICAL RESTORATIVE****DENTISTRY. (Cr ar [may be repeated for cr]) Goodkind**

Clinical and technological theories and practices interrelated in an effort to solve more complex problems in restorative therapy.

8005. ADVANCED CLINICAL PROSTHODONTICS**I. (Cr ar [may be repeated for cr]) Goodkind**

Practical clinical experience in examination, diagnosis, treatment planning, and various phases of treatment of patients with restorative dental problems. New and/or unfamiliar concepts and techniques emphasized.

8006. ADVANCED CLINICAL PROSTHODONTICS**II. (Cr ar [may be repeated for cr]; prereq #) Goodkind**

Experience in prosthodontic treatment of patients having systemic complications. Patient therapy coordinated in a hospital environment as well as in graduate clinic of dental school.

Graduate Programs

8010. SEMINAR: ADVANCED RESTORATIVE DENTISTRY. (Cr ar [may be repeated for cr]) Goodkind
Review of current and selected historical literature with discussion of current research and its implication for restorative dental therapy.

8012. TOPICS IN PROSTHODONTICS. (Cr ar [may be repeated for cr]; prereq #) Goodkind
Special topics for advanced students.

8015. SEMINAR: PROSTHODONTICS I. (Cr ar [may be repeated for cr]; prereq #) Goodkind
Current concepts and practices related to treatment of the partially edentulous patient by means of fixed and removable partial prosthetic restorations. Based upon application of related sciences with emphasis on prevention.

8016. SEMINAR: PROSTHODONTICS II. (Cr ar [may be repeated for cr]; prereq #) Goodkind
Tissues involved and treatment of the completely edentulous patient.

8018. SEMINAR: ADVANCED PROSTHODONTICS. (Cr ar [may be repeated for cr]; prereq #) Goodkind
Treatment planning for the completely edentulous patient.

8020. APPLIED GNATHOLOGY. (Cr ar [may be repeated for cr]; prereq #; offered alt yrs) Schulte
Seminar and clinical experience involving concepts and philosophies of jaw function. Emphasis on application of kinematics in the development of a dental occlusion.

8025. SEMINAR: APPLIED BIOMATERIALS I. (Cr ar; prereq #) Douglas
Principles that govern manipulation of materials used in restorative dental practice. Physical properties and dimensional changes emphasized.

8032. PRINCIPLES OF MAXILLOFACIAL CARE. (Cr ar [may be repeated for cr]; prereq #) Lund
Treatment biomechanics and technical procedures associated with fabrication, fitting, and servicing of various types of oral and facial restorations.

8034. ADVANCED CLINICAL MAXILLOFACIAL PROSTHETICS. (Cr ar [may be repeated for cr]; prereq 8030, 8032, #) Goodkind, staff
Factors involved in diagnosis and organization of a treatment plan for maxillofacial patient and practical experience in associated clinical and lab procedures.

Design, Housing, and Apparel

Professor: William J. Angell; Marian-Ortolf Bagley; Signe T. Betsinger; Timothy T. Blade; Marilyn R. DeLong; Joanne B. Eicher; Earl W. Morris

Associate Professor: Gloria M. Williams, *director of graduate studies*; Homa Amir-Fazli; Margaret K. DiBlasio; Ann M. Erickson; Evelyn M. Franklin; Edward G. Goetz; Denise A. Guerin; Kim K. P. Johnson; Wanda W. Olson

Assistant Professor: Louis B. Casagrande II; Delores A. Ginthner; Karen L. LaBat; Barbara E. Martinson; Becky L. Yust

Other: Suzanne J. Baizerman; David T. Grimsrud

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B), M.S. (Plan A and Plan B), and Ph.D.

Curriculum—Emphases are in apparel, design communication, interior design, and housing. Concentrated study in apparel includes the history, design, and aesthetics of clothing; museology; textile and apparel product analysis; and the social science aspects of textiles and apparel. Focus in design communication is on the design process and involves concentrations in design practice; color theory and technology; and the history of design and of the decorative arts. Concentrations in interior design focus on the application of the design elements to interior environments and includes aesthetics, energy consumption, and health and safety issues. Study in housing prepares students for careers in state and federal agencies, non-profit community organizations, and housing management and regulation. Concentrations include the analysis of designed environments and technology; policy and community development; and housing for special populations.

Note—In 1992, department course numbers were changed. The designators Dsgn, Hsg, and TexC were changed to DHA effective winter quarter 1994. Please contact the department for further information.

Prerequisites for Admission—Individuals must have adequate undergraduate education in the area of emphasis and background in the basic disciplines of art, social science, physical science, and biological science appropriate to the area of emphasis. Specific requirements may be obtained by contacting the director of graduate studies.

Special Application Requirements—Consult the director of graduate studies; scores from the Graduate Record Examination are required. Students are admitted each quarter.

Degree Requirements—Consult the director of graduate studies. A final oral examination is required.

Language Requirements—Determined by the graduate faculty in the area of emphasis or the adviser in consultation with the student.

For Further Information and Applications—Contact the director of graduate studies, Design, Housing, and Apparel, University of Minnesota, 240 McNeal Hall, 1985 Buford Avenue, St. Paul, MN 55108 (612/624-1790).

DHA 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

DHA 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

DHA 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Design, Housing, and Apparel (DHA)

5101. INTRODUCTION TO DESIGN, HOUSING, AND APPAREL RESEARCH. (4 cr; prereq grad student or #) Goetz

5103. FIELD STUDY: NATIONAL/INTERNATIONAL. (1-15 cr; prereq #)

5105. HISTORY OF VISUAL COMMUNICATION. (4 cr; prereq art history course)
Technological, cultural, and aesthetic influences on graphic design.

5107. HISTORY OF DECORATIVE ARTS: TEXTILES. (3 cr, §Dsgn 5107, §Dsgn 5507; prereq Arch 3411, Arch 3412 or ArtH 1002 or #) Erickson
Textiles from early civilization to 20th century. Design, materials, and techniques.

5109. HISTORY OF DECORATIVE ARTS: CERAMICS, METAL, AND GLASS. (3 cr, §Dsgn 5109, §Dsgn 5509; prereq Arch 3411, Arch 3412 or ArtH 1002 or #) Blade
Ceramics, metal, and glass from selected historical periods in a global context.

5112. HISTORY OF EUROPEAN FURNITURE AND INTERIORS. (3 cr, §Dsgn 5112, §Dsgn 5512; prereq Arch 3411, Arch 3412 or #) Erickson
Furniture and interiors from ancient civilization through the 19th century.

5114. HISTORY OF AMERICAN FURNITURE AND INTERIORS. (3 cr, §Dsgn 5114, §Dsgn 5514; prereq 5112 or Dsgn 5112 or #) Blade
Styles of American interiors and furnishings from the 17th to the 20th century.

5115. TWENTIETH-CENTURY INTERIORS AND FURNISHINGS. (3 cr, §Dsgn 5115, §Dsgn 5515; prereq 5114 or #) Erickson
In-depth study from Victorian time to present.

5118. HISTORY OF COSTUME: 19TH AND 20TH CENTURIES. (4 cr, §Dsgn 5118, §Dsgn 5518; prereq 3117 or 3517 or #) DeLong
Emphasis on American costume. Study of historic costumes from the Goldstein Gallery's costume collection.

5170. SPECIAL TOPICS IN DESIGN, HOUSING, AND APPAREL. (1-4 cr)
In-depth investigation of single topic, announced in advance.

5203. FIELD EXPERIENCE IN RETAIL MERCHANDISING/CLOTHING DESIGN. (1-4 cr, §TexC 5203; prereq completion of at least half of professional sequence, plan to be submitted and approved in advance by adviser and employer, #)
Supervised work experience relating activity in business, industry, or government to student's area of study. Integrative paper.

5211. ISSUES AND TRENDS IN TEXTILES AND APPAREL. (3 cr, §TexC 5211)
Needs of textile consumer; protection from deception and hazard; analysis of federal, state, and local legislation; voluntary standards; change mechanisms; business practices; and professional ethics.

5212. CLOTHING AND HUMAN BEHAVIOR. (4 cr, §TexC 5212; prereq jr or sr or #) Eicher
Clothing in relation to individual and group behavior patterns; personal and social meaning attributed to dress; conventions and standards influencing clothing choice and use.

5213. ADVANCED TEXTILE ANALYSIS. (5 cr, §TexC 5213, §TexC 5621; prereq 5215 or 5631 or 5254 or 5627)
Relating visual and tactile properties of textiles to microscopically and submicroscopically detectable physical and chemical characteristics.

5216. TEXTILE AND APPAREL CONSUMER. (4 cr, §TexC 5216, §TexC 5662; prereq 3216 or 3621, AgEc 1101 or Econ 1101 or #) Williams
Textile and clothing problems; effects of psychological dispositions, socioeconomic conditions, technology, and public/private policies.

5217. INTERNATIONAL TRADE IN TEXTILES AND APPAREL. (4 cr, §TexC 5217, §TexC 5685; prereq #) Williams
Comparison of production, distribution, and consumption in United States and Europe. Effects of world trade on supply and distribution.

5218. PATTERN DEVELOPMENT III. (4 cr, §TexC 3221; prereq 3218 or TexC 3218)
Advanced problems in pattern manipulation and grading.

Graduate Programs

5231. CLOTHING DESIGN STUDIO IV. (4 cr, §Dsgn 5231, §Dsgn 5541; prereq 3232, 5218, Dsgn 3232, Dsgn 5218) Amir-Fazli

Advanced problems in draping and sketching. Pencil, crayon, and watercolor techniques. Studies and reports. Undergrads develop their senior line.

5232. CLOTHING DESIGN STUDIO V. (4 cr, §Dsgn 5232, §Dsgn 5544; prereq 5231 or Dsgn 5231) Amir-Fazli

Clothing design for mass production, including costing and lay-out.

5234. CLOTHING DESIGN FOR SPECIAL NEEDS. (4 cr, §Dsgn 5234; prereq 5231 or 5541, TexC 3216 or TexC 3621)

Experimental design concepts as they relate to special market segments: physical limitations, safety protection, energy consumption. Emphasizes integration of human needs, fabric character, and garment structure.

5241. RETAIL PROMOTION. (4 cr, §TexC 3646, §TexC 5241; prereq 1211 or TexC 1211, Mktg 3000) Johnson

Marketing communication theory, concepts, and research with in-depth treatment of elements of retail promotion mix: advertising, sales promotions, point-of-purchase communication, direct marketing.

5242. MANAGERIAL DECISION MAKING. (4 cr, §TexC 5242; prereq 3646 or 5241) Johnson
Decision making in retail situations, including merchandise planning and management of sales and human resources.

5252. TEXTILE COLORATION AND FINISHING. (4 cr, §TexC 5252, §TexC 5624; prereq 5213 or 5621)
Comprehensive survey of processes and operations for coloring and finishing textiles; development of a rational base for predicting hazard and performance in service and recycling, and a realistic limiting perspective for textile design.

5253. RECYCLING PROCESSES. (3 cr, §TexC 5253, §TexC 5626; prereq 5213 or 5621)

Principles and practice in recovery of initial appearance and properties of textile products; application to restoration of historic textile materials; water pollution by effluent from wet cleaning processes.

5254. PERFORMANCE EVALUATION: FABRICS AND GARMENTS. (5 cr, §TexC 5254, §TexC 5627; prereq 3216 or TexC 3216)

Testing procedures, standards, and specifications used in designing and purchasing fabrics and garments. Application of test results to design and specification of garments.

5261. ADVANCED APPAREL DESIGN AND CONSTRUCTION PROBLEMS. (2-4 cr per qtr [max 12 cr], §TexC 5261, §TexC 5600; prereq 3216 or 3621, #)
Analytical study and construction of advanced apparel design using draping and flat pattern techniques. Relating latest technological developments in textiles to garment design.

5262. EXPERIMENTAL STUDIES IN APPAREL.

(3-5 cr, §TexC 5262, §TexC 5603; prereq 6 cr construction or tchg exper, #)
Selected procedures in apparel production and design.

5263. THE DYEING MEDIUM AND COLOR. (3 cr, §TexC 5263, §TexC 5623; prereq 3216 or 3621, Dsgn 1328 or Dsgn 1528 or #)

Principles of dye selection for specific fibers; precision dyeing for exploring perceived color relationships and expanding utility of this medium.

5266. ETHNIC DRESS. (3 cr, §TexC 5266, §TexC 5668; prereq 3212 or 3661, Anth 1102, Soc 1001 or #)
Sociocultural analysis of ethnic dress (apparel, accessories, and body modification) emphasizing cultural patterns of technology, aesthetics, ritual, morality, and symbolism. External and internal influences encouraging change.

5280. DIRECTED STUDY IN APPAREL SCIENCES AND DESIGN. (1-4 cr [max 8 cr], §TexC 5280; prereq #)

Independent study under tutorial guidance.

5289. PROBLEMS IN DESIGN: COSTUME. (3-4 cr per qtr [max 12 cr], §Dsgn 5289; prereq dsgn or hsg or apparel major)

Independent study under tutorial guidance.

5323. DESIGN PROCESS: DRAWING III. (4 cr; prereq 3323 or 3523 or #)

Application of design principles to advanced drawing problems.

5325. DESIGN PROCESS: TWO-DIMENSIONAL DESIGN III. (4 cr; prereq 3325 or grad student; A-F only)

Students complete design projects and examine design and visual perception research literature.

5328. COLOR AND DESIGN. (4 cr, §Dsgn 5328, §Dsgn 5528; prereq 1328 or 1528 or #)
Color concepts and their application to design.

5331. SURFACE FABRIC DESIGN III. (4 cr, §Dsgn 5331, §Dsgn 5531; prereq 3331 or 3531, pass portfolio review, dsgn or hsg or apparel major)

Designing in one special surface textile technique. Studio problems. Readings.

5380. DIRECTED STUDY IN DESIGN COMMUNICATION. (1-4 cr per qtr [max 8 cr], §Dsgn 5380, §Dsgn 5585; prereq #)

Independent study under tutorial guidance.

5461. HOUSING MANAGEMENT. (5 cr, §Hsg 5461, §Hsg 5861; prereq 3463 or #)

Management of multi-unit housing. Historical perspectives, current status of housing, management approaches, psychosocial impact of housing and community design, specific residential populations. Students conduct post-occupancy evaluation of housing complex.

5463. HOUSING POLICY. (3 cr, §Hsg 5463, §Hsg 5863, §PA 5611; prereq grad student or adult spec or 3463 or 3863) Goetz

Role of American national, state, and local government in financing, control, taxation, and construction of housing.

5465. HOUSING IN WORLD PERSPECTIVE I. (4 cr, §Hsg 5465, §Hsg 5865; prereq 3463 or 3863 or #) Morris

Social analysis of housing around world; emphasizes population, environment, and social organization of nations as contexts for national policy and for housing choices of households.

5466. HOUSING IN WORLD PERSPECTIVE II. (4 cr, §Hsg 5866; 5465 recommended)

Response of selected countries to housing problems of low- and middle-income people in urban areas; implications of cultural values and technological changes for housing solutions; examples from Eastern Europe, India, Japan, and other areas.

5467. HOUSING AND THE SOCIAL ENVIRONMENT. (4 cr, §Hsg 5467, §Hsg 5867; prereq 3463 or 5863 or #) Yust

Housing choices of households; emphasis on special needs of the elderly, the disabled, minorities, large families, and female-headed households.

5468. HOUSING PROBLEMS OF THE FAMILY. (5 cr, §Hsg 5468, §Hsg 5868; prereq 1401 or 1801, 3463 or 3863 or Dsgn 1642 or Dsgn 1555 or #) Franklin

Housing problems of low-income, elderly, and minority individuals and families. Rehabilitation of older housing, including rehabilitation process, programs, and projects. Students work with low-income inner-city client family on home improvement project.

5480. DIRECTED STUDY IN HOUSING. (1-4 cr [max 8 cr], §Hsg 5480, §Hsg 5888; prereq #) Independent study under tutorial guidance.

5481. DESIGNED ENVIRONMENTS FOR AGING. (4 cr, §Hsg 5481, §Hsg 5881; prereq 3463 or 3863 or Dsgn 1555 or Dsgn 1642 or #; offered alt yrs) Franklin

Design of environments with potential to compensate for deficits in physical and mental functioning. Older adults and barrier-free, flexible, and responsive physical environments.

5482. THE FAMILY AND ENERGY ISSUES. (3 cr, §Hsg 5482, §Hsg 5801; prereq 1400 or 1851, 1401 or 1801 or #; offered alt yrs) Yust

Analysis of family behavior as it relates to energy use, impact of scarcity on quality of family functioning, family energy issues in future.

5483. HOUSING DISCRIMINATION. (4 cr; prereq 3463 or #; A-F only; offered alt yrs)

Causes, effects, and patterns of housing segregation and discrimination; public policies aimed at addressing problems.

5485. HOMELESSNESS. (5 cr, §Hsg 5485; offered alt yrs)

Causes of homelessness in contemporary times; subpopulations among the homeless; public policies aimed at addressing the problem.

5612. INTERIOR DESIGN RESEARCH. (2 cr, §Dsgn 5575, §Dsgn 5612; prereq 3553 or 3643 or #) Guerin
Examination and development of studies.

5634. INTERIOR DESIGN CODES AND ENVIRONMENTAL ISSUES. (3 cr; A-F only; offered alt yrs)

Impact of environmental issues, legislation, and social awareness on designing for life safety, health, diverse populations, and earth's resources.

5645. INTERIOR DESIGN STUDIO V. (4 cr, §Dsgn 5552, §Dsgn 5645; prereq DHA 3216 or TexC 3621, DHA 3631 or Dsgn 3557, DHA 3633 or Dsgn 3548, DHA 3643 or Dsgn 3553, #) Erickson, Guerin

Advanced problems related to residential spaces.

5646. INTERIOR DESIGN STUDIO VI. (4 cr, §Dsgn 5554, §Dsgn 5646; prereq DHA 3216 or TexC 3621, DHA 3631 or Dsgn 3557, DHA 3633 or Dsgn 3548, DHA 3643 or Dsgn 3553, #) Ginthner

Advanced problems related to non-residential spaces.

5647. INTERIOR DESIGN THESIS. (6 cr, §Dsgn 5555, §Dsgn 5647; prereq 5575 or 5612, 5552 or 5645, 5554 or 5646)

Comprehensive independent project generated from research conducted in Dsgn 5612.

5680. DIRECTED STUDY IN INTERIOR DESIGN. (1-4 cr per qtr [max 8 cr], §Dsgn 5586, §Dsgn 5680; prereq #)

Independent study under tutorial guidance.

8103. ADVANCED RESEARCH METHODS IN DESIGN, HOUSING, AND APPAREL. (4 cr; prereq 1 stats course)

Developing skills in analysis and interpretation of data, application of theories in research, and reporting of results; using statistical packages.

8170. SPECIAL TOPICS IN DESIGN, HOUSING, AND APPAREL. (1-4 cr per qtr)

In-depth investigation of specific topic, announced in advance.

8181. INTEGRATIVE SEMINAR. (1 cr)

Ideas, issues, and trends in design, housing, and apparel.

8262. LITERATURE OF DRESS I. (3 cr, §TexC 8662; offered alt yrs) Eicher

Orientation to classic historical readings; basis for key ideas.

8263. LITERATURE OF DRESS II. (3 cr, §TexC 8663; offered alt yrs) Williams

Orientation to contemporary readings; basis for key ideas.

8264. FASHION THEORY AND ANALYSIS. (3 cr, §TexC 8664; prereq 8262 or #; offered alt yrs)

Fashion theories and factors that influence adoption and diffusion of innovations. Methodologies used in analysis of the fashion process.

Graduate Programs

8266. AESTHETIC CONCEPTS RELATED TO APPAREL DESIGN. (3 cr, §TexC 8666; prereq 3217 or #; offered alt yrs) DeLong

Comprehensive survey and application of theory to the analysis of clothing design. Development of a methodology for visual perceptual evaluation.

8267. THEORETICAL ORIENTATIONS IN CLOTHING AND HUMAN BEHAVIOR. (4 cr, §TexC 8668; prereq #; offered alt yrs) Williams

Evolution and status of theoretical knowledge on clothing and human behavior; application of ways of theory building and evaluation of theory; issues underlying development of theoretical and practical knowledge.

8268. METHODOLOGICAL ORIENTATIONS IN CLOTHING AND HUMAN BEHAVIOR. (4 cr, §TexC 8668; prereq #; offered alt yrs) Williams

Alternative methodological perspectives interrelated with theoretical streams in clothing and human behavior; orientation to knowledge use and evaluation in practical settings.

8280. DIRECTED STUDY IN APPAREL SCIENCES AND DESIGN. (1-4 cr, §TexC 8280; prereq #) Independent study under tutorial guidance.

8290. READINGS IN APPAREL SCIENCES AND DESIGN. (1-3 cr per qtr [max 9 cr], §TexC 8290; prereq #; A-F only)

Independent study and review of books and periodicals useful for individual programs but not available in other courses.

8323. DESIGN PROCESS: DRAWING. (4 cr, §Dsgn 8523; prereq #) Bagley

Drawing media as applied to design problems.

8325. DESIGN PROCESS: TWO-DIMENSIONAL DESIGN. (4 cr, §Dsgn 8525; prereq #) Bagley

Experiments with principles of two-dimensional design; emphasis on alternative solutions to design problems.

8328. DESIGN PROCESS: COLOR. (1-4 cr, §Dsgn 8528; prereq #; A-F only) Bagley

Color concepts and their application to design.

8380. DIRECTED STUDY IN DESIGN COMMUNICATION. (1-4 cr, §Dsgn 8380; prereq #) Independent study under tutorial guidance.

8390. READINGS IN DESIGN COMMUNICATION. (1-3 cr, §Dsgn 8390; prereq #)

Independent study and review of books and periodicals useful for individual programs, but not available in other courses.

8467. HOUSING THEORY. (3 cr; prereq 5101, 5467 or #; offered wtr 1996)

Theories applied to study of housing behavior of households.

8480. DIRECTED STUDY IN HOUSING. (1-4 cr, §Hsg 8480; prereq #; A-F only) Independent study under tutorial guidance.

8490. READINGS IN HOUSING. (1-3 cr, §Hsg 8490; prereq #) Independent study and review of books and periodicals useful for individual programs but not available in other courses.

8671. INTERIOR DESIGN CRITICISM AND THEORY. (3 cr; A-F only)

Design theories examined to establish framework for criticism. Field investigation in Twin Cities to develop critical inquiry methods.

8676. ENVIRONMENTAL STUDIES IN INTERIOR DESIGN. (4 cr, §Dsgn 8556; prereq 6 cr interior design or #)

Human needs as related to interior design.

8680. DIRECTED STUDY IN INTERIOR DESIGN. (1-4 cr, §Dsgn 8680; prereq #) Independent study under tutorial guidance.

8690. READINGS IN INTERIOR DESIGN. (1-3 cr, §Dsgn 8690; prereq #) Independent study and review of books and periodicals useful for individual programs but not available in other courses.

Human Ecology (HE)

5003. FIELD EXPERIENCE. (1-5 cr per qtr [max 15 cr]; prereq #) Directed preprofessional work experience in home economics position in business or industry, government, or other appropriate organization.

5130. INDEPENDENT STUDY IN HOME ECONOMICS. (1-5 cr [16 cr max]; prereq #)

5201. SEMINAR: RESEARCH AND ACTION FOR SOCIAL CHANGE. (1 cr; prereq human ecol major, jr, #)

Implementing a plan of social change; assessment and evaluation of action; strategies in organizational, community, and social change; politics, legislation, social policy, and other approaches to social change; citizen and professional responsibility and approaches to social change.

Development Studies and Social Change (DSSC)

Regents' Professor: Vernon W. Ruttan (agricultural and applied economics)

Professor: Raymond D. Duvall (political science), *director of graduate studies;* Ronald R. Aminzade (sociology); Vernon B. Cardwell (agronomy and plant genetics); William P. Cunningham (genetics and cell biology); Allen F. Isaacman (history); Robert T. Kudrle (public affairs); Philip W. Porter (geography); Eric S. Sheppard (geography)

Associate Professor: Susan N. G. Geiger (women's studies); Amy K. Kaminsky (women's studies); Anne R. D. Kapuscinski (fisheries and wildlife); Daniel R. Kelliher (political science); John W. Mowitt (cultural studies and comparative literature); August H. Nimitz, Jr.

(political science); Abdi I. Samatar (geography); Kathryn A. Sikkink (political science); Janet D. Spector (anthropology); Ann B. Waltner (history); John S. Wright (Afro-American and African studies)

Assistant Professor: Ragui Assaad (public affairs); Jeffrey P. Broadbent (sociology); Lisette E. Josephides (anthropology); Deborah Levison (public affairs)

Course of Study—Minor in development studies and social change, applicable to doctoral programs.

Curriculum—A structured interdisciplinary graduate minor in development studies and social change is offered in conjunction with the MacArthur Interdisciplinary Program on Peace and International Cooperation. The minor program focuses on three major areas:

- 1) the relationships between macroscopic processes of political, economic, and social change, and the microscopic conditions of lived experience in the developing world;
- 2) specifically interdisciplinary perspectives (encompassing the social sciences, the biological sciences, and the humanities) on this general thematic concern; and 3) preparation of doctoral students for field research in the developing world.

Prerequisites for Admission—Admission to the graduate minor in development studies and social change is contingent upon prior admission to a doctoral degree-granting program within the Graduate School and upon affiliation with the MacArthur Program.

Special Application Requirements—Students enrolled in a doctoral degree-granting program may apply for the minor at any time during the academic year; acceptance will take effect the following term.

Minor Requirements—A sequence of three core seminars in development studies and social change (totaling ten credits) is required. In addition, students take two or three courses (totaling eight credits) chosen from an approved list, from across the Graduate School curriculum, which are relevant to the field of development studies and social change.

Language Requirements—None specific to the minor program.

For Further Information and Applications—Contact the MacArthur Interdisciplinary Program on Peace and International Cooperation, University of Minnesota, 260 Social Sciences Building, 267 19th Avenue South, Minneapolis, MN 55455 (612/624-0832; fax 612/626-2242).

8110s. APPROACHES TO KNOWLEDGE AND TRUTH: DEFINING WAYS OF KNOWING IN DEVELOPMENT STUDIES AND SOCIAL CHANGE. (3 cr; prereq DSSC minor student or #) Staff Approaches as practiced by physical, biological, and social scientists and scholars in the humanities. "Ways of knowing" as practiced in different cultures or by different groups within cultures. Team taught by faculty from biological and social sciences and the humanities.

8210-8211-8212. FIELD RESEARCH METHODOLOGY IN DEVELOPMENT STUDIES AND SOCIAL CHANGE. (1 cr per qtr; prereq DSSC minor student or #) Staff Identification of potential funding sources for field research and the writing of grant proposals. Preparing for and conducting field research. Students take this course during the year before undertaking field research, typically the third year of graduate study.

8310-8311f,w. TOPICS IN DEVELOPMENT STUDIES AND SOCIAL CHANGE. (2 cr per qtr; prereq DSSC minor student or #) Staff Offered in conjunction with MacArthur Program workshop series.

East Asian Languages, Literatures, and Linguistics

Professor: Stephen S. Wang (Chinese), *director of graduate studies:* Chun-Jo Liu (*emeritus:* Chinese); Richard B. Mather (*emeritus:* Chinese)

Associate Professor: Polly E. Szatrowski (Japanese). Ann B. Waltner (Chinese; history)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—Chinese: M.A. (Plan A and Plan B) and Ph.D. Japanese: M.A. (Plan A and Plan B) and Ph.D. See also East Asian Studies following this listing.

Curriculum—*Chinese:* Two areas of concentration are available—literature and linguistics. Programs may include courses from both of these areas, but must minimally fulfill the core requirements for one of them, as determined in consultation with the student's adviser. Areas of subspecialty in

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the literature concentration include medieval, early modern, and 20th century. Areas of subspecialty in Chinese linguistics include aspects of synchronic and diachronic studies of Chinese.

Japanese: Two areas of concentration are available—literature and linguistics. Programs may include courses from both of these areas, but must minimally fulfill the core requirements for one of them, as determined in consultation with the student's adviser. Areas of subspecialty in the literature concentration include medieval, Tokugawa, modern and contemporary, modern drama, and modern literary theory and criticism. Areas of subspecialty in the linguistics concentration include aspects of the phonology, syntax, semantics, discourse structure, pragmatics, and history of Japanese.

Prerequisites for Admission—Normally, an undergraduate major in Chinese or Japanese is the prerequisite for graduate studies. Students from other academic areas may be admitted with the provision that prerequisite coursework be made up after admission.

Special Application Requirements—Three letters of recommendation and a statement of purpose should be submitted to the department. Graduate Record Examination General Test scores (verbal and quantitative sections) are required. Students normally are admitted in fall quarter of each academic year. To be considered for financial aid, completed applications must be received by the first week of January.

Master's Degree Requirements—A complete list of degree requirements may be obtained from the director of graduate studies. A final oral examination is required.

Doctoral Degree Requirements—Programs are designed by the student and the adviser, with approval from the director of graduate studies, to provide a coherent course of study in an area of concentration. A complete list of requirements may be obtained from the director of graduate studies.

Language Requirements—For the M.A., students are expected to have research competence in Chinese or Japanese. For the Ph.D., students are also required to complete, or demonstrate by examination an ability equivalent to, two years of Chinese or Japanese language study (whichever language is not the chosen area of concentration); they must also demonstrate a reading knowledge in one of the following: French, German, or Russian (which may be fulfilled by passing the Graduation Reading Proficiency Test offered by the relevant language program at the University of Minnesota).

Minor Requirements for Students Majoring in Other Fields—A description of minor requirements in Chinese or Japanese is available from the director of graduate studies.

For Further Information and Applications—Contact the Department of East Asian Languages, Literatures, and Linguistics, University of Minnesota, 192 Klæber Court, 320 16th Avenue S.E., Minneapolis, MN 55455 (612/624-3331).

Chn 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Chn 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Chn 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Jpn 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Jpn 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Jpn 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Chinese (Chn)

5041-5042-5043. THIRD-YEAR MODERN CHINESE. (4 cr per qtr, §3041, §3042, §3043; prereq 3023 for 5041, 3031 for 5042, 3042 for 5043)
5041: Reading and analysis of 20th century texts.
5042-5043: Reading and analysis of vernacular texts.

5051, 5052. ADVANCED CHINESE CONVERSATION AND COMPOSITION. (4 cr per qtr, §3051, §3052; prereq 3023 or #)
To perfect conversation and pronunciation; to advance competence in grammar by exercises in composition and translation from English into Chinese. Additional work beyond that required for 3051, 3052.

5101. CONTEMPORARY CHINESE WRITING. (4 cr; prereq 3041)
Reading, translation, and discussion of representative works of Chinese authors since 1976.

5102. READINGS IN MODERN CHINESE FICTION. (4 cr; prereq 3041)
Reading and analysis of selected short fiction from 1918 to the present day.

5103. PRE-MODERN PROSE. (4 cr; prereq 3031, 3041)
Reading of representative Chinese texts of pre-modern periods.

5105. READINGS IN CHINESE VERNACULAR FICTION. (4 cr; prereq 3041)
Selections from great works of traditional fiction including short stories and novels such as *Journey to the West* and *Dream of the Red Chamber*.

5165. HISTORY OF CHINESE LITERATURE. (4 cr; prereq 3033, 3043)
Survey of major Chinese literary movements from emergence of early Confucian canon to May 4th movement in 1919.

5251. STRUCTURE OF STANDARD CHINESE. (4 cr; prereq 1013)
Introduction to phonological and syntactic structures of modern standard Chinese.

5252. HISTORY OF THE CHINESE LANGUAGE. (4 cr; prereq 3031, Ling 3601 recommended)
Survey using both traditional native philological sources as well as modern dialectal evidences.

5451, 5452. STUDIES IN CHINESE LINGUISTICS. (4 cr per qtr; prereq jr or #)
Topic for each quarter chosen in advance, in consideration of students' interests, from the following: syntax of modern standard Chinese, Chinese dialectology, Chinese historical phonology, grammar of classical Chinese.

5460. TOPICS IN CHINESE LITERATURE. (4 cr per qtr [max 12 cr])
Reading and discussion of selected texts from all periods of Chinese civilization and from all genres—poetic, expository, narrative, or dramatic. Topics announced in advance.

5704. EARLY CHINESE POETRY. (4 cr; prereq 5165 or #)
Reading and analysis of selected major poets and poetic forms from first anthologies through twelfth century.

5705. CHINESE FICTION IN THE MING AND QING. (4 cr; prereq 3033, 3043)
Contextual readings of traditional fiction, including short stories and novels such as *Journey to the West* and *Dream of the Red Chamber*.

5706. CHINESE PHILOSOPHICAL/HISTORICAL TEXTS. (4 cr; prereq 3033, 3043)
Major texts in Chinese philosophy and historical tradition; Confucian/Buddhist/Taoist and other canonical writings; selections from Dynastic histories.

5970. DIRECTED STUDIES. (1-4 cr; prereq #, Δ, CLA approval)
Guided individual reading for study.

8650. SEMINAR: CHINESE LINGUISTICS. (4 cr; prereq 5451 or 5452)

8660. SEMINAR: VERNACULAR CHINESE LITERATURE. (4 cr; prereq 5472, 5990 or #)
Consult Class Schedule for topics to be discussed during any given year.

Japanese (Jpn)

5042. CLASSICAL JAPANESE. (5 cr; prereq 3033)
Masterpieces of Japanese literature in classical language grammatical construction.

5051-5052-5053. ADVANCED JAPANESE CONVERSATION AND COMPOSITION. (4 cr per qtr, §3051-3052-3053; prereq 3033 or #)
Verbal expression, oral and written; grammar review; idioms and nuances; short compositions, correspondence.

5061f-5062w-5063s. SOCIAL SCIENCE READINGS. (4 cr; prereq 3053, 5051, 5052, 5053 or #)
Advanced Japanese reading, discussion, and writing on topics related to newspaper/magazine articles and social science texts.

5071f-5072w-5073s. COMMUNICATION FOR JAPAN-ORIENTED CAREERS. (4 cr; prereq 3053, 5051, 5052, 5053 or #)
Effective communication using spoken Japanese in contexts likely to be encountered by a career-oriented professional in Japan.

5166. LITERATURE BY 20TH-CENTURY JAPANESE WOMEN. (4 cr; prereq 3033 for Japanese majors, previous work in lit and feminist theory or #)
Analysis of fiction and nonfiction writings by 20th-century Japanese women.

5251. HISTORY OF JAPANESE LANGUAGE. (4 cr; prereq 3033, 5451 or #)
Development of Japanese grammar from classical to modern language.

5361, 5362. READINGS IN MODERN JAPANESE LITERATURE I. (4 cr per qtr; prereq 3031)
Works of traditionalist and aestheticist authors of 19th- and 20th-century Japan.

5364. READINGS IN MODERN JAPANESE LITERATURE II. (4 cr; prereq 3031)
Works of realist, naturalist, and humanist authors of 19th- and 20th-century Japan.

5451. STRUCTURE OF JAPANESE—SYNTAX/ SEMANTICS. (4 cr; prereq 3023, Ling 3001 or #)
Structure and meaning of Japanese sentence patterns.

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5452. STRUCTURE OF JAPANESE—PHONOLOGY/MORPHOLOGY. (4 cr; prereq 3023, Ling 3001 or #)
Generative and nongenerative approaches to Japanese sound and word structure.

5453. STRUCTURE OF JAPANESE DISCOURSE/CONVERSATIONAL ANALYSIS. (4 cr; prereq 3023, Ling 3001 or #)
Emergence of grammar in discourse; discourse/conversational structural units, patterns, genre, strategies, style, and sociolinguistic variables.

5460. TOPICS IN JAPANESE LITERATURE. (4 cr; prereq 3033)
Topics in context of culture and intellectual history.

5650. PROSEMINAR: JAPANESE LINGUISTICS. (4 cr [max 12 cr]; prereq 5451 or #)
Selected topics from the syntax, pragmatics, and lexicon of Japanese and/or comparative English/Japanese, with attention to contributions from Eastern and Western linguistic traditions.

5970. DIRECTED STUDIES IN JAPANESE. (1-15 cr; prereq #, Δ, CLA approval)
Individual study of selected texts with guidance of faculty member.

8650. SEMINAR: JAPANESE LINGUISTICS. (4 cr; prereq 5451, 5452 or #)
Research in a selected topic from the syntax, pragmatics, lexicon, or history of Japanese language; emphasis on gathering and analysis of primary data.

8960. SEMINAR IN JAPANESE LITERATURE (CLASSICAL). (4 cr; prereq Δ)
Intensive study of particular authors or works within the total range of the classical Japanese written literary tradition.

East Asian Studies

Professor: Edward L. Farmer (history); Mei-ling Hsu (geography); Chin-Chuan Lee (journalism and mass communication); Byron K. Marshall (history); Robert J. Poor (art history); Stephen S. Wang (Chinese)

Associate Professor: Alan L. Kagan (music); Daniel Kelliher (political science); Polly E. Sztatowski (Japanese); Ann B. Waltner (history)

Assistant Professor: Jeffrey P. Broadbent (sociology)

Other: Nobuya Tsuchida (director, Asian/Pacific American Learning Resource Center)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—East Asian Studies: M.A. (Plan A and Plan B). See also East Asian Languages, Literatures, and Linguistics.

Curriculum—The East Asian Studies master's program is interdisciplinary, and the student may formulate an individualized program concentration.

Prerequisites for Admission—Ideally, an applicant's background should include undergraduate study in fields related to East Asia or East Asian languages. Students from other academic areas may be admitted, however, with the provision that prerequisite coursework be made up after admission.

Special Application Requirements—Three letters of recommendation and statement of purpose should be submitted to the department. Graduate Record Examination General Test scores are required. Students are admitted each quarter.

Master's Degree Requirements—A complete list of degree requirements and applicable courses may be obtained from the director of graduate studies. Coursework pertaining to East Asia taken outside of East Asian studies may be applied toward the degree. A final oral examination is required.

Language Requirements—Three years of training in Chinese or Japanese (or an equivalent or greater competency) is required.

Minor Requirements for Students

Majoring in Other Fields—A description of minor requirements in East Asian studies is available from the director of graduate studies.

For Further Information and Applications—Contact East Asian Studies, Area Studies Programs, University of Minnesota, 214 Social Sciences Building, 267 19th Avenue South, Minneapolis, MN 55455 (612/624-8543).

EAS 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Area Studies (Area)

5910. TOPICS IN EAST ASIAN STUDIES. (2-4 cr)

5970. DIRECTED STUDIES. (1-15 cr per qtr; prereq #, Δ, □)
Tutorial for qualified seniors and graduate students.

5990. DIRECTED RESEARCH. (1-15 cr per qtr; prereq #, Δ, □)
Tutorial for qualified seniors and graduate students.

East Asian Studies (EAS)

8061. SCIENCE AND METHODS OF EAST ASIAN STUDIES. (4 cr)

Introduction to subfields, problems, and methodologies involved in study of East Asia as a world area.

Ecology (EEB)

Regents' Professor: Margaret B. Davis; Eville Gorham

Professor: Patrice A. Morrow, *head*; Edward J. Cushing, *director of graduate studies*; Peter A. Abrams; Franklin H. Barnwell; Elmer C. Birney; Patrick L. Brezonik; Kendall W. Corbin; James W. Curtsinger; David F. Grigal; Kerry R. Kelts; D. Frank McKinney; Donald C. McNaught; L. David Mech; Robert O. Megard; Jean-Alex E. Molina; Craig Packer; Richard E. Phillips; Anne E. Pusey; Philip J. Regal; William D. Schmid; Joseph Shapiro; Michael J. Simmons; Donald B. Siniff; Anthony M. Starfield; John R. Tester; G. David Tilman; Melbourne C. Whiteside¹

Associate Professor: Donald N. Alstad; David A. Andow; John H. Beatty; Robert C. Bright; Yosef Cohen; Glenn R. Furnier; Michael J. Sadowsky; Ruth G. Shaw; Peter W. Sorensen; Robert M. Zink

Assistant Professor: Linda L. Kinkel

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Activity centers on the biology of organisms: how they interact in social groups, populations, and communities, and how those interactions have influenced the distribution of organisms in space and time. The program provides unusual breadth of training and encourages the interrelation of two or more fields of specialization, including animal behavior, ethology, evolutionary ecology, vertebrate ecology, radio-telemetry, population biology, invertebrate ecology, microbial ecology, plant-animal interactions, plant ecology, paleoecology, limnology, and wetland ecology. Opportunities exist for field research in various parts of the world as well as in local habitats. Each student's program is planned to meet individual requirements. Seminars and tutorials constitute an important part of all student programs.

Prerequisites for Admission—Incoming graduate students are ordinarily expected to have completed coursework in inorganic chemistry and at least one quarter of organic chemistry, one year of college physics, one year of college calculus, and at least one course each in the areas of animal biology, plant biology, genetics, biochemistry, and physiology. Deficiencies must be made up early in the graduate program.

Special Application Requirements

Students are admitted only in fall quarter. Deadline for application is January 15; earlier application is encouraged for individuals seeking financial aid. Three letters of recommendation evaluating the applicant's scholarship are required, plus Graduate Record Examination scores (including the Subject Test). Successful applicants are encouraged to participate in the Lake Itasca Biology Session during the summer before their first quarter in residence.

Master's Degree Requirements—A complete statement of degree program requirements may be obtained from the director of graduate studies. There are few specific course requirements; each program is planned to meet the individual interests and needs of the student. Participation at a field station and competence in statistics are required. The final examination is oral.

Doctoral Degree Requirements

Individual programs are designed by the student and a three-person advisory committee. Participation at a field station and competence in statistics and the use of computers are required.

Language Requirements—For the M.S. degree, none. For the Ph.D. degree, one foreign language is required.

For Further Information and

Applications—Contact the Department of Ecology, Evolution, and Behavior, University of Minnesota, 100 Ecology Building, 1987 Upper Buford Circle, St. Paul, MN 55108 (612/625-4466; fax 612/625-4490).

¹ University of Minnesota, Duluth

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EEB 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

EEB 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

EEB 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Community Ecology and Paleoecology

5004. EARTH SYSTEM: GEOSPHERE/BIOSPHERE INTERACTIONS. (4 cr, §Geo 5631; prereq Geo 3202, 3301 or #) Davis, Kelts
Interdisciplinary study of mechanisms that force global change, feedbacks, and dynamics on various time scales, using paleorecord to illustrate processes.

5008. QUATERNARY ECOLOGY. (4 cr; prereq Biol 5041 or Biol 5841 or #) Cushing, Davis
Impact of changes in physical and biological environment during Quaternary period on plants and animals. Evolutionary rates, geographical distributions, community composition, and fluctuations in population sizes. Prehistoric human culture and ecosystem-level changes recorded in sedimentary sequences. Recent climatic changes. Principles of analysis, methods of investigation and interpretation.

5014. ECOLOGY OF VEGETATION. (5 cr; prereq Biol 5041 or Biol 5841, 1 qtr statistics or #) Cushing
Methods of describing, sampling, and classifying vegetation; spatial and temporal variation of vegetation on landscapes; theory of structure and dynamics of plant communities. Field trips to examine local vegetation types; analysis of quantitative data.

5016. ECOLOGICAL PLANT GEOGRAPHY. (5 cr; prereq Biol 5041 or Biol 5841, PBio 3201 or #PBio 3201 or #; offered alt yrs) Cushing
Vegetation regions of the world in general and North America in detail; ecological principles of plant distribution; interpretation of regional and temporal patterns in the distribution of vegetation and taxonomic groups. Field trips to floristic regions of Minnesota.

8014. PALEOECOLOGICAL METHODS. (5 cr; prereq #) Bright
Introduction to morphology and anatomy of fossil (Quaternary) seeds, wood, other plant remains, and freshwater and land mollusks.

8410. COMMUNITY ECOLOGY SEMINAR. (1 cr; prereq #)
Reading and discussion of recent literature on community ecology.

Population and Evolutionary Biology

5033. POPULATION AND QUANTITATIVE GENETICS. (4 cr, §GCB 5033; prereq Biol 5003 or GCB 3022, biometry or statistics course or #) Curtsinger, Shaw
Introduction to genetic basis of microevolutionary change. Allelic frequency dynamics, emphasizing natural selection and adaptive topography. Molecular evolution, additive genetic variance, consequences of artificial selection, and current topics.

5044. EVOLUTION. (4 cr; prereq Biol 1106 or Biol 3011, Biol 1103 or Biol 3012) Regal
Evidence for and causes of biological evolution.

5051. ANALYSIS OF POPULATIONS. (4 cr; prereq Biol 5041 or Biol 5841 or #; offered alt yrs) Siniff, Starfield
Factors in regulation, growth, and general dynamics of populations. Data needed to describe populations, population growth, population models, and regulatory mechanisms.

5052. THEORETICAL POPULATION ECOLOGY. (5 cr; prereq Biol 5041 or Biol 5841 or #; offered alt yrs) Tilman
Models of growth and regulation of single populations; models of interactions between populations, including competition, predation, mutualism; assumptions and rationales of models and their predictions for dynamics, stability, and diversity of communities.

5063. INSECT ECOLOGY. (3 cr; prereq Biol 5041 or Biol 5841 or #) Alstad
Dynamics and regulation of insect populations; life history evolution; cytogenetic patterns, reproductive competition, mating systems, modes of speciation; mechanisms and implications of frequency dependent coevolution.

5064. THE PROCESS OF EVOLUTION. (4 cr; prereq Biol 5041 or Biol 5841 or #) Alstad
Introduction to mechanistic bases of evolution, including causes and consequences of natural selection, stochastic consequences of Mendelian segregation, and their combined influences on structure of natural and captive populations. Includes lab exercises based on "Populus" computer simulation software.

8300. TOPICS IN EVOLUTION. (2 cr; prereq 5064 or GCB 5033 or #)
Topics change annually.

8400. POPULATION BIOLOGY SEMINAR. (1 cr; prereq #)
Reading and discussion of recent literature on biology of plant and animal populations.

8430. EVOLUTIONARY GENETICS SEMINAR. (3 cr; prereq 5063 or GCB 5033 or #; offered alt yrs) Curtsinger
Reading and discussion of recent literature in evolutionary biology that has genetic component.

Organismal Biology and Physiological Ecology

5122. PLANT/ANIMAL INTERACTIONS. (4 cr; prereq Biol 1106 or Biol 3011, Biol 1103 or Biol 3012, 10 cr biological sciences or #) Morrow
Herbivory, pollination, seed dispersal. Implications of interaction for plants and animals at organismal, population, and community levels. Coevolution.

5129. MAMMALOLOGY. (5 cr, §FW 5129; prereq Biol 1106 or Biol 3011 or #) Birney
Recent families and orders of mammals of the world and of genera and species of mammals of North America, with emphasis on morphology, evolution, and zoogeographic history.

5134. INTRODUCTION TO ORNITHOLOGY. (5 cr; prereq Biol 1106 or Biol 3011) Zink
Lab and field course in structure, classification, distribution, migration, habits, habitats, and identification of birds. Weekend trips scheduled.

5136. ICHTHYOLOGY. (4 cr; prereq 15 cr incl Biol 1106 or Biol 3011)
Biology of fishes including development, systematics, anatomy, physiology, and ecology.

5156. COMPARATIVE ANIMAL PHYSIOLOGY. (5 cr; prereq Biol 1106 or Biol 3011, Chem 3302 or #) Schmid
The environment imposes passive stresses upon organisms—not equilibrium; various physiological adaptations allow maintenance of homeostasis. Introduction to the passive organism; environmental stresses and biological mechanisms by which they are counteracted.

8162w. WINTER ECOLOGY. (4 cr; prereq #; offered alt yrs) Schmid
Seminar on characteristics of subnivean environment and adaptations by plants and animals to winter stresses. Includes weekend fieldwork.

Behavior

5321. EVOLUTION OF SOCIAL BEHAVIOR. (4 cr; prereq Biol 1106 or Biol 3011 or #) McKinney
Introduction to current theories and concepts relating to mating systems, spacing systems, and cooperative behavior in animals.

5323. MECHANISMS OF BEHAVIOR. (3 cr; prereq 3111 or Biol 3011 or #; offered alt yrs) Barnwell, Phillips
Neural and hormonal mechanisms that mediate adaptive behavior in invertebrate and vertebrate animals, using series of well-studied examples to illustrate general principles.

5324. EVOLUTION OF PRIMATE SOCIAL BEHAVIOR. (3 cr; prereq 3111 or #)
Ecological factors that influence variation in demography, social structure, and social behavior of non-human primates. Application of current evolutionary theory (e.g., kin selection, reciprocity) to understanding of social behavior.

5325. BEHAVIORAL ECOLOGY. (4 cr; prereq 3111 or 5321 or Biol 5041 or Biol 5841 or #; offered alt yrs) Packer
Evolutionary principles applied to study of aggressive competition, mating systems, cooperation, and parental investment. Optimization models used to examine foraging strategies, predator/prey interactions and territoriality. Evolution of sex, sexual selection, and dispersal.

8061. SOCIAL SYSTEMS. (3 cr; prereq 5322 or equiv, #; offered when feasible) McKinney

8510. BEHAVIORAL BIOLOGY SEMINAR. (1 cr; prereq #)
Critical reading and discussion of recent literature in behavioral biology.

Limnology and Ecosystem Ecology

5601. LIMNOLOGY. (4 cr, §Geo 5601; prereq Chem 1005 or #) Shapiro, Megard
Description and analysis of events in lakes, reservoirs, and ponds, beginning with their origins and progressing through their physics, chemistry, and biology. Interrelationships of these parameters, and effects of civilization on lakes.

5607. ECOLOGY OF ANIMAL PLANKTON. (5 cr; prereq 5601, Biol 5041 or Biol 5841 or #; offered when feasible) McNaught

5608. ECOSYSTEMS: FORM AND FUNCTION. (4 cr; prereq 5601 or Biol 5041 or Biol 5841 or equiv, advanced course in writing such as Comp 3015 or Comp 3027 or Comp 3033 or Comp 3085 or Rhet 3562) Davis, Gorham
Nature and development of terrestrial, wetland, and aquatic ecosystems. Analysis of energy flow and element cycling in relation to environmental controls, self-regulation, natural and human disturbances.

5621. LIMNOLOGY LABORATORY. (2 cr, §Geol 5621; prereq 5601 or Geol 5601 or #) Megard
Principal techniques for obtaining information about environmental conditions in lakes and streams. Procedures for measuring abundance and population dynamics of aquatic organisms, especially plankton. Field instruments, sampling devices, chemical analyses, microscopy, and analysis of data. One Saturday field trip.

8602. ADVANCED LIMNOLOGY. (3 cr, §Geol 8602; prereq 5601 or Geol 5601 or equiv)
Selected problems in limnology using current and classical literature. Term paper required.

Courses Offered at

Lake Itasca Forestry and Biological Station

(In addition to courses listed below, Itasca offers special topic courses for 1 to 5 weeks during the summer. For information on these courses, contact the Itasca Biology Program through the Ecology and Behavioral Biology Department office.)

5814su. PLANT COMMUNITY ECOLOGY. (5 cr; prereq ecol course, Δ; limited to 20 students; offered annually)
Communities represented in Itasca Park and vicinity, with emphasis on vegetation. Patterns of distribution of communities, interaction with environment, dynamic relationships. Methods of community description and analysis.

Graduate Programs

5817su. VERTEBRATE ECOLOGY. (5 cr; prereq ecol course, Δ ; limited to 20 students)

Field studies on vertebrate populations and their relationships to local environments; habitat analysis and ecological research methods. Students work as team investigating factors influencing distribution and abundance of selected vertebrates in various habitats. Research-oriented course supplemented with lectures and field trips.

5834su. FIELD ORNITHOLOGY. (5 cr; prereq general biol course including study of zoology, Δ ; limited to 15 students)

Emphasis on breeding season, biology, and behavioral ecology of birds in Itasca Park region. Field trips to variety of habitats to learn bird identification and to observe and practice techniques for conducting field studies. Lab sessions investigate family distinctions and species identification. Individual field projects.

5839su. FIELD STUDIES IN MAMMALOLOGY. (5 cr; prereq college-level biol course including study of animals or #, Δ)

Techniques used in study of small mammals. Lectures and field projects emphasizing identification, distributions, community interactions, ecophysiology, and population ecology.

5852. ECOLOGICAL GENETICS. (5 cr; prereq college-level course in general biol or genetics or #) Basic population and quantitative genetics; variation in natural populations; electrophoretic analysis of field samples; reconstructing phylogeny; genetic studies of population structure; introduction to mitochondrial DNA analysis.

Directed Studies

5965. DECISION ANALYSIS. (4 cr; prereq conservation biol grad student or #) Starfield
Use of decision analysis techniques and modeling to clarify issues in conservation biology; active-learning class.

5970. DIRECTED STUDIES. (Cr ar; prereq #, Δ)

5990. DIRECTED RESEARCH. (Cr ar; prereq #, Δ)
Lab or field investigation of selected areas of research.

8390. GRADUATE SEMINAR. (Cr ar; prereq #) Staff

8391. ADVANCED WORK IN ECOLOGY AND BEHAVIORAL BIOLOGY. (Cr ar; prereq #) Staff
Individual work in some special aspect of the area.

8990. GRADUATE RESEARCH. (Cr ar; prereq #) Staff

See other graduate programs and Related Courses for descriptions of the following courses:

Biol 5816. FIELD BIOLOGY PHOTOGRAPHY

Biol 5841. ECOLOGY

Biol 5870. ITASCA SEMINAR

Biol 5890. RESEARCH PROBLEMS AT ITASCA

Geo 8602. ADVANCED LIMNOLOGY

Economics (Econ)

Regents' Professor: John S. Chipman; Vernon W. Ruttan

Professor: Craig E. Swan, *chair*; Edward Foster, *director of graduate studies*; Beth E. Allen; Varadarajan V. Chari; Roger D. Feldman; John F. Geweke; Edward J. Green; James P. Houck; Leonid Hurwicz (*emeritus*); James S. Jordan; John H. Kareken; Timothy J. Kehoe; Stephen F. LeRoy; Herbert D. Mohring (*emeritus*); Edward C. Prescott; Marcel K. Richter; G. Edward Schuh

Associate Professor: George D. Green; Michael P. Keane; Patrick J. Kehoe; Nobuhiro Kiyotaki; Andrew McLennan; Richard Rogerson; Jan Werner; Randall D. Wright

Assistant Professor: Sumru G. Altug; Hidehiko Ichimura; Yuichi Kitamura; Antonio Merlo; T. Scott Thompson

Other: Simran Sahi

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—The department offers degree work in the following fields: economic theory; econometrics; economic development; financial economics; game theory; industrial organization; international economics; labor economics; mathematical economics; monetary economics; public economics.

Prerequisites for Admission—The general requirement is the capability to pursue Ph.D.-level work. Normally the student should have an undergraduate record from a recognized college that includes coursework in economic theory and mathematics (multivariate calculus and linear algebra).

Special Application Requirements—Scores from the Graduate Record Examination (GRE) and letters of recommendation must be submitted. Applicants desiring financial assistance should submit their applications, including a record of GRE scores and three letters of recommendation, to the director of graduate studies no later than December 15. Students are admitted in fall quarter only.

Degree Requirements—A description of the M.A. and Ph.D. programs can be obtained by writing to the director of graduate studies.

Language Requirements—None.

For Further Information and

Applications—Contact the Department of Economics, University of Minnesota, 937 Management and Economics, 271 19th Avenue South, Minneapolis, MN 55455 (612/625-6833; fax 612/624-0209; e-mail econdgs@atlas.socsci.umn.edu).

Econ 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Econ 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Econ 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

General

5021. ECONOMICS, ETHICS, AND ECONOMIC PHILOSOPHY. (3-5 cr; prereq 1001, 1002 or equiv) Literature and the issues it raises; relation of ethics to economic organization, practice, and policy. Different economic philosophies; elements involved in formulation of an economic philosophy.

5041 (formerly 5421). THE PROSPECTIVE WORLD ECONOMY. (4 cr; prereq 3101 or 3105 or #; offered when feasible)

5960. TOPICS IN ECONOMICS. (4 cr per qtr; prereq 3101, 3102, 3103 or equiv) Topics specified in *Class Schedule*.

5970. READINGS IN ECONOMICS. (Cr ar; prereq consent of adviser, #, Δ, CLA approval; offered when feasible)

8990. INDIVIDUAL GRADUATE RESEARCH. (Cr ar)

Theory

5107H. HONORS COURSE: GAME THEORY AND ITS APPLICATIONS. (4 cr for grad students; prereq 3101, 3102, 3103 or equiv, Math 1251-1252, Math 1261 or equiv) Introduction to games; normal and extensive form; wars of attrition; games of timing; bargaining applications in industrial organization, macroeconomics, and international economics.

5113. INTRODUCTION TO MATHEMATICAL ECONOMICS. (4 cr; prereq 3101, 3102, 3103 or equiv, Math 1251-1252, Math 1261, Math 3251 or equiv) Development in mathematical terms of selected models of economic behavior. Topics selected to illustrate advantages of a mathematical formulation.

5151. ELEMENTS OF ECONOMIC ANALYSIS: FIRM AND HOUSEHOLD. (3 cr; prereq 3101 or equiv, 1 qtr linear algebra, 1 qtr calculus, grad student or #)

Decision making by households and by firms under conditions of monopoly, competition, and monopolistic competition.

5152. ELEMENTS OF ECONOMIC ANALYSIS: INCOME AND EMPLOYMENT. (3 cr; prereq 3101, 3102 or equiv, 1 qtr linear algebra, 1 qtr calculus, grad student or #)

Determinants of national income, employment, and price level; aggregate consumption, investment and asset holding.

8101-8102-8103. MICROECONOMIC THEORY. (4 cr per qtr; prereq 3101 or 5151, Math 3142, Math 3211 or equiv)

Decision problems faced by the household and firm; theories of choice under conditions of certainty and uncertainty. Partial equilibrium analysis of competition and monopoly. General equilibrium analysis. Welfare economics: economic efficiency of alternative market structures; social welfare functions. Dynamics: stability of markets, introduction to capital theory.

8104-8105-8106. MACROECONOMIC THEORY. (4 cr per qtr; prereq 3102, Math 3142, Math 3211 or equiv)

8104: Dynamic general equilibrium models: solving for paths of interest rates, consumption, investment, and prices. *8105-8106:* General equilibrium models with uncertainty, search, matching, indivisibilities, private information, etc. Implications of theory for measurement and data reporting. Overlapping generations and dynasty models with money and government. Variational and recursive methods.

8111-8112-8113. INTRODUCTION TO MATHEMATICAL ECONOMICS. (3 cr per qtr; prereq Math 3211 or equiv, Math 3142, ¶8101, ¶Math 5612 or equiv for 8111, Math 5243 recommended) Use of mathematical models in economic theory; the more standard techniques developed in 8111 and 8112; 8113 may include special topics.

8117, 8118. NONCOOPERATIVE GAME THEORY. (3 cr; prereq Math 5614 or equiv or #)

Solution concepts for noncooperative games in normal form, including Nash and perfect equilibrium and stable sets of equilibria. Extensive form games of perfect and incomplete information, sequential equilibrium, and consequences of stability for extensive form. Applications including bargaining and auctions.

8119. COOPERATIVE GAME THEORY. (3 cr; prereq 8101-8102-8103, Math 5614 or equiv or #) Allen Basics of cooperative game theory, emphasizing concepts used in economics. Games with and without transferable utility; the core, the value, and other solution concepts. Recent results, including potentials, reduced games, consistency, and noncooperative implementation of cooperative solution concepts.

8181-8182-8183. ADVANCED TOPICS IN MICROECONOMICS. (3 cr per qtr; prereq 8103; offered when feasible)

Graduate Programs

8184-8186. ADVANCED TOPICS IN MACROECONOMICS. (3 cr per qtr; offered when feasible)

8192. WORKSHOP IN MATHEMATICAL ECONOMICS. (Cr ar)

Written and oral presentations by Ph.D. students engaged in or planning to engage in thesis research in mathematical economics.

Econometrics

5231-5232. INTRODUCTION TO ECONOMETRICS. (4 cr per qtr; prereq 3101 or equiv, Stat 5121-5122 or Stat 5131-5132-5133, Math 1251-1252, Math 1261 or equiv or #)

Review of basic linear regression model and deviations from it: heteroskedasticity, serial correlation, correlation of residuals and regressors—errors in variables, simultaneous equations, and others.

8201-8202-8203. APPLIED ECONOMETRICS. (4 cr per qtr; prereq 3101, 3102, Stat 5122, 1 qtr linear algebra)

Conceptual basis of econometric theory (omitting many proofs of theorems) with application to economic models. Lab section required.

8211-8212-8213. ECONOMETRICS. (3 cr per qtr; prereq 5151, 5152, Stat 5133 or Stat 5122, Math 5243 or equiv or #)

8211: Linear regression. General linear hypotheses. Gauss Markov Theorem, generalized least squares and their applications. Decision-theoretic choice among estimators. 8212: Simultaneous equations models; identification and estimation. Asymptotic distribution theory. 8213: Asymptotic distribution theory for nonlinear models. Applications, including multivariate time series models and/or limited dependent variables models.

8281-8282. ADVANCED TOPICS IN ECONOMETRICS. (3 cr per qtr; offered when feasible)

Development

5301. ECONOMIC DEVELOPMENT. (4 cr, §5331; not open to economics majors; prereq 1101, 1102 or equiv)

Problems of economic growth in low income countries. Theory of aggregate and per capita income growth. Role of population growth, productivity increases and capital formation. Allocation of resources between consumption and investment and among sectors. International assistance and trade.

5307. COMPARATIVE ECONOMIC SYSTEMS. (4 cr; not open to economics majors; prereq 1101, 1102 or equiv)

Functions of economic systems; market economy vs. centrally planned economy. Post-socialist transitions in Eastern Europe and reforms in China. Initial conditions and strategy for reforms; results of reforms in terms of key economic indicators.

5312. TECHNOLOGY AND DEVELOPMENT. (4 cr; prereq 3101, 3102 or equiv or #)

Economics of research development; technical change and productivity growth; impact of technology on institutions; science and technology policy.

5315. THE JAPANESE ECONOMY. (4 cr, §3315; prereq 3101 or equiv; offered when feasible)

5331. ECONOMIC DEVELOPMENT. (4 cr, §5301; prereq 3101, 3102 or equiv)

Problems of economic growth in low income countries. Theory of aggregate and per capita income growth. Role of population growth, productivity increases, and capital formation. Allocation of resources between consumption and investment and between sectors. International assistance and trade.

5331H. HONORS COURSE: ECONOMIC DEVELOPMENT. (4 cr for grad students, §5301; prereq 3101, 3102 or equiv, 1 qtr calculus; B avg recommended)

For description, see 5331.

5337. COMPARATIVE ECONOMIC SYSTEMS. (4 cr, §5307; prereq 3101, 3102 or equiv)

Functions of economic systems; market economy vs. centrally planned economy. Post-socialist transitions in Eastern Europe and reforms in China. Initial conditions and strategy for reforms; results of reforms in terms of key economic indicators.

8311. ECONOMIC GROWTH AND DEVELOPMENT THEORY. (3 cr; prereq 8103, 8105)

Technical change and economic growth, role of population change, productivity increases, capital formation, trade and international assistance.

8312. TECHNOLOGY AND DEVELOPMENT. (3 cr; prereq 8103, 8105; offered when feasible)

International Economics

5401. INTERNATIONAL ECONOMICS. (4 cr, §5429, §5431, §5432; not open to economics majors; prereq 1101, 1102 or equiv)

Explanation of trade patterns. Commercial policy, protection, factor mobility. Balance of payments, exchange rate determination, international monetary system.

5431. INTERNATIONAL TRADE. (4 cr, §5401, §5429; prereq 3101, 3102, 3103 or equiv)

Theories of trade and explanation of trade patterns. Trade restrictions and commercial policy. International factor movements. Economic growth and trade.

5431H. HONORS COURSE: INTERNATIONAL TRADE. (4 cr for grad students, §5401; prereq 3101, 3102, 3103 or equiv, 1 qtr calculus; B avg recommended)

For description, see 5431.

5432. INTERNATIONAL FINANCE. (4 cr, §5401; prereq 3101, 3102, 3103 or equiv; 5431 or equiv recommended)

Balance of payments, foreign exchange market, exchange rate determination. International monetary system.

8401-8402-8403. INTERNATIONAL TRADE AND PAYMENTS THEORY. (3 cr per qtr; prereq 8102, 8104)

8401: Impact of trade on factor rentals. Stolper-Samuelson, Rybczynski, and factor price equalization theorems. Heckscher-Ohlin theorem. Derivation of offer curves and general international equilibrium. Transfer problem. 8402: Tariffs, quotas, and other barriers to trade; gains from trade; trading blocs; increasing returns; growth. 8403: International business cycles; exchange rates; capital movements; international liquidity.

8483. ADVANCED TOPICS IN INTERNATIONAL TRADE THEORY. (3 cr; prereq 8101, 8102, 8403 or equiv or #; offered when feasible)**8491-8492. WORKSHOP IN TRADE AND DEVELOPMENT.** (Cr ar)

Written and oral presentations by Ph.D. students engaged in or planning to engage in thesis research in trade and development.

Labor**5531. LABOR ECONOMICS.** (4 cr, §3501; prereq 3101, 3102 or equiv)

Role of labor in economy; labor as a factor of production; population and the labor force; economics of labor markets; labor market institutions; theories of wages and employment; unions and collective bargaining; public policy.

5534. ECONOMIC SECURITY. (4 cr; prereq 1101, 1102 or equiv; offered when feasible)**8501-8502. WAGES AND EMPLOYMENT.** (3 cr per qtr; prereq 8101, 8104)

Economic analysis of labor markets and their operation under conditions of both individual and collective bargaining. Implications of labor market operations for resource allocation, wage and price stability, income and employment growth. Wage structures and wage levels. Wage and employment theories and practices. Economic impacts of unions.

8583. ADVANCED TOPICS IN LABOR ECONOMICS. (3 cr; offered when feasible)**Industrial Organization****5611. RESOURCE AND ENVIRONMENTAL ECONOMICS.** (4 cr; prereq 3101 or equiv, 1 qtr calculus)

Exhaustible resources and theory of optimal depletion. Renewable resources and theory of optimal use. Does resource scarcity limit growth? Natural resources and natural environments. Environmental pollution and economic efficiency.

5611H. HONORS COURSE: RESOURCE AND ENVIRONMENTAL ECONOMICS. (5 cr; prereq 3101 or equiv, 1 qtr calculus)

Exhaustible resources and theory of optimal depletion. Renewable resources and theory of optimal use. Does resource scarcity limit growth? Natural resources and natural environments. Environmental pollution and economic efficiency.

5621. URBAN ECONOMICS. (4 cr; prereq 3101 or equiv)

Location of economic activity and of cities; central place theory; site rents and form of city; urban economic base and economic policy; urban problems and economic policies: transportation, poverty and segregation, housing, public finance.

5623. HOUSING MARKETS AND PUBLIC POLICY. (4 cr; prereq 1101, 1102 or equiv)

Analysis of housing markets. Market failures, externalities and the case for government intervention. Relative efficiency of particular forms of intervention.

5631. INDUSTRIAL ORGANIZATION AND ANTITRUST POLICY. (4 cr, §3601; prereq 3103, 3103 or equiv)

Economic aspects of antitrust and related policies. Relations between market structure and economic efficiency and welfare. Economic origins of monopoly and other restraints on competition. Purposes and effects of antitrust and related legislation.

5631H. HONORS COURSE: INDUSTRIAL ORGANIZATION AND ANTITRUST POLICY. (4 cr for grad students; prereq 3101, 3103 or equiv, 1 qtr calculus; B avg recommended)

For description, see 5631.

8601-8602-8603. INDUSTRIAL ORGANIZATION AND GOVERNMENT REGULATION. (3 cr per qtr; prereq 8101)

Behavior of businesses and industries: productivity, firm size distributions, exit-entry dynamics, etc. Theories of the firm, industry structure and performance, invention and innovation, and technology adoption. Positive and normative theories of regulation.

8683. ADVANCED TOPICS IN INDUSTRIAL ORGANIZATION. (3 cr; offered when feasible)**Money and Financial Economics****5701. MONEY, BANKING, AND MONETARY POLICY.** (4 cr, §3701, §5761; not open to economics majors; prereq 1001, 1002 or equiv or #)

Economic role of financial institutions, with emphasis on commercial banks, money supply, and monetary policy.

5721. MONEY AND BANKING. (4 cr, §5701; prereq 3101, 3102 or equiv; offered when feasible)**5721H. HONORS COURSE: MONEY AND BANKING.** (4 cr for grad students; prereq 3101, 3102 or equiv, 1 qtr calculus; B average recommended)

For description, see 5721.

5731. MACROECONOMIC POLICY. (4 cr; prereq 3101, 3102 or equiv)

Monetary vs. fiscal policy debate in context of underlying macroeconomic theory controversy. Comparison of Keynesian, Monetarist, and Classical theories; rational expectations; policy ineffectiveness; time inconsistency; rules vs. discretion; budget deficits; unemployment and inflation.

Graduate Programs

5731H. HONORS COURSE: MACROECONOMIC POLICY. (4 cr for grad students; prereq 3101, 3102 or equiv, 1 qtr calculus; B average recommended)
For description, see 5731.

5733. INTERTEMPORAL ECONOMICS AND MONEY. (4 cr; prereq 3101, 3103 or equiv, Math 1251-1252, Math 1261 or equiv)
Real intertemporal economics: overlapping-generations models of interest rates; applications of social security and deficit finance. Representative agent model, Ricardian Equivalence, introduction to neo-classical growth model.

5741. BUSINESS CYCLES. (4 cr; prereq 3101, 3102, Stat 3011 or equiv)
Models of economic growth are developed and matched to U.S. data; review of business cycle facts; growth model is used to examine impact of changes in important growth factors, including public finance and technology and for business fluctuations.

5741H. HONORS COURSE: BUSINESS CYCLES. (4 cr for grad students; prereq 3101, 3102, Stat 3011 or equiv, 1 qtr calculus; B avg recommended)
For description, see 5741.

5752H. HONORS COURSE: FINANCIAL ECONOMICS II. (4 cr for grad students, §3752; prereq 3751; B avg recommended)
Efficiency of financial markets. Theoretical concepts and empirical evidence.

8701-8702. MONETARY ECONOMICS. (3 cr per qtr; prereq 8102, 8105)
Economic role of principal financial institutions. Determinants of value of money. Principal problems of monetary policy.

8704-8705-8706. FINANCIAL ECONOMICS. (3 cr per qtr; prereq 8102, 8105)
Role of financial institutions in efficient allocation of risk; multiperiod and continuous-time securities markets; theory of firm under uncertainty; financial intermediation; derivation of empirical asset-pricing relationships; tests concerning alternative market structures.

8781-8782. ADVANCED TOPICS IN MONETARY ECONOMICS. (3 cr per qtr; offered when feasible)

8793. WORKSHOP IN MACROECONOMICS. (Cr ar)
Written and oral presentations by Ph.D. students engaged in or planning to engage in thesis research in macroeconomics.

Public Finance

5821. INTRODUCTION TO PUBLIC ECONOMICS. (4 cr, §3801; prereq 3101, 3103 or equiv)
Tax and expenditure policies, primarily at federal level. Impact of tax structure on distribution of income. Evaluation of public programs. Optimal mix of public and private sector output.

5831. COST-BENEFIT ANALYSIS. (4 cr; prereq 3101, 3103 or equiv)
Principles for evaluation of benefits and costs of public projects or programs. Issues connected with definition and measurement of benefits and costs. Rate of return and rate of discount. Market imperfections, risk, and uncertainty.

5831H. HONORS COURSE: COST-BENEFIT ANALYSIS. (4 cr for grad students; prereq 3101, 3103 or equiv, 1 qtr calculus; B avg recommended)
For description, see 5831.

8801-8802-8803. PUBLIC ECONOMICS. (3 cr per qtr; prereq 8102, 8105)
Theories of public choice and role of government in economy. Economic effects of taxes, public debt, and public expenditure. Current problems in economics of public sector, including local public economics.

8882-8883. ADVANCED TOPICS IN PUBLIC FINANCE. (3 cr per qtr; offered when feasible)

Education¹

Degrees Offered—M.A., Ph.D., and Certificate of Specialist in Education.

Curriculum—The broad goal of graduate programs with a major in education is to develop, validate, and disseminate knowledge on educational theory and practice to improve the quality of education at all levels. The master's degree is offered with emphases in curriculum and instruction and in vocational education. The doctoral degree is offered with emphases in curriculum and instruction (see Curriculum and Instruction for description); recreation, park, and leisure studies (see Kinesiology and Leisure Studies for description); and vocational education (see Vocational and Technical Education for description). The specialist certificate is offered with emphases in general curriculum supervision and mathematics education.

¹ *Advanced work leading to the professional degree of master of education (M.Ed.) is offered by the College of Education in adult education; agricultural education; art education; business and marketing education; community education administration; curriculum and instructional systems; early childhood education; elementary education; home economics education; industrial education; mathematics education; music education; physical education; developmental/adapted physical education; recreation, park, and leisure studies; special education; vocational education; and several secondary academic fields. Interested persons should consult the College of Education Bulletin.*

Please note that the Ph.D. thesis credit course entry for education is divided as follows into sections corresponding to the various emphases:

Educ 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Educ 8888. THESIS CREDITS: DOCTORAL. (36 cr required for Ph.D.)

- Section 1. Curriculum and Instruction
- Section 2. Vocational Education
- Section 3. Recreation, Park, and Leisure Studies

Note—For other education-related degrees, see also Child Psychology; Curriculum and Instruction; Educational Policy and Administration; Educational Psychology; Kinesiology and Leisure Studies; and Vocational and Technical Education.

Educational Administration

See Educational Policy and Administration.

Educational Policy and Administration (EdPA)

Professor: William M. Ammentorp¹; Ayers Bagley; Robert H. Bruininks¹; John J. Cogan¹; Glenn L. Hendricks; Vernon L. Hendrix¹; Stephen A. Hoenack; Darrell R. Lewis¹; Karen Seashore Louis¹; Marion Lundy-Dobbert; Tim L. Mazzoni¹; Josef A. Mestenhauser¹; Charles E. Moore¹; Van D. Mueller¹; Neal C. Nickerson¹; James R. Rest; Charles H. Sederberg¹; Robert D. Tennyson; Richard F. Weatherman¹; W. Keith Wharton¹; Kathleen M. Zurcher

Associate Professor: Gary F. Alkire^{1,2}; Arthur M. Harkins; Jean A. King¹; Elaine L. Leach¹; John M. McLaughlin¹; Robert E. Orton; R. Michael Paige¹; Barbara Pillinger¹; Byron J. Schneider¹; Caroline S. Turner¹

Assistant Professor: Melissa S. Anderson; Jennifer L. York¹

Senior Fellow: Richard B. Heydinger¹; Dean Honetschlager¹; Josie R. Johnson¹

Research Associate: Darwin D. Hendel

Lecturer: Neil E. Christenson¹; Timothy J. Delmont¹; David R. Johnson¹; Clark M. Kirkpatrick¹; Thomas F. Morgan¹; Joseph H. Nathan¹; Barbara J. S. Shin¹; Kyla L. Wahlstrom¹

Adjunct Lecturer: Michael J. Lovett¹

Other: Carol M. Boyer¹; Gerald A. McIntosh¹; David Murphy

¹ Also holds graduate faculty appointment in educational administration.

² Advising role restricted to students pursuing the M.A., Ed. D., or Certificate of Specialist degree.

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) in educational policy and administration; Ed.D. in educational administration; Ph.D. in educational policy and administration; Certificate of Specialist in Education in educational administration.

Curriculum—The Department of Educational Policy and Administration has recently reorganized to provide a more integrated and focused program for graduate studies. A single M.A. and Ph.D. degree program is offered with concentrations in several areas, including educational administration, higher education, comparative and international development education, and policy and evaluation studies. The department cooperates with other departments within the College of Education and the University to offer individualized concentrations in areas such as youth policy and special education policy.

The master's degree ordinarily serves as a first step for students beginning graduate study in the field. The Ph.D. program emphasizes intensive and individualized study in one of the emphases described above, and is especially appropriate for those who plan to pursue research, teaching, or leadership careers in the field of educational policy and administration. The Ed.D. program is particularly suitable for individuals interested in leadership careers in the operation of K-12 or two-year postsecondary institutions. The specialist certificate is intended to lead to licensure in general educational administration (superintendents and central office personnel), secondary school administration, elementary school administration, and special education administration.

Prerequisites for Admission—Applicants must have completed appropriate undergraduate and graduate study. In some cases, where previous coursework or degrees are marginally related, otherwise qualified applicants will be asked to complete

Graduate Programs

additional background courses after admission. Applications for doctoral studies are encouraged from individuals who may have completed master's programs in areas such as curriculum studies, sociology, psychology, economics, political science, international relations, management science, measurement and statistics, and educational psychology. Opportunities are designed for mature/employed students as well as for those who wish to pursue graduate studies full time.

Special Application Requirements—Scores from the Graduate Record Examination (GRE), General Test only, are required from all applicants. Applicants must also submit a department application that includes a statement on background, interests, and goals, and two personal references.

Master's Degree Requirements—There is considerable flexibility in designing programs to meet individual circumstances, depending on the student's emphasis and career interests. A typical program includes 20 to 24 credits in the area of emphasis, 8 to 10 credits in a related field, 6 to 9 credits in related methodology preparation, and 9 to 12 credits in electives or an optional internship. The final requirements for the Plan B program, which is recommended for most students, are an oral examination and a research paper. More specific information and sample course plans for each separate degree program are available from the department.

Doctorate of Education Degree Requirements—The doctorate of education consists of a major of at least 21 credits in the core curriculum, 12 credits in a research methodology sequence, 0 to 9 credits in an internship or clinical experience (depending on the previous professional experience of the applicant), and 12 to 21 credits in specializations (e.g., seminars, leadership courses, technical courses). Twenty-four credits are taken in supporting areas; typically at least 15 of these are taken from outside the College of Education in areas that are appropriate for the study of administration.

The preliminary written and oral examination requirements vary depending on the Ed.D. program. The final project is a research project that should contribute to the improvement of practice. Several specialized cohort programs are available or are under development (e.g., an Ed.D. in leadership in two-year institutions and a cooperative Ed.D. with St. Cloud State University).

Doctorate of Philosophy Degree Requirements—Students must take 18 credits in the department core curriculum. The various emphases also have common core requirements that range from 15 to 18 credits. A minimum of 18 credits is required in a research sequence that includes either quantitative or qualitative methods. Fifteen to 18 credits (collateral field) must be in coursework taken outside the department and preferably outside the College of Education if the applicant does not have undergraduate or graduate preparation in a related social science, history, and philosophy. In addition, at least 18 credits are required in a minor or supporting program. All Ph.D. students take a preliminary written examination that covers the department core courses and the student's area of emphasis, and an oral examination. The final dissertation is a research project that should contribute to the theory of educational policy or administration.

Specialist Certificate Requirements—The specialist certificate requires a minimum of 90 credits, including the following: at least 45 credits in educational administration; at least 6 credits in curriculum, instruction, and supervision; and at least 12 credits in coursework taken outside the College of Education (collateral field) and/or in educational policy and administration advanced seminars. Registration for EdPA 8273—Field Study, satisfies the requirement for a 6-credit research paper. A final oral examination covering all program areas is required. For general requirements, see Specialist in Education in the General Information section of this bulletin. The following specialist certificate programs are available in educational administration:

general educational administration, secondary school administration, elementary school administration, and special education administration.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Educational Policy and Administration, University of Minnesota, 275 Peik Hall, 159 Pillsbury Drive S.E., Minneapolis, MN 55455 (612/624-1006; fax 612/624-3377).

EdAd 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral EdD student who has not passed oral prelims)

EdAd 8888. THESIS CREDITS: DOCTORAL. (36 cr required; EdD only)

EdPA 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

EdPA 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

EdPA 8888. THESIS CREDITS: DOCTORAL. (36 cr required; PhD only)

5090. SCHOOL AND SOCIETY. (3 cr; prereq sr or postbac student in educ or CLA music ed major or College of Educ approval; cannot apply to tchr educ prog if taken correspondence; A-F only) Bagley, Harkins, King, Lewis, Lundy-Dobbert, Mueller
Readings in social science and philosophy relevant to thinking about role of school in a changing American society.

5099. DIRECTED STUDY. (Cr ar [max 9 cr]; prereq #)
Individual or group work on topics or problems in social and philosophical foundations of education.

5100. PUBLIC SCHOOL ADMINISTRATION. (3 cr; not open to majors in educational administration; prereq 9 cr educ) Mueller
Organization, administration, and general support of public schools in state and local school districts.

5101. HISTORICAL FOUNDATIONS OF MODERN EDUCATION. (3 cr) Bagley
Background course for all other courses in history and philosophy of education. Analysis and interpretation of important elements in modern education derived from the Greeks, the Romans, the Middle Ages, and the Renaissance.

5102. EDUCATION IMAGERY IN EUROPE AND AMERICA. (3 cr) Bagley
Images and ideas of education expressed in the visual arts of Western civilization (antiquity to 20th century) in relation to concurrent educational thought and practice; symbolism, myth, propaganda, didacticism, genre, caricature.

5103. SUPERVISION AND ADMINISTRATION OF SPECIAL EDUCATION. (3 cr, §EPsy 5660; prereq #)
Weatherman
Procedures in establishing and improving educational programs for exceptional children.

5120. HISTORY OF CHILDHOOD EDUCATION. (3 cr) Bagley
Childhood education in Western civilization; emphasis on images, symbols, ideas important to educational theory and practice in home and school.

5125. YOUTH IN MODERN SOCIETY. (4 cr, §Soc 5952)
Youth in advanced societies and as a social entity; functions and roles in industrial society, family, education, politics and government, economy and work, welfare and religion; organizations, social movements, and subcultures; empirical research and cross-cultural perspectives.

5127. WORKSHOP: POLICY DEVELOPMENT FOR SCHOOL MANAGERS. (3 cr)
Elements of feedback control applied to policy development and implementation in education; policies for instructional management, personnel administration, and fiscal control; implementation plans and procedures for analysis of policy impact.

5128. WORKSHOP: EDUCATIONAL ADMINISTRATION. (1-6 cr)
Lab approach provides opportunities for experienced administrators to concentrate on common administrative and supervisory problems.

5130. LEADERSHIP DEVELOPMENT SEMINAR. (3 cr; prereq advanced application, College of Educ approval) Nickerson
Assessment and development of skills required of the educator in areas of planning, decision making, and human relations; introduction to contemporary issues in educational administration.

5131. COMPARATIVE EDUCATION. (3 cr) Cogan
European, Asiatic, and American systems and philosophies of education; possibilities of international education.

5139. LABORATORY IN DECISION MAKING. (3 cr; prereq advanced application) Nickerson
Contribution of recent research and theory to effective administration; analysis of administrative behavior in realistic settings and relations of administration to human behavior.

5140. ADMINISTRATION OF EARLY EDUCATION PROGRAMS. (3 cr) Weatherman
Issues and skills relevant to an administrator who directs a preschool program or the student planning a leadership position in early education.

5141. CRITICAL ISSUES IN CONTEMPORARY EDUCATION. (3 cr) King
Introduces graduate students to ideas involved in current theory and practice.

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5142. MINORITIES IN HIGHER EDUCATION.

(3 cr; A-F only) Turner

Access and equity issues related to participation of minority populations in American higher education institutions. Analysis of educational status of minority students and faculty in two- and four-year colleges as presented in research literature.

5155. HISTORY OF WESTERN EDUCATIONAL THOUGHT. (3 cr) Bagley

Major educational classics of Western civilization: Plato, Aristotle, Cicero, Quintilian, Montaigne, Milton, Locke, Rousseau, and others.

5156. HISTORY OF IDEAS IN AMERICAN EDUCATION. (3 cr) Bagley

Readings in American political, economic, and social development related to education; reference to the emerging system of public education. Recommended as background for EdPA 5170, but not a prerequisite.

5167. THE AMERICAN MIDDLE SCHOOL. (3 cr) Nickerson

Sources of the movement; purposes, functions, and limitations; fundamental problems, types, and curricular implications of reorganization.

5169. ETHNIC GROUPS AND COMMUNITIES: PERSPECTIVES ON FAMILIES, CHILDREN, AND YOUTH. (3 cr) Lundy-Dobbert

Roles of young people in widely varied North American communities. Comparative aspects of youth commitment to society, economic value of youth, youth-adult conflict, and youth roles in family. Well-defined analyses of contextual roles. Complexity of policy for appropriate educational and community development.

5170. AMERICAN PRAGMATISM AND EDUCATION. (3 cr)

Analysis and interpretation of the educational philosophy of pragmatism (experimentalism); readings from Dewey, Kilpatrick, Bode, Counts, Childs, and others.

5171. ANTHROPOLOGY AND EDUCATION. (4 cr, §Anth 5145) Lundy-Dobbert

Cross-cultural perspectives in examining educational patterns, the implicit and explicit cultural assumptions underlying them; methods and approaches to cross-cultural studies in education.

5173. CASE STUDIES FOR POLICY RESEARCH. (3 cr; prereq education or grad student or #; A-F only) Turner

Introduction to use of qualitative case study research method and its application to questions of educational practice. Emphasis on design of studies that employ open-ended interviewing as primary data collection technique. Class project required.

5174. ETHNOGRAPHIC RESEARCH METHODS. (4 cr; prereq 5171 or SPFE 5171 or Anth 1502 or Anth 5144 or Anth 5145) Lundy-Dobbert

Practice in aspects of field methodology below the level of full field study; detailed reading; analysis of studies in anthropology and education for methodological content.

5175. SYSTEMS THINKING FOR INNOVATIVE PROFESSIONALS. (3 cr) Harkins, Lundy-Dobbert

Fundamental aspects of creative systems analysis and thinking. Visual modeling of learning systems and their relationship to innovative thinking and practice. Students develop systems skills applicable to evolution of their careers.

5176. ETHNOGRAPHIC RESEARCH SKILLS LABORATORY. (2 cr; prereq ¶5174 or SPFE 5174; S-N only) Lundy-Dobbert

Introduction to processes of creating evaluative design; supervised practice in data analysis, use of theory, proposal writing, reporting.

5180, 5181. SEMINAR: ADMINISTRATION OF SPECIAL EDUCATION. (3 cr per qtr, §EPsy 8760, 8761; prereq 5103 or EdAd 5103 or EPsy 5660 or #) Weatherman

Problems of administration and organization of special education programs.

5182. COMPARATIVE PHILOSOPHIES OF EDUCATION. (3 cr)

Examination of competing philosophies of education.

5190. SOCIOLOGY OF EDUCATION. (4 cr, §Soc 5953) Louis

Advanced studies in social aspects of education including schooling as a socialization process, the social structure of education, the role of school in social change.

5200. DESIGN AND MANAGEMENT OF EDUCATION SERVICES. (3 cr) Ammentorp

Educational services offered by schools, hospitals, industries, government agencies; contemporary technology, roles, authority systems, communication networks; resource-policy relationships, evaluation and management of activities of clients and staff members.

5201. FORMAL ORGANIZATIONS IN EDUCATION. (3 cr) Louis, Turner

Introduction to classical and current theories of organizational behavior and administration in education. Leadership and control, communication, conflict, effects of educational environments, organizational design and change, and organizational effectiveness.

5202. POLITICS OF EDUCATION. (3 cr) Mazzoni

Social science findings, concepts, and methods used to consider political context of educational administration; emphasis on creation of public school policy by local and state governments; role of administrators.

5204. FINANCING ELEMENTARY AND SECONDARY SCHOOLS. (3 cr) Mueller

Value assumptions and educational finance policy, economic factors, sources and characteristics of educational revenue, state and local distribution systems, federal support, urban/rural variations, institutional financing alternatives.

5207. HISTORY OF CURRICULUM IN U.S. PUBLIC SCHOOLS. (4 cr, §CI 5136)

Survey of formation of public school subjects and curriculum theory in United States from their European roots and early development in 19th century to contemporary issues of reform discussed in relation to past. Social, political, and economic implications of curriculum history.

5209. EDUCATION IN FUTURE SOCIAL SYSTEMS. (3 cr) Harkins

Interdisciplinary inquiry into problems of social specialization and generalization; projections and analysis of long-range (30 years or more) social and technological trends related to education.

5210. SOCIAL FORECASTING AND EDUCATIONAL FUTURES. (3 cr) Harkins

Application of social sciences in their academic and applied dimensions to formal education, including social-scientific and systems orientation toward communities; emphasis on short-range social and educational planning, near-present to a few years hence.

5211. SOCIAL DESIGN AND EDUCATIONAL FUTURES. (3 cr) Harkins

Medium-range interdisciplinary approach to community design and analysis emphasizing formal education systems in community context; focus upon new neighborhoods, towns, experimental cities, and subcultural enclaves in rural and urban settings emphasizing time periods from several years to three decades hence.

5212. SCHOOL BUDGETING. (3 cr) Sederberg

Concepts and skills involved in preparing financial budgets for public schools; competency in translating educational programs into budgetary systems, anticipating revenue receipts, planning expenditures, and techniques for preparing a balanced budget.

5213. FINANCIAL RESOURCE MANAGEMENT.

(3 cr) Sederberg

Concepts and skills involved in management of financial resources in public schools; performance exercises related to public school accounting systems, purchasing, the controller function, and reporting and interpreting school financial data.

5214. SCHOOL MANAGEMENT INFORMATION SYSTEMS. (3 cr) Hendrix, Sederberg

Basic techniques required to generate, maintain, and make accessible computer-based management information system in education.

5215. THE PRINCIPALSHIP. (3 cr) Alkire, Nickerson

Role of the principal: qualifications, duties, and problems.

5216. RECENT RESEARCH IN ELEMENTARY SCHOOL ADMINISTRATION. (3 cr; prereq 5215 or EdAd 5215) Alkire

Pertinent research literature.

5222. INTRODUCTION TO POLICY RESEARCH.

(3 cr; A-F or S-N for grad students, A-F for others)

Anderson, Hendrix, Mazzoni, Mueller
Political, philosophical, environmental, and methodological issues that accompany policy research in education; determinants of applicability of quantitative and qualitative methods.

5223. LAW AND THE HANDICAPPED: IMPLICATIONS FOR EDUCATION. (2-4 cr, §EPsy 5605; A-F only)

Recent litigation and legislation; implementation of right to education, right to treatment, labeling, due process, and related issues.

5224. LEGAL IMPLICATIONS OF ACTS BY SCHOOL BOARDS, ADMINISTRATORS, AND TEACHERS. (3 cr; A-F only)

Constitutional, statutory, and common law bases of school administration; principles growing out of fundamental legal procedures.

5225. EDUCATIONAL POLICY AND THE LAW.

(3 cr; A-F only)

Analysis of court decisions, statutes, and administrative regulations related to equality of educational opportunity and equal protection under the law.

5226. EDUCATIONAL FACILITIES PLANNING.

(3 cr) Alkire

Planning educational facilities for public and private school systems and institutions of higher education.

5227. PUBLIC SCHOOL PERSONNEL PROGRAMS. (3 cr) Alkire

Selection, assignment, evaluation, and development of school personnel; salary and conditions of service; policies of administrative, instructional, and noninstructional personnel.

5240. SEMINAR: CLINICAL EXPERIENCES IN EDUCATIONAL ADMINISTRATION. (1-9 cr, §8240; S-N only)

For educational administration majors engaged in clinical experiences.

5245. ETHICS, MORALITY, AND VALUES IN EDUCATION. (3 cr)

Application to key issues of professional practice.

5246. COMPUTERS IN EDUCATIONAL POLICY AND ADMINISTRATION. (3 cr; A-F or S-N for grad students, A-F for others) Hendrix

Hands-on microcomputer introduction to software applications for administrative/policy tasks in educational institutions.

5250. AMERICAN HIGHER EDUCATION. (4 cr)

Anderson, Lewis

American higher and postsecondary education in historical and contemporary perspective; special emphasis on societal and political demands on higher education system; consequent changes in various forms and functions.

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5260. INTRODUCTION TO EDUCATIONAL PLANNING. (3 cr)

Principles, tools, and emerging issues in higher and elementary/secondary education settings, including decision-making models, strategic planning, forecasting, program planning, and short-range planning.

5265. ADMINISTERING THE HIGH SCHOOL PROGRAM. (3 cr) Nickerson

Principal as instructional leader; practices and procedures used in building master schedule; analysis and evaluation of school program and services.

5266. PRINCIPAL-CONSTITUENT DECISION MAKING. (3 cr) Nickerson

For school administrators and those preparing for administrative positions in educational institutions; focus on administrator's role in large group, small group, and dyadic interaction decision making; role playing, simulation, and case study analysis.

5267. GROUP DYNAMICS AND SHARED DECISION MAKING. (3 cr, §EPsy 5155; EPsy 5150 recommended)

Review of theory and research; applications and skills lab in leading small groups.

5272. PROBLEMS: EDUCATIONAL POLICY AND ADMINISTRATION. (1-3 cr per qtr, §8272)

For students in educational policy and administration who are qualified to carry out intensive studies of a school system.

5274. TWO-YEAR POSTSECONDARY INSTITUTIONS. (3 cr, §VoEd 5274) Turner

Present status, development, functions, organization, curriculum, and trends in postsecondary but nonbaccalaureate institutions.

5280. INTRODUCTION TO THE ECONOMICS OF EDUCATION. (4 cr) Lewis

Economic impact of education on educational markets, prices and production relationships, distribution of income, and investment and cost-benefit analysis in education.

5281. COST AND ECONOMIC ANALYSIS IN EDUCATIONAL EVALUATION. (3 cr; S-N only)

Lewis
Use and application of cost-effectiveness, cost-benefit, cost-utility, and cost-feasibility in evaluation of educational problems and programs.

5285. PRINCIPLES AND METHODS OF EVALUATION. (3 cr, §EPsy 5240) King

Introduction to program evaluation; theory; practical examples; purposes, role, program descriptions, and evaluation strategies.

5292. THE LAW AND POSTSECONDARY EDUCATIONAL INSTITUTIONS. (3 cr; A-F only)

Analysis of court opinions and Federal regulations affecting postsecondary educational institutions.

5340. ORGANIZATIONAL APPROACHES TO YOUTH DEVELOPMENT. (3 cr, §VoEd 5430; prereq VoEd 5410 or #)

Defining youth development within framework of formal and informal organizations; organizational systems responsible for youth development in the community; policy issues surrounding these systems.

5370. AMERICA'S SCHOOLS IN THE 20TH CENTURY. (3 cr, §CI 5149; prereq educ or grad student or #)

Analysis and interpretation of events and issues that shaped America's schools in 20th century; current proposals for reform of education and their antecedents.

5420. LEADERSHIP AND ADMINISTRATION OF STUDENT AFFAIRS. (3 cr, §EPsy 8420, §EPsy 5420)

Scope, administration, coordination, and evaluation of programs in college and university student affairs.

5540. SEMINAR: THE COLLEGE STUDENT. (3 cr, §EPsy 5451; prereq 6 cr psychology or educational psychology) Rest

Psychology and sociology of college students; research on diversity of populations, vocational development, student society, culture, mental health, underachievement, dropouts, values and attitudes; relevant research methods.

5601. INTERNATIONAL EDUCATION; TOPICS IN CLASSROOM PRACTICES AND PROCEDURES.

(1-12 cr [max 12 cr], §AdEd 5601; prereq tchg licensure, #; A-F only) Cogan, Paige
Educational practices in a designated country, region, or cultural group; impact of social and cultural features; organization, school structures, classroom practices, and delivery of educational services; potential for implementation in the United States.

5603. INTERNATIONAL EDUCATION AND DEVELOPMENT. (3 cr, §AdEd 5603; A-F only)

Cogan, Paige
Contemporary theories relating formal and nonformal education to national development in social, cultural, political, and economic sectors; alternative conceptualizations and theoretical perspectives on education and development.

5605. RESEARCH TOPICS: INTERNATIONAL DEVELOPMENT EDUCATION. (3 cr, §AdEd 5605; A-F only) Cogan

Empirical research conducted in developing societies relating formal and nonformal education to national development in social, cultural, political, and economic sectors.

5607. APPLIED INTERNATIONAL DEVELOPMENT EDUCATION. (3 cr, §AdEd 5607; A-F only)

Educational innovations designed to promote national development in selected developing nations; educational case studies in the context of such objectives; conceptualizations of the role of education in development and outcomes.

5609. CRITICAL ISSUES IN INTERNATIONAL EDUCATION AND EDUCATIONAL EXCHANGES. (4 cr) Mestenhäuser

Comprehensive, multi-dimensional, and policy practices of U.S. and other universities. Curricular strategies. The field's conceptual development; its multi-disciplinarity; integration of learning; production, consumption, and transfer of international knowledge; and, especially, practical application to programs, global careers, and pedagogy.

5701. THEORIES OF INTERNATIONAL DEVELOPMENT. (4 cr; prereq international relations major or #)

Interdisciplinary approaches to understanding contemporary development theory and practice. Selected theoretical framework and case studies illustrating complexities of development planning and implementation.

5931. MINNESOTA STUDIES IN INTERNATIONAL DEVELOPMENT (MSID) SEMINAR. (4 cr; prereq international relations major or #)

Intercultural living and learning, and undertaking research activities in developing nations, in preparation for internships in overseas development agencies.

8170. SEMINAR: RESEARCH METHODS IN ANTHROPOLOGY AND EDUCATION. (1-3 cr [max 9 cr]; prereq 5174 or 5175 or Anth 8152 or SPFE 5174 or SPFE 5175 or #) Lundy-Dobbert

Anthropological research below dissertation level including designing and carrying out a research project related to education, schools, or socialization; emphasizes relevant theory, reliability and validity, research ethics, and reporting.

8220. QUANTITATIVE FOUNDATIONS FOR MANAGEMENT METHODS. (3 cr)

Quantitative techniques for research and analysis of policy, program, and management problems, and decision situations in administration of educational organizations; includes computer usage.

8228. PROBLEMS: HIGHER EDUCATION. (Cr ar; prereq #)

Selected topics on college programs, instruction, organization, and administration.

8229. SEMINAR: HIGHER EDUCATION. (1-4 cr; prereq #)

Intensive study of selected topics.

8230. SEMINAR: DISSERTATION RESEARCH IN HIGHER EDUCATION. (1 cr per quarter; S-N only)

Anderson, Lewis, Louis, Turner
Two-quarter seminar for candidates designing or conducting studies. Selecting a problem; designing an appropriate study; collecting, analyzing, and summarizing data and preparing a written account; critical review of candidates' individual projects.

8234. SEMINAR: EDUCATIONAL FINANCE. (3 cr; prereq 5204 or EdAd 5210, 8210 or #) Mueller
Economic setting, sources and allocation of education finances; evaluation of local, state, and federal educational finance systems with reference to analysis of foundation aid formulas.

8238. SEMINAR: THEORY AND RESEARCH. (3 cr; prereq educational administration or educational policy major or #) Ammentorp, Hendrix, Mazzoni, Mueller
Research design involving thesis or field project; includes interrelatedness of formulation of conceptual framework and the analytical process; clinical and research problems.

8241. SEMINAR: INTERNSHIP IN EDUCATIONAL ADMINISTRATION. (0-9 cr; S-N only) Sederberg
For interns in elementary, secondary, general, and postsecondary administration.

8242. SEMINAR: PUBLIC SCHOOL PERSONNEL PROGRAMS. (3 cr; prereq 5227 or EdAd 5227 or #) Alkire
Analysis of selected school personnel topics for in-depth study.

8247. SEMINAR: SCHOOL DISTRICT POLITICS. (3 cr; prereq 5202 or EdAd 5202 or SPFE 5202) Mazzoni

Local school district as an arena for political action; emphasis on conceptual and technical skills useful to administrators exercising policy leadership in this arena.

8248. SEMINAR: METROPOLITAN SCHOOL GOVERNANCE. (3 cr; prereq 5202 or EdAd 5202 or SPFE 5202)

Impact of metropolitanization on policy issues confronting public schools in core cities; strategies proposed for restructuring educational governance emphasizing Twin Cities metropolitan area.

8250. THE HIGHER EDUCATION INSTITUTION: ORGANIZATION AND ENVIRONMENT. (3 cr;

prereq 5201, 5250 or EdAd 5250 or HiEd 5250) Turner
Colleges and universities as complex organizations. Emphasis on effects of social, economic, political, and demographic environment on structures and processes; reciprocal effects of colleges and universities on their environments.

8251. DEVELOPMENT AND EVALUATION OF ACADEMIC PROGRAMS. (3 cr; prereq 5250 or EdAd 5250 or HiEd 5250) Louis
Nature of academic programs; change processes; role of evaluation.

8252. INSTRUCTION AND LEARNING IN HIGHER EDUCATION. (3 cr, §HiEd 8252; prereq 5250 or EdAd 5250 or HiEd 5250)

Teaching-learning relationship; study and appraisal of methods employed to encourage, guide, and appraise students' learning.

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8255. LEADERSHIP AND ADMINISTRATION IN HIGHER EDUCATION. (3 cr; prereq 5201, 5250 or EdAd 5250 or HiEd 5250) Anderson
Higher education governance, administration, and leadership from theoretical and applied perspectives; decision-making structures and processes, and planning.

8256. ECONOMICS OF HIGHER EDUCATION. (3 cr; minimal background in inferential stats, econ, study of higher educ recommended; S-N only)
Institutional responses to changing external economic factors; economic effects on society as result of higher education's output in teaching, research, and service; research on institutional and governmental policy.

8257. FINANCING HIGHER EDUCATION. (3 cr) Ammentorp
Financing postsecondary systems at national and state levels; financing postsecondary students; budgeting and financial analysis in postsecondary institutions; cost-effectiveness analysis.

8260. SEMINAR: SOCIAL AND PHILOSOPHIC FOUNDATIONS OF EDUCATION. (3 cr)
Systematic analysis of issues related to development of the field of teaching and research; problems of interdisciplinary relationships and directions for the future.

8261. SOCIAL AND PHILOSOPHICAL FOUNDATIONS OF EDUCATION. (Cr ar; prereq #)
For graduate students interested in research and original work in these areas.

8268. SEMINAR: SOCIAL AND EDUCATIONAL FUTURES. (1-6 cr [max 6 cr]; prereq 5209 or 5210 or 5211 or SPFE 5209 or SPFE 5210 or SPFE 5211 or #)
Harkins
Review and critique of outstanding theoretical contributions of leading social and educational futurists to delineate areas for additional inquiry and research.

8270. PROBLEMS: ELEMENTARY SCHOOL ADMINISTRATION. (Cr ar; prereq #)

8271. PROBLEMS: SECONDARY SCHOOL ADMINISTRATION. (Cr ar; prereq #)

8273. FIELD STUDY. (0-10 cr; prereq #)
Required for specialist in education certificate. The 10 credits are based on a written report covering an approved field study. Students may register for the general planning and organization of their study without credit.

8340. POLICY SYSTEMS IN EDUCATION. (3 cr; prereq 8220 or EdAd 8220; S-N only) Ammentorp
Policy systems as feedback control structures; reduction of policy problems to causal structures translated into mathematical models; general principles of system structure and response used to interpret behavior of typical policy systems in education.

8341. ANALYSIS OF EDUCATION POLICY SYSTEMS. (3 cr; prereq 8340 or EdAd 8340; S-N only) Ammentorp
Techniques of computer simulation applied to study of policy impact and management structures in education; simulation analysis of specific education policies and techniques applicable to problems of personal interest.

8603. SEMINAR: INTERNATIONAL DEVELOPMENT EDUCATION. (3 cr, §AdEd 8603; prereq 5603 or AdEd 5603 or Educ 5603) Cogan, Paige
Key theoretical issues; formal and nonformal education.

8605. PROBLEMS: INTERNATIONAL EDUCATION RESEARCH. (3-6 cr, §AdEd 8605; prereq 5605 or AdEd 5605 or Educ 5605) Cogan, Paige
Examination of comparative research studies, emphasizing development education.

Educational Psychology (EPsy)

Professor: Mark L. Davison, *chair*; William M. Bart; Jerome Beker; Henry Borow (*emeritus*); Robert H. Bruininks; Stanley L. Deno; Byron Egeland; David L. Giese; L. Sunny Hansen; Vernon L. Hendrix; Thomas J. Hummel; Susan C. Hupp; David W. Johnson; Paul E. Johnson; Roger T. Johnson; Frances P. Lawrenz; Dorothy R. Loeffler; Geoffrey R. Maruyama; Patricia R. McCarthy Veach; Jack C. Merwin (*emeritus*); James R. Rest; John E. Rynders; S. Jay Samuels; Thomas M. Skovholt; Martin L. Snoke (*emeritus*); Robert D. Tennyson; W. Wesley Tennyson (*emeritus*); James S. Terwilliger; James E. Turnure; Richard F. Weatherman; Richard A. Weinberg; Wayne W. Welch; Frank B. Wilderson, Jr.; Frank H. Wood; James E. Ysseldyke

Associate Professor: Marie Knowlton, *director of graduate studies*; Sandra L. Christenson; Ernest C. Davenport; Lynne K. Edwards; V. Lois Erickson; Joan B. Garfield; Jean A. King; Donald G. MacEachern; Scott R. McConnell; Mary A. McEvoy; John L. Romano; Susan Rose; John M. Taborn; Paul W. van den Broek

Assistant Professor: Annie Baldwin; Christine A. Espin; Lynn Friedman; Jennifer L. York

Lecturer: Ann M. Casey; David R. Johnson; Ronald P. Matross; Steven L. Robinson; Joyce D. Weinsheimer

Other: Kevin J. Nutter; Kay A. Thomas

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B), Ph.D., and Certificate of Specialist in Education.

Curriculum—Program areas are counseling and student personnel psychology (CSPP); school psychology; special education; and psychological foundations of education (including evaluation, computer applications, statistics, and research design,

as well as learning, cognition, human relations, measurement, personality, social psychology, and instructional systems).

Prerequisites for Admission—There are no special prerequisites for admission at the M.A. level in any of the four program areas, or at the Ph.D. level in school psychology or psychological foundations of education. Applicants to the CSPP doctoral program should hold either a bachelor's or master's degree with a major in psychology, education, counseling, or a related field. CSPP applicants interested in earning the specialist certificate should hold an M.A. degree; if not, they should apply to both the M.A. and specialist certificate programs.

Special Application Requirements—Applicants must submit a department application (*with clear indication of the desired program area*), a statement of goals and interests, three letters of recommendation, and a Graduate School application accompanied by official transcripts from all colleges and universities attended. These test scores are required: the CSPP and psychological foundations of education programs require the Graduate Record Examination (GRE); the school psychology and special education programs require the GRE and later an interview for those who make the initial cut.

Applications to CSPP, school psychology, and special education are accepted for fall admission only; the deadline is January 15. Applications to psychological foundations are accepted throughout the year.

Master's Degree Requirements—Programs must include a minimum of four core courses (one in each of the following content areas): statistics, measurement or evaluation, human learning or cognition, and personality or social psychology. The final examination in CSPP is a written comprehensive exam. The other final examinations are oral.

Doctoral Degree Requirements—Programs must include a minimum of twelve core courses: three in statistics; two in human learning or cognition; at least one in each of the following areas—measurement,

evaluation, personality, social psychology, and critical issues in educational psychology; plus two more. Students should check with their specific program area concerning additional course requirements, written general preliminary examination requirements, and thesis procedures.

Specialist Certificate Requirements—Programs must include a minimum of six core courses, one in each of the following areas—statistics, measurement or evaluation, human learning or cognition, personality or social psychology—plus two more. The final examination is oral. For general requirements, see Specialist in Education in the General Information section of this bulletin. These specialist certificate programs are available:

Counseling—This program provides advanced training in one or more specialized areas related to the field of counseling. Applicants should have a broad background in the social and behavioral sciences. The program allows for in-depth study related to the work of the counselor. It is expected that the student will have completed coursework or can demonstrate competency in specified areas, with specialization in one or two.

School Psychology—In the first year, the student completes requirements for the M.A. degree. The second year includes additional work in educational psychology, psychology, child psychology, diagnostic and remedial procedures, and special education. Specialist certificate students complete an internship during the third year, doctoral students during the fifth year.

Special Education—This program is for students preparing for administrative, supervisory, and consultative positions in special education. Flexibility allows concentration in a particular field (e.g., education of persons who are learning disabled, mentally retarded, or deaf/hard of hearing). Generally students are expected to develop competencies in several areas of special education. Applicants should have basic preparation and experience in at least one special education area as well as licensure for public school work.

Graduate Programs

Minor Requirements for Students

Majoring in Other Fields—A minor in educational psychology for doctoral students consists of 21 quarter credits, 12 of which must be at the 8xxx level. The minor must include either (a) 21 credits in psychological foundations or (b) 12 credits in psychological foundations plus 9 credits in the applied areas CSPP, school psychology, special education, 6 of which must be the same area. A minor in educational psychology for master's students consists of 9 quarter credits.

Language Requirements—None.

For Further Information and

Applications—Contact separate program areas as follows: Counseling and Student Personnel Psychology (CSPP), University of Minnesota, 129 Burton Hall, 178 Pillsbury Drive S.E., Minneapolis, MN 55455 (612/624-6827); School Psychology, University of Minnesota, 344 Elliott Hall, 75 E. River Road, Minneapolis, MN 55455 (612/624-4156); Special Education, University of Minnesota, 227 Burton Hall, 178 Pillsbury Drive S.E., Minneapolis, MN 55455 (612/624-2342); Psychological Foundations of Education, University of Minnesota, 206 Burton Hall, 178 Pillsbury Drive S.E., Minneapolis, MN 55455 (612/624-6083).

EPsy 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

EPsy 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

EPsy 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5110. INTELLIGENCE. (3 cr) Bart
Theories of intelligence; its development; implications for educational practices and psychological research.

5111. PSYCHOLOGY AND PEDAGOGY OF READING. (3 cr) Samuels
Physiological, psychological, and linguistic factors influencing beginning and fluent reading, implications for instruction.

5112. KNOWING, LEARNING, AND THINKING. (4 cr) Samuels
Principles of human information processing; issues in memory and thought; discussion of mental operations in comprehension and understanding; analysis of intellectual structures supporting problem solving in applied settings.

5113. INTRODUCTION TO THE PSYCHOLOGY OF INSTRUCTION. (3 cr) R Tennyson
Survey of psychological factors in design of instruction; performance criteria, strategy, and sequence in context of research; development and implementation activities in instructional techniques, technologies, and delivery systems; psychological processes relevant to measures of effectiveness in teaching-learning environment.

5114. PSYCHOLOGY OF STUDENT LEARNING. (3 cr) Samuels, van den Broek
Survey of psychological methods and principles; models of the learner; topics in development, creativity, intelligence, and motivation; implications for teaching and curriculum design in preschool, elementary, and secondary education; professional training with children and adolescents as clients.

5115. PSYCHOLOGY OF ADULT LEARNING. (4 cr) R Tennyson
Survey of psychological methods and principles in human learning; models of adult learner, topics in motivation, creativity, achievement, intelligence; implications for teaching and curriculum design in higher education, continuing education, and professional training.

5116. BEHAVIOR ANALYSIS IN EDUCATION. (4 cr) Deno, McEvoy
Practical applications of reinforcement theory; behavior analysis, precision teaching, programmed instruction.

5117. PROBLEM SOLVING AND DECISION MAKING. (4 cr; offered when feasible)

5119. LEARNING AND COGNITIVE FOUNDATIONS OF EDUCATION. (4 cr; prereq educ or CLA music educ student or College of Educ approval; 1 previous course in psych recommended)
Principles of development, learning, cognition, individual differences, classroom management, instructional delivery, and related topics, and their applicability to instruction and organization of curricular materials.

5130. PERSONALITY AND SOCIAL DEVELOPMENT. (3 cr; prereq 5 cr intro psych)
Major concepts and research findings in adjustment and development, with special emphasis on educational implications.

5135. WORKSHOP IN HUMAN RELATIONS. (6 cr; S-N only)
Experientially based course including simulation activities, curriculum writing, and supervised practice in basic human relations skills, emphasizing individual, cultural, and ethnic differences and their implication for educational practice.

5139. INTERPERSONAL AND PERSONALITY EFFECTS ON LEARNING. (4 cr; prereq sr or postbac in educ or CLA music educ major, at least 1 course in psych or College of Educ approval)
Major theories of and research on schooling as it relates to human relations, small groups, face-to-face relations, and individual personality and social development.

5150. SOCIAL PSYCHOLOGY OF EDUCATION.

(3 cr) D Johnson
 Concepts and theories applied to educational problems and settings; applications and skills lab in group behavior.

5151. STRUCTURING LEARNING: SOCIAL PSYCHOLOGICAL APPROACHES. (3 cr) D Johnson

How to use cooperation, competition, and individualization to affect learning climate and cognitive and affective outcomes of instruction.

5154. ORGANIZATIONAL DEVELOPMENT AND CHANGE. (3 cr, §8151; 5150 recommended; offered alt yrs) D Johnson

Review of theory and research on procedures and methods for changing organizations, particularly educational organizations.

5155. GROUP DYNAMICS AND SHARED DECISION MAKING. (3 cr, §EdPA 5267; 5150 recommended; offered alt yrs) D Johnson

Review of theory and research. Lab for developing and applying skills in leading small groups.

5200. SPECIAL TOPICS: PSYCHOLOGICAL FOUNDATIONS. (3-6 cr)

Analysis of psychological and methodological concepts relevant to current educational practice.

5220. EDUCATIONAL MEASUREMENT IN THE CLASSROOM. (4 cr)

Principles and methods for construction, evaluation, and improvement of classroom measures; techniques for describing results statistically; use of measurement in evaluating instruction and student performance; assignment of grades.

5221. BASIC PRINCIPLES OF MEASUREMENT.

(3 cr; prereq 5260 or 8260 or PsyF 5110 or 8110)
 Fundamental concepts, principles, and methods in educational and psychological measurement; educationally useful properties of tests; types and uses of derived scores; factors influencing reliability and validity.

5222. MODERN MEASUREMENT THEORY AND PRACTICE. (3 cr; prereq 5221, 8260, 8261 or equiv; offered alt yrs) Davison

Introduction to modern measurement practices, such as item banking and test scoring equipment; modern measurement theories of test items analysis, reliability, and validity.

5229. CLASSROOM ASSESSMENT METHODS.

(2 cr; concurrent practice tchg or similar field exper recommended)
 Concepts and techniques for effective diagnosis of learning problems and assessment of educational outcomes. Emphasis on constructing teacher-made assessment devices that are efficient, technically sound, and directly relevant to classroom decision making.

5240. PRINCIPLES AND METHODS OF EVALUATION. (3 cr, §EdPA 5285, §PsyF 5125)

Introductory course in program evaluation; theory; practical examples; purpose, roles, program descriptions, and evaluation strategies.

5243. PRACTICUM: SURVEY AND OBSERVATIONAL RESEARCH METHODS. (3 cr; prereq 5220 or 5221 or equiv; offered alt yrs)

Planning, development, implementation, analysis, and reporting of survey and observational methods including questionnaires, interviews, and various observational techniques.

5246. EVALUATION COLLOQUIUM. (1 cr [max 6 cr]; S-N only; offered when feasible)

5260. INTRODUCTORY STATISTICAL METHODS. (4 cr)

Techniques for organizing and presenting data; descriptive indices of central tendency, variability and bivariate correlation/regression; procedures for making inferences concerning means and proportions.

5261. APPLIED MATRIX AND VECTOR CONCEPTS. (1 cr; S-N only)

Introduction to concepts and operations; applications in multiple regression, factor analysis of variance.

5262. STATISTICAL COMPUTING USING MINITAB. (2 cr; prereq 5260 or equiv; S-N only; offered alt yrs)

Practical experience using time-sharing computer language MINITAB; applications of introductory statistical methods and concepts to data files.

5280. COMPUTER PROGRAMMING: PASCAL. (3 cr; prereq sr; offered alt yrs)

Computer as tool for research in behavioral sciences; Pascal is taught for both micro and mainframe; lab experience.

5281. INTRODUCTION TO COMPUTER OPERATIONS: U OF M SYSTEMS, SPSS. (1 cr; S-N only) Hendrix

Procedures for operation of batch and interactive computers; emphasis on statistical packages for the social sciences (SPSS).

5400. WORKSHOP: COUNSELING PSYCHOLOGY. (1-6 cr [max 12 cr])

For all counselors, teachers, and administrators; aspects of intervention theory in relation to psychological principles; counseling, career development, assessment, psychological education, and consultation.

5401. COUNSELING PROCEDURES. (3 cr)

For persons whose professional work includes counseling and interviewing; not for licensure as school counselor. Emphasis on counseling relationship and principles of interviewing; case studies, role playing, and demonstration.

Graduate Programs

5417. CLINICAL USE OF TESTS IN PSYCHOLOGICAL SERVICES. (3 cr; prereq 5260 or PsyF 5110 or Psy 3801, 5221 and PsyF 5121 or Psy 5862 or #) Hummel
Psychological theories related to test interpretation and counseling process; critical review and selection of standardized tests.

5420. LEADERSHIP AND ADMINISTRATION OF STUDENT AFFAIRS. (3 cr, §8420; prereq EdPA 5420)
Scope, administration, coordination, and evaluation of programs in college and university student affairs.

5430. FOUNDATIONS OF CAREER DEVELOPMENT. (3 cr) Hansen
Introduction: theory, research, practice; examination of concepts of work, work values, career and career education; application of theory and research to career guidance practice in educational, industrial, and community agency settings.

5431. CAREER DEVELOPMENT: THEORY AND COUNSELING APPLICATIONS. (3 cr; prereq CSPP student) Hansen
Provides students in counseling and allied fields with background; emphasis on counseling skills; topics include work and other life values, counseling process, planning and decision making, information and employment trends, sex equity in career options, needs of specific groups.

5432. CAREER DEVELOPMENT PROGRAMS AND ORGANIZATIONAL CHANGE. (3 cr; prereq 5430 or 5431 or PsyS 5210 or PsyS 5331 or equiv or #) Hansen
Provides knowledge and skills to create and implement programs for a variety of populations and settings; life-roles concept integrated with systematic model of program development; consultation process, organizational intervention, and race, age, and gender issues.

5433. DEVELOPMENTAL CAREER COUNSELING OF WOMEN. (3 cr; S-N optional) Hansen
Counseling skills and interventions to facilitate career development of girls and women at different life stages; sex role system, female socialization and stereotyping; facts, myths, and trends regarding women's changing roles in technological society; issues of sexism in strategies and programs.

5434. COUNSELING ADULTS IN TRANSITION. (3 cr) Romano
Theoretical and empirical knowledge to provide bases for analyzing adaptation to transitions; applications of counseling interventions and training in coping skills to cases of life change.

5451. SEMINAR: THE COLLEGE STUDENT. (3 cr, §EdPA 5540; prereq 6 cr psych or educ psych)
Psychology and sociology of college students; research concerning diversity of populations, vocational development of students, student society, culture, mental health, underachievement, dropouts, values and attitudes; relevant research methods.

5461. CROSS-CULTURAL COUNSELING. (3 cr; prereq #) Thomas
Effect of cross-cultural and cross-national differences in counseling process.

5531. CAREER SKILLS. (2 cr; prereq CSPP student or #)
Applied course is part of career counseling sequence and is coordinated with career development theories and field placement. Applications of theories from 5431 and practice through case studies, role plays, simulations, and assessments.

5600. CHILDHOOD LANGUAGE DEVELOPMENT: CLASSROOM IMPLICATIONS. (3 cr, §PsyS 5100)
Turnure
Recent trends and findings in study of language acquisition and communication; classroom implications, including education of exceptional children.

5601. EDUCATION OF EXCEPTIONAL CHILDREN. (4 cr)
Introduction to field of special education for classroom teachers and other school personnel.

5602. COMPUTER TECHNOLOGY IN SPECIAL EDUCATION. (3 cr) Rose
Application of computer technology to special education in light of learning theory, principles of effective instruction, and the instructional needs of special education populations.

5604. TRANSITION FROM SCHOOL TO WORK AND COMMUNITY LIVING FOR PERSONS WITH SPECIAL NEEDS. (4 cr)
Organization and design of training programs to promote independent living and vocational and community adjustment for persons with disabilities and for other at-risk populations; curriculum materials, methods, and organizational strategies for adolescent and adult learners, families, and community service providers.

5605. LAW AND THE HANDICAPPED: IMPLICATIONS FOR EDUCATION. (2-4 cr, §EdPA 5223)
Analysis of recent litigation and legislation; emphasis on implementation of right to education, right to treatment, labeling, due process, and related issues.

5607. COLLABORATION FOR INCLUSIVE SCHOOL COMMUNITIES. (3 cr, §PsyS 5107)
Rationale for, implications of, and strategies for including students with unique needs (e.g., disabilities) in general education classroom settings. Importance of creating sense of community among students and adults in today's heterogeneous classrooms and schools.

5608. PARENT AND PROFESSIONAL PLANNING FOR HANDICAPPED STUDENTS. (3 cr) Wilderson
Study and demonstration of constructive approaches to cooperative planning and implementation of education programs by parents, teachers, and persons involved with children who have special needs.

5609. FAMILY-PROFESSIONAL PLANNING FOR PERSONS WITH SEVERE HANDICAPS. (3 cr) McEvoy
Interdisciplinary course on needs of families who have children with severe handicaps, emphasizing life-cycle needs, service issues, programs of support from infancy through adulthood, services from different agencies, disciplines, professional requirements, and responsibilities in serving families.

5612. EDUCATION OF LEARNING-DISABLED CHILDREN. (3 cr) Deno, Espin

Analysis of considerations in design and conduct of services for learning-disabled children; approaches to education of such children.

5615. EDUCATIONAL INTERVENTIONS FOR LEARNING DISABILITIES. (3 cr; prereq 5612) Deno, Espin

Planning, implementing, and evaluating academic programs for students with disabilities in written and spoken language, quantitative concepts, and cognitive skills required for learning.

5620. INTRODUCTION TO MENTAL RETARDATION. (4 cr, §CPsy 5315; prereq 5601 or PsyS 5101 or #) Turnure

Issues relating to educational practices; community planning; educational philosophy, administration and organization, and programming.

5621. METHODS AND MATERIALS FOR STUDENTS WITH MILD TO MODERATE MENTAL RETARDATION. (4 cr, §PsyS 5121; prereq 5601 or PsyS 5101 or equiv) Rynders

Curriculum content, materials and methods of instruction for students with mental retardation; preparation of instructional instruments leading to both individual and group teaching expertise.

5622. PROGRAMS AND CURRICULA FOR LEARNERS WITH MODERATE TO SEVERE DISABILITIES. (4 cr) Hupp

Elementary and secondary school program design and curricula for learners with severe disabilities. Emphasis on preparing children and youth for integrated, normalized community environments in domestic living, leisure, and vocational domains. Developmentally appropriate programming. Structured observation of learners with severe disabilities.

5624. BIOMEDICAL AND PHYSICAL ASPECTS OF DEVELOPMENTAL DISABILITIES. (3 cr, §PsyS 5124)

Selected information in genetics; anatomy, physiology, and kinesiology; central and peripheral nervous system; prenatal, perinatal, and postnatal development; physically disabling conditions; and management and educational procedures.

5625. EDUCATION OF INFANTS AND PRESCHOOL CHILDREN WITH DEVELOPMENTAL DISABILITIES. (3 cr, §PsyS 5125; prereq 5601 or 5620 or PsyS 5101 or PsyS 5120 or #) McEvoy, Rynders

Issues, problems, and practical applications in designing strong programs for young children with all types of disabilities.

5626. INSTRUCTION FOR LEARNERS WITH MODERATE TO SEVERE DISABILITIES. (4 cr; prereq 56116, 5622) Hupp

Data-based strategies for school and nonschool instruction: basic measurement principles; assessment, design, implementation, and evaluation of instruction; concept and task analysis; natural and instructional cues, corrections, consequences.

5635. EDUCATION OF STUDENTS WITH PHYSICAL DISABILITIES. (4 cr; prereq 5601 or PsyS 5101 or #)

Characteristics and abilities; methods and materials for training; observation of teaching situations involving these groups; personal consultation in addition to class hours.

5636. EDUCATION OF MULTIHANDICAPPED LEARNERS WITH SENSORY IMPAIRMENTS. (3 cr; prereq 5601) Hupp

Characteristics of learners with visual and auditory impairments; design of instructional programs to remediate or circumvent disabilities, including use of prosthetic devices; related areas of performance affected by sensory impairments.

5640. PSYCHOLOGICAL, SOCIAL, AND EDUCATIONAL ASPECTS OF DEAFNESS. (3 cr, §PsyS 5140) Rose

Historical and current societal perceptions of deaf individuals; analysis of effects and patterns of hearing loss on children and adults; intelligence, personal and social adjustment, effect of psychological processes on acquisition of language, speech, and speechreading skills.

5641. MODELS OF SERVICE DELIVERY TO STUDENTS WITH HEARING LOSS. (3 cr, §PsyS 5141; prereq 5644 or #) Rose

Programmatic systems of support for infants, children, and youth who are deaf or hard of hearing; educational delivery system models, curriculum and material adaptation, and consultation skills.

5643. LANGUAGE FOR DEAF/HARD-OF-HEARING CHILDREN. (4 cr, §PsyS 5143; prereq 5640 or PsyS 5140) Rose

Functional language development in communicatively disabled persons; overview of language curricula and programming strategies, pertinent research and models of instruction for use in educational environment.

5644. LANGUAGE PROGRAMMING FOR CHILDREN WITH HEARING LOSS. (3 cr, §PsyS 5144; prereq 5643 or #) Rose

Programs and practices focusing on development of language in deaf and hard-of-hearing infants, children, and youth; comparative study of language development among deaf, hard-of-hearing, and hearing persons.

5646. READING AND INSTRUCTIONAL PRACTICES WITH DEAF AND HARD-OF-HEARING STUDENTS. (4 cr; prereq 5643 or #) Rose

Knowledge and skills required to assess, plan, and implement instruction for individuals with hearing loss. Emphasis on theoretical and programmatic issues in acquisition of reading and writing skills, curricular adaptations, and effective instructional approaches.

5647. AURAL AND SPEECH PROGRAMMING FOR CHILDREN WITH HEARING LOSS. (4 cr, §PsyS 5147) Rose

Fundamentals of speech and hearing mechanisms; survey of instructional practices and technology-based assistive devices to develop auditory and speech skills. Strategies to adapt classroom environments.

Graduate Programs

5648. MODES OF COMMUNICATION FOR PERSONS WITH DISABILITIES. (3 cr, §PsyS 5148)

Rose

Theoretical and applied study of selection and application of alternative communication modalities; assessment and development of modes including gestures, speech reading, cued speech, sign language, form boards, and technology-based systems.

5651. MANAGING PROBLEM BEHAVIOR IN THE CLASSROOM. (3 cr) Wilderson

Typical patterns of problem behavior in classroom settings; relationships to teacher mental health; simulation of methods for prevention and management.

5656. EDUCATIONAL NEEDS OF STUDENTS WITH EMOTIONAL DISTURBANCES OR BEHAVIORAL DISORDERS. (3 cr) Wilderson, Wood
Preparation for specialists: educational characteristics, educational interventions, teaching of social behavior, legal and ethical issues.

5657. EDUCATIONAL INTERVENTIONS FOR STUDENTS WITH EMOTIONAL DISTURBANCES OR BEHAVIORAL DISORDERS. (3 cr; prereq 5656) Wilderson, Wood

Preparation for specialists: assessment and planning procedures, interagency cooperation, career preparation and transition for EBD students.

5660. SUPERVISION AND ADMINISTRATION OF SPECIAL EDUCATION. (3 cr, §EdPA 5103)

Weatherman

Procedures in establishing and improving educational programs for exceptional children.

5670. INTRODUCTION TO EDUCATION OF CHILDREN WITH VISUAL DISABILITIES. (3 cr, §PsyS 5170) Knowlton

Educational programs, services, and resources for blind and partially seeing children; historical background; philosophy; sociological and psychological problems.

5671. LITERARY BRAILLE. (3 cr; prereq 5670 or PsyS 5170) Knowlton

Mastery of literary Braille code: analysis of specialized equipment with emphasis on use of Braille writers, slates, and computers for Grade 2 Braille transcription.

5672. ADVANCED BRAILLE. (3 cr; prereq 5671 or PsyS 5171) Knowlton

Mastery of Nemeth Code of mathematics, introduction to foreign languages, computer notation, and consideration of Braille textbook formats and techniques; consideration of music Braille.

5673. METHODS OF TEACHING CHILDREN WITH VISUAL DISABILITIES. (4 cr, §PsyS 5173; prereq 5670 or PsyS 5170) Knowlton

Principles of preparation, selection, and effective use of instructional materials and adaptive devices; adaptation of school environment; use of family, school, and community resources.

5674. ORIENTATION AND MOBILITY TECHNIQUES FOR STUDENTS WITH VISUAL DISABILITIES. (3 cr, §PsyS 5174) Knowlton

Introduction to basic techniques to gain skills in pre-cane techniques, orientation to learning environment, construction of mobility maps; consideration of cane, guide dog, and telescopic aids to mobility.

5675. STRUCTURE AND FUNCTION OF THE EYE: EDUCATIONAL IMPLICATIONS. (3 cr) Knowlton

Ophthalmological and educational considerations of anatomy and physiology of the eye and visual tract, visual screening and visual efficiency.

5676. EDUCATIONAL MANAGEMENT OF CHILDREN WITH VISUAL DISABILITIES. (3 cr; prereq 5675 or #) Knowlton

Advanced course evaluating and managing cognitive, psychosocial, and physical needs of students; consideration of parent, teacher, and student counseling.

5680. EDUCATION OF THE DISADVANTAGED.

(3 cr; prereq 12 cr psych or educ psych or sociology)
Educational needs of children handicapped by behavior related to deficiencies of physical and/or cultural environment; adaptations of educational programs.

5681. METHODS AND MATERIALS FOR INFANTS AND PRESCHOOL CHILDREN WITH DEVELOPMENTAL DISABILITIES. (4 cr, §PsyS 8181; prereq 12 cr educ or #) McEvoy, Rynders

Methods, materials, conceptual models for maximizing educational development of young children with all types of disabilities.

5700. ASSESSMENT AND DECISION MAKING IN SPECIAL EDUCATION. (3 cr) Deno

For teachers and other educational personnel. Identifying needs of handicapped students; planning, monitoring, evaluating instructional programs; practice in use of standardized devices and development of clinical measures for handicapped students.

5701. PRACTICUM: SPECIAL EDUCATION. (Cr ar; prereq #; S-N only) Staff

Supervised experience in teaching or related work in schools or other agencies serving exceptional children.

5702. WORKSHOP: SPECIAL EDUCATION. (Cr ar; prereq #)

Lab approach. Provides opportunities for school personnel to study specific problems related to special education.

5703. PRACTICUM EXPERIENCE: SPECIAL EDUCATION. (Cr ar; prereq #) Hupp, McEvoy, Rynders

Supervised teaching or related work in schools or other agencies serving exceptional children.

5704. WORKSHOP: INTERVENTIONS AND PRACTICES IN EDUCATIONAL AND HUMAN SERVICE PROGRAMS. (Cr ar; S-N only)

Concepts, issues, and practices; development of educational and psychological support services in school and human service settings. For practicing professionals.

5705. BEHAVIORAL ANALYSIS WITH PEOPLE WHO HAVE MILD OR MODERATE DISABILITIES. (3 cr, §PsyS 5305; 5116 recommended)

Deno, Espin, McConnell
Behavioral approaches to improving academic and personal-social behavior of people who have mild or moderate disabilities in mainstream and resource programs.

5708. DESIGN OF INSTRUCTIONAL ENVIRONMENTS FOR LEARNERS WITH SEVERE HANDICAPS. (3 cr; prereq 5622, 5626)

Strategies for planning context of instructional delivery, emphasizing community-based instruction; program implementation features; massed and distributed trials, homogeneous and heterogeneous grouping patterns; design of ecological inventories; transition of learners between educational settings and between educational and community settings.

5709. COGNITIVE AND SOCIAL IMPAIRMENTS OF LEARNERS WITH SEVERE HANDICAPS. (3 cr; prereq 5622; offered when feasible) Hupp

5710. CONTEMPORARY SERVICES FOR PERSONS WITH DEVELOPMENTAL DISABILITIES. (3 cr) York

Survey of characteristics and service needs of persons with developmental disabilities using multidisciplinary approaches. Changing concepts, models of services, issues related to promoting self-determination, independence, productivity, and integration into the community.

5849. ASSESSMENT OF THE PRESCHOOL CHILD. (3 cr; prereq statistics or measurement or grad course in assessment) Christenson, McConnell

Review of assessment of children ages 0-5 from developmental perspective; overview of normal and abnormal development; issues and techniques in cognitive, social, and emotional assessment; early education programs.

5850. CREATING FAMILY-SCHOOL-COMMUNITY PARTNERSHIPS FOR EDUCATIONAL SUCCESS. (4 cr) Christenson

Interactive television/distance education course covering theoretical and empirical bases for creating such partnerships; partnership variables essential for creating a collaborative ethic; and models/programs for K-12. Practical home-school partnership strategies for use by educational personnel to address academic, social, and behavioral concerns of individual students as well as systems-level concerns.

5900. INDEPENDENT STUDY. (Cr ar [max 12 cr]; prereq #)

Independent study in areas of special interest to students.

8111. KNOWLEDGE AND SKILL. (3 cr; offered when feasible)

8115. PSYCHOLOGY OF INSTRUCTION. (3 cr; prereq course in learning and/or instructional psych) R Tennyson

Identification and analysis of issues in development of instructional theory; review and analysis of research in teaching-learning processes in instruction; practice in design, development, evaluation of instructional techniques and technologies.

8129. RESEARCH PROBLEMS: LEARNING AND COGNITION. (Cr ar; prereq #)

Formulation of research designs.

8130. PERSONALITY DEVELOPMENT AND SOCIALIZATION. (4 cr, §5130; prereq 1 grad course in personality or child psych)

Major research strategies; emphasis on educational and developmental influences on personality.

8131. DEVELOPMENT OF MORAL-POLITICAL JUDGMENT AND PROGRAMS IN VALUE EDUCATION. (2-4 cr; prereq #: ¶8149 recommended)

Consideration of research and theory in moral judgment and political socialization, with emphasis on cognitive-developmental approach; consideration of value education programs.

8149. RESEARCH PROBLEMS: PERSONALITY. (Cr ar [max 9 cr]; prereq #)

Formulation of research topics and designs.

8150. PSYCHOLOGY OF CONFLICT RESOLUTION. (3 cr; prereq 5150 or PsyF 5170 or equiv) D Johnson

Review of research and theory, application to practical settings.

8153. SOCIAL AND PSYCHOLOGICAL INFLUENCES ON INDIVIDUAL BEHAVIORS.

(3 cr; prereq intro course in social psych or #) Maruyama
Social and situational influences on individual behavior, focusing on effects of norms, peers, and others; situational characteristics affecting evaluation by self or others.

8169. RESEARCH PROBLEMS: SOCIAL PSYCHOLOGY. (Cr ar; prereq #)

Formulation of research topics and designs.

8210. METHODS IN EDUCATIONAL RESEARCH. (3 cr; prereq spring qtr PhD students only) Hummel

Methods and techniques employed in investigation and reporting of educational problems. Suggested for all candidates for graduate degrees.

8220. ADVANCED THEORY OF MEASUREMENT. (3 cr; prereq 5221, 8261, PsyF 5121, PsyF 8111 or #; offered alt yrs) Davison

Principles underlying construction and use of psychological and educational measuring instruments, limitations of tests for purposes of measurement and evaluation. Students may register concurrently or subsequently for 8239 for individual extensions and applications.

Graduate Programs

8221. THEORY OF PSYCHOLOGICAL SCALING.

(3 cr; prereq 5221, 8261 or PsyF 5121, 8111 or #; offered alt yrs) Davison

Principles and theories underlying unidimensional scaling of properties of psychological behaviors, with minor attention to multidimensional scaling and mapping. Students may register concurrently or subsequently for 8239 for individual extensions and applications.

8239. PROBLEMS: MEASUREMENT. (1-3 cr [max 9 cr])

Intensive study and individual research.

8245. SEMINAR: SPECIAL TOPICS IN EDUCATIONAL EVALUATION. (3 cr; prereq 5240 or PsyF 5125 or #; offered when feasible) Welch

8247. INTERNSHIP: EVALUATION. (3 cr [max 12 cr]; prereq #) Welch

Practical experience on an evaluation project. Student is given specified responsibilities under the supervision of an evaluator.

8259. PROBLEMS: EVALUATION. (Cr ar; prereq

5243 or 8245 or PsyF 5621 or 8525) Welch
Designing, implementing, analyzing strategies. Students work on their own problems, on evaluation problems of schools in area, or on problems associated with national curriculum projects.

8260, 8261, 8262. STATISTICAL METHODS. (3 cr per qtr; prereq 5260 or PsyF 5110 or Psy 3801 or equiv for 8260, 8260 for 8261, 8261 for 8262)

Foundations of statistical theory; practice in applying theories in solution of educational and psychological problems.

8263. DESIGN AND ANALYSIS OF

EXPERIMENTS. (3 cr; prereq 8262 or PsyF 8112 or #) Functional approach to principles of efficient design of experiments and other types of observational programs; improved sampling techniques; methods of analyzing observational results.

8264. MULTIPLE REGRESSION ANALYSIS. (3 cr; prereq 5261 and 8261 or ¶5261 or PsyF 5111, PsyF 8111 or #) Davenport, Terwilliger

Techniques appropriate to analysis of data in education and behavioral sciences including polynomial regression, stepwise solutions, and analysis of variance; experience with computer applications.

8265. FACTOR ANALYSIS. (3 cr; prereq 5261, 8261 or ¶5261 or PsyF 5111, 8111 or #) Davenport, Terwilliger

Techniques appropriate to analysis of data in education and behavioral sciences including component, common factor, and image analysis; approaches to factor extraction, rotation, and factor score estimation; experience with computer applications.

8266. ANALYSIS OF RESULTS FROM NONEXPERIMENTAL RESEARCH. (4 cr; prereq 8261 or PsyF 8511 or equiv or #) Maruyama

Examination of quantitative techniques for drawing causal inferences, including path analysis, panel analysis, multitrait, multimethod analysis, structural equation approaches, and applications in social psychology of education.

8279. PROBLEMS: STATISTICS FOR STUDENTS IN EDUCATION AND PSYCHOLOGY. (Cr ar)

Recent developments in statistical science; application to educational and psychological problems.

8280. STATISTICAL COMPUTING USING SPSSX.

(3 cr; prereq 8261 or equiv) Hendrix
In-depth understanding of statistical package, SPSSX, on micro and mainframe; interpretation of results; attention to large-scale problems.

8402. INDIVIDUAL COUNSELING: THEORY AND PROCEDURES. (3 cr; prereq EPsy MA or PhD student with CSPP subprog or #) Romano

Theories of individual counseling and psychotherapy and their application.

8403. SOCIAL/CULTURAL CONTEXTS OF COUNSELING: THEORY AND PROCEDURES.

(3 cr; prereq EPsy MA or PhD student with CSPP subprog or #) Hansen
Multicultural populations within United States, with focus on race, ethnicity, gender, and class. Systems interventions and social change. Students examine own biases as well as counseling and human development models and procedures for diverse groups.

8404. GROUP COUNSELING: THEORY AND PROCEDURES. (3 cr; prereq EPsy MA or PhD student with CSPP subprog or #) Romano

Theories and procedures of group process; ethical issues in group counseling.

8410. SEMINAR: COUNSELING ETHICS AND PROFESSIONAL DEVELOPMENT. (4 cr; prereq EPsy PhD student with CSPP subprog or #)

Ethical and professional development of counseling psychologists.

8411. SEMINAR: ADVANCED COUNSELING RESEARCH. (4 cr; prereq PhD student, #) Hummel

Analysis and integration of counseling research.

8412. SEMINAR: ADVANCED COUNSELING THEORY. (4 cr; prereq EPsy PhD student with CSPP subprog or #)

Comparative analysis of major models of counseling and psychotherapy.

8431. MASTERS SEMINAR: CSPP. (Cr ar [max 6 cr]; prereq MA student, #) Hummel

Discussion of significant issues in the field.

8435. INTEGRATIVE SEMINAR: SCHOOL COUNSELING. (3 cr [max 9 cr]; prereq CSPP student in school counselor licensure prog; not open to sr or

MEd students, A-F only)
Professional and ethical issues, problems, and programs related to students in practicum or internship settings.

8450. PSYCHOLOGICAL ASPECTS OF COUNSELING SUPERVISION. (3 cr, §PsyS 8150; prereq CSPP doctoral student or #) McCarthy Veach Consideration of theories; review of relevant research; demonstration and in-class practice of supervision skills.

8501. COUNSELING PRE-PRACTICUM. (3 cr; A-F only) McCarthy Veach Demonstration and in-class practice of individual helping skills.

8502-8503-8504†. COUNSELING PRACTICUM I, II, III. (4 cr each; prereq ¶8402 and # for 8502, ¶8403 and 8502 and # for 8503, ¶8404 and 8503 and # for 8504; A-F only) McCarthy Veach, Romano, Skovholt Supervised practice in counseling with individuals and groups; emphasis on systematic evaluation of progress through direct observations, video and audio tapes.

8505-8506-8507. FIELD PLACEMENT IN COUNSELING AND STUDENT PERSONNEL PSYCHOLOGY. (1-3 cr per qtr [max 9 cr]; prereq MA student in CSPP; ¶8402 and ¶8502 for 8505, ¶8403 and ¶8503 for 8506, ¶8404 and ¶8504 for 8507) Supervised involvement of beginning M.A. students in appropriate agencies.

8508. GROUP COUNSELING SKILLS. (2 cr; prereq CSPP grad student, 8404 or #; S-N only) Romano Observation, practice, and processing of group counseling skills and techniques.

8509. SUPERVISION PRACTICUM. (2 cr; prereq 8450, CSPP doctoral student or #; A-F only) McCarthy Veach, Romano, Skovholt Supervised practice in development, management, and supervision of counseling practicum.

8510. INTERNSHIP: CSPP. (0-6 cr [max 9 cr for MA and specialist students, 18 cr for PhD students]) Veach Supervised employment at department-approved sites.

8513-8514-8515†. COUNSELING PRACTICUM: UNIVERSITY COUNSELING SERVICES. (4 cr per qtr [max 9 cr]; prereq #; S-N only) Loeffler, Loper Supervised experience in counseling at college and adult levels; 3 consecutive quarters beginning fall.

8520. COUNSELING PRACTICUM: ADVANCED. (1-3 cr [max 9 cr]; prereq CSPP doctoral student; S-N only) Loeffler, Romano, Skovholt, Veach Opportunity to continue development of counseling skills. Each student assigned to senior staff member for supervision.

8521. PRACTICE IN STUDENT PERSONNEL WORK. (1-3 cr [max 9 cr]; prereq 8404, 8504, 8420, 5451 or PsyS 8304, 8604, 8140, 5540 or #) Supervised practice in college student personnel work in settings selected to match student interest.

8603. SERVICES FOR PERSONS WITH DEVELOPMENTAL DISABILITIES: RESEARCH AND POLICY ANALYSIS. (3 cr; offered when feasible) Bruininks

8612. CURRENT ISSUES IN LEARNING DISABILITIES. (4 cr; offered alt yrs) Deno, Espin Survey, analysis, application of relevant theories and research to current issues in the field; development of skill in scholarly inquiry, writing, and debate.

8620. PSYCHOLOGICAL THEORY AND RESEARCH IN MENTAL RETARDATION. (4 cr, §PsyS 8120; offered alt yrs) Turnure Review of research and theories in context of relevant developmental theories; important contributions in primary sources concerning principles of cognitive development and applied problems.

8621. FUNCTIONAL ANALYSIS OF BEHAVIOR AND COGNITION IN PERSONS WITH MENTAL RETARDATION. (4 cr, §PsyS 8121; prereq 8620 or PsyS 8120 or #; offered alt yrs) Turnure Empirical approach to study of development in persons with mental retardation, emphasizing psychological research; procedures for deriving appropriate field applications; generating and implementing researchable questions.

8652. RESEARCH IN EDUCATION OF DISTURBED CHILDREN. (3 cr; prereq #; offered alt yrs) Wilderson, Wood Review; critical analysis of specific designs and procedures; critique of current status of research.

8677. SEMINAR: ISSUES AND RESEARCH IN VISUAL IMPAIRMENT. (3 cr [max 9 cr]; prereq 5675, NSc 5031 or Psy 5031 or equiv) Knowlton Research findings from diverse disciplines on impact of visual impairment on social, cognitive, language, and motor development.

8702. SEMINAR: SPECIAL EDUCATION. (Cr ar; prereq #) Staff Special topics and schedules announced by department.

8706. SINGLE CASE DESIGNS FOR INTERVENTION RESEARCH. (3 cr) Deno Design and analysis of single case experiments to examine effects of interventions on individual behavior in school, home, and community environments.

8725. SOCIOCULTURAL THEORY AND RESEARCH ON HANDICAPPING CONDITIONS. (4 cr; offered alt yrs) Service arrangements, effects of labeling and stigma, deinstitutionalization, epidemiological trends; impact of handicapped person on family and society; adult/community adjustment, social position, influence of social forces; cross-cultural research and legal and economic factors.

8760, 8761. SEMINAR: ADMINISTRATION OF SPECIAL EDUCATION. (3 cr per qtr, §EdPA 5180, §EdPA 5181; prereq 5660 or PsyS 5160, EdAd 5103 or #) Weatherman Problems of administration and organization of special education programs.

8770. INTERVENTION STRATEGIES FOR PERSONS WITH DEVELOPMENTAL DISABILITIES: INTERDISCIPLINARY PERSPECTIVES. (3 cr; prereq admission to educ to human servs grad prog or #) Bruininks, McConnell Introduction to principles and procedures.

Graduate Programs

8810. ASSESSMENT APPROACHES IN SCHOOL PSYCHOLOGY I. (3 cr, §PsyS 8310; prereq #)

Christenson, McConnell, Ysseldyke
Theories of and models, strategies, and techniques for psychoeducational assessment of child and adolescent within home, school, and community. Conceptual and empirical foundations of eco-behavioral assessment approach in schools; efficient data gathering regarding child's cognitive-intellectual functioning, social-emotional functioning, and educational progress. Interpreting child-oriented assessment data in relation to child's social milieu (home, school, peer environments).

8811. ASSESSMENT APPROACHES IN SCHOOL PSYCHOLOGY II. (3 cr, §PsyS 8311; prereq #)

Assessment and decision-making issues, especially for determining eligibility for special education services and developing appropriate interventions for students with disabilities. Current practice in assessing students with disabilities; psychometric and legal perspectives on bias in assessment; and introduction to administration of scoring and interpretation of individualized assessment instruments.

8812. ASSESSMENT APPROACHES IN SCHOOL PSYCHOLOGY III. (3 cr, §PsyS 8311; prereq #)

Final preparation for school practicum: students recommend comprehensive evaluation and suggest goals for future intervention. Factors affecting reliability of educational diagnosis and evidence for differential diagnosis; guidelines for planning interventions in schools; making placement decisions in special education; and introduction to multidisciplinary team (MDT) process.

8813. ASSESSMENT PRACTICUM IN SCHOOL PSYCHOLOGY. (2 cr; prereq school psych student or #) Christenson, McConnell, Ysseldyke

Administering assessment devices and communicating results in written and oral forms. Students practice content from 8810, 8811, and 8812 in assigned schools. Guided practice and supervision.

8815. THEORIES AND METHODS OF INSTRUCTIONAL INTERVENTION. (4 cr, §PsyS 8515; prereq EPsy major with school psych subprog or #) McConnell

Theoretical considerations and training in use of functional techniques and appropriate preventive and remedial procedures. Emphasis on psychological implications of individual and classroom instructional practice and consultation skills with school personnel.

8816. SCHOOL CONSULTATION AND INTERVENTION PLANNING. (4 cr; prereq EPsy major with school psych subprog or #; A-F only) Casey, Christenson

Theory underlying psychological interventions and analysis of interventions used in schools. Principles and models of consultation, process and content of intervention planning, and review of research on academic and behavioral interventions and on school, teacher, and instructional effectiveness.

8817. SCHOOL PSYCHOLOGICAL INTERVENTIONS: AFFECTIVE DOMAIN. (4 cr; prereq EPsy major with school psych subprog or #; A-F only) Christenson

Analysis of school-based interventions for psychological problems and childhood disorders. Prevention, program development, family systems theory, family process and functioning, counseling approaches, and interface with community agencies and services.

8818. INTERVENTION PRACTICUM IN SCHOOL PSYCHOLOGY. (1 cr; prereq school psych student or #) Casey, Christenson, McConnell

Observation of school psychologists in collaboration with educators and parents in intervention-related activities. Students design, implement, and evaluate effectiveness of an intervention with individual and/or groups of students under supervision of practicing school psychologists.

8820. SEMINAR: RESEARCH IN SCHOOL PSYCHOLOGY. (2 cr [max 6 cr]; S-N only) Egeland, McConnell, Ysseldyke

Seminar for doctoral candidates planning dissertation research in school psychology.

8821. SEMINAR: SCHOOL PSYCHOLOGY. (Cr ar) Casey, Christenson, Ysseldyke

Intensive study of significant topics from behavioral sciences as they apply to contemporary educational problems.

8831. PRACTICUM: SCHOOL PSYCHOLOGICAL SERVICES. (1-5 cr; prereq EPsy major with school psych subprog or #) Casey

Typical functions of school psychologists; assessment procedures, case studies, consultation with parents, school personnel, and community agencies. Field experience under supervision, participation in seminar required.

8832. CLINICAL PRACTICE IN SCHOOL PSYCHOLOGY. (1-5 cr; prereq 8810 or PsyS 8310)

Casey
Supervised diagnosis and treatment of children referred to psychoeducational settings; training in broad range of approaches to problems of adjustment in school-age children, their families, schools, and community settings.

8840. INTERNSHIP: SCHOOL PSYCHOLOGICAL SERVICES. (5-15 cr; prereq EPsy major with school psych subprog or #; S-N only) Casey, Christenson

Advanced field experience for doctoral candidates in school psychology.

8841. INTERNSHIP: INSTRUCTION AND SUPERVISION IN SCHOOL PSYCHOLOGY. (1-9 cr; prereq EPsy major with school psych subprog or #; S-N only) Christenson, McConnell, Ysseldyke

Experience and tutorial for doctoral candidates preparing to train school psychologists in higher education settings.

8853. NEW APPROACHES TO PSYCHOPATHOLOGY IN CHILDREN AND ADOLESCENTS. (3 cr, §CPsy 8606) Egeland
Alternative formulation of childhood disorders, emphasizing competency training rather than medical nosology.

8900. RESEARCH PROBLEMS. (Cr ar; prereq # except for sect 3)
Research methodology and techniques; examination of literature; participation in formulating and executing research proposal.

8905. LANDMARK ISSUES AND GREAT CONTROVERSIES IN EDUCATIONAL PSYCHOLOGY. (3 cr; prereq 1st-yr EPsy doctoral student or #) Samuels

Overview of intellectual history of educational psychology highlighting philosophical underpinnings, conceptual and theoretical milestones, major debates, and roots of critical issues.

8910. DIRECTED STUDY. (Cr ar; prereq # except for sect 3)
Reading and analysis of research on selected problems.

Electrical Engineering (EE)

Regents' Professor: Lawrence Markus

Professor: Mostafa Kaveh, *head*; Vernon D. Albertson, *associate head*; Richard Y. Kain, *director of graduate studies*; Fredric N. Bailey; Steven K. Case; Keith S. Champlin; Lorne M. Chanin; Stephen Y. Chou; Philip I. Cohen; David H. Du; Tryphon T. Georgiou; Anand Gopinath; Jack H. Judy; John C. Kieffer; Larry L. Kinney; K. S. P. Kumar; E. Bruce Lee; Ned Mohan; Rolf K. Mueller (*emeritus*); Marshall I. Nathan; Allen Nussbaum (*emeritus*); Hendrik J. Oskam (*emeritus*); Robert P. Patterson; William T. Peria; Mahmoud Riaz; William P. Robbins; James R. Slagle; Marian Stachowicz¹; Allen R. Tannenbaum; Bruce F. Wollenberg

Adjunct Professor: Barry K. Gilbert; William E. Hogan II; David Lamb; David S. Lo; Andrzej Peczkalski; Vladimir Sokolov; Frank G. Soltis; Frederick M. Waltz

Associate Professor: Kevin M. Buckley; Stephen A. Campbell; Vladimir S. Cherkassky; Douglas W. Ernie; James E. Holte; Vipin Kumar; Thomas S. Lee; James R. Leger; Keshab K. Parhi; Dennis L. Polla; P. Paul Ruden; Gerald E. Sobelman; Ahmed H. Tewfik; Jian-Gang Zhu

Assistant Professor: Anthony T. Chronopoulos; Shantanu Dutt; Ramesh Harjani; Ted K. Higman; Gyungho Lee; David J. Lilja; Lori E. Lucke; Jay Moon; Matthew T. O'Keefe; Nikolaos P. Papanikolopoulos; Andrew R. Teel; Bapiraju Vinnakota; Michael E. Zervakis¹

Other: Blaise Morton

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S.E.E. (Plan A and Plan B), M.E.E. (Coursework Only and Design Project), and Ph.D.

Curriculum—Emphases in the major are solid state and physical electronics, surface physics, thin films, sputtering, noise and fluctuation phenomena, quantum electronics, plasma physics, automation, power systems theory, wave propagation, communication systems and theory, optics, lasers, fiber optics, magnetism, semiconductor properties and devices, VLSI and WSI engineering in theory and practice, network theory, signal and image processing, and computer and systems engineering. Interdisciplinary work is also available in bioelectrical sciences, control sciences, computer sciences, solar energy, applications of systems theory to urban transportation and economic planning, and biological modeling.

Prerequisites for Admission—Graduate work is open to students who have shown exceptional scholarship and ability in an accredited undergraduate curriculum in electrical engineering or physics. Consideration is given to students who have completed another curriculum in engineering, science, or mathematics which includes sufficient preparation to pursue a graduate program in electrical engineering. In some instances, additional preparatory studies may be required after admission.

Special Application Requirements—Scores from the Graduate Record Examination (General Test only) are required of all students desiring financial aid. International students applying from within the country should furnish letters attesting to their ability to understand technical instruction in English from United States faculty members. Students submitting transcripts from non-American institutions should furnish letters of recommendation that verify their academic standing in a specific way (e.g., class rank). Entry other than in fall quarter is not recommended. Applicants for fall quarter admission who are interested in financial aid should have a completed application for admission filed

¹ University of Minnesota, Duluth

Graduate Programs

with the Graduate School by January 10, 1995, for September 1995 admission, or by December 15, 1995, for September 1996 admission, and should send a copy of their application materials directly to the department.

Master's Degree Requirements—For the M.S.E.E. degree, part-time students must choose the Plan B program, whereas full-time students may choose either Plan A or Plan B. For the M.E.E. degree, see Professional Master's Degree in Engineering in the General Information section of this bulletin. The M.E.E. degree is offered under both the design project and coursework-only tracks. The final examination for the M.S.E.E. degree is oral, but no final oral examination is required for the M.E.E. degree taken under the coursework-only track.

Doctoral Degree Requirements—The preliminary written examination is conducted by the department twice each year. Students who enter the program with the M.S. degree in electrical engineering must pass the examination during their first academic year in residence. All other students must pass the examination before the end of their second academic year in residence. The department requires that each Ph.D. program include a minimum number of credits in advanced graduate courses; consult the department for details. Each Ph.D. student must satisfactorily complete the department's program in oral paper presentation before the thesis proposal will be approved.

Minor Requirements for Students Majoring in Other Fields—Credits presented to satisfy the minor requirement in electrical engineering must be from classroom and laboratory courses graded on an A-F scale. In particular, colloquia, seminar, and special investigations credits do not count toward meeting the minor requirements.

Language Requirement—None.

For Further Information and Applications—Contact the director of graduate studies, Department of Electrical Engineering, University of Minnesota, 4-178 Electrical Engineering/Computer Science Building, 200 Union Street S.E., Minneapolis, MN 55455 (612/625-3300).

EE 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

EE 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

EE 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Courses Acceptable Only for Satisfaction of Minor Requirements

5002. DIGITAL SIGNAL PROCESSING. (3 cr; prereq upper div EE major or grad IT major, 3012 or #) General concepts of signal processing; discrete-time systems and digital filters.

5003. DIGITAL SIGNAL PROCESSING LABORATORY. (1 cr; prereq upper div EE major, 3402 or ¶3402, 5002 or #) Computer experiments in digital signal processing and digital filter design.

5053. DESIGN OF DIGITAL CIRCUITS. (3 cr; prereq upper div EE major or grad IT major, 3062 or #) Design of modern digital integrated circuits at subsystem level. Nonlinear device models, use to predict system performance. Comparison of performance and topology of various logic families including TTL, MOS, CMOS, PL, and ECL.

5055. INSTRUMENTATION AND CONTROL ELECTRONICS. (4 cr; prereq upper div EE major or grad IT major, 3012 or ¶3012, 3062 or #) Characteristics of operational amplifiers; applications of operational amplifiers including A-D and D-A converters; compensation of operational amplifiers; power amplifiers; semiconductor controlled rectifiers, applications; linear and switching voltage regulators.

5056. ELECTRONICS CIRCUITS LABORATORY. (1 cr; prereq IT student or grad IT major, 3402 or ¶3402, ¶5055)

5090. DIGITAL CIRCUIT DESIGN LABORATORY. (1 cr; prereq 3402 or ¶3402, ¶5053)

5151. MATERIALS AND DEVICES I. (4 cr; prereq IT student or grad IT major, 3062, 3111, Phys 3501 or #) Fundamental electronic properties of materials, with emphasis on semiconductors. Carrier transport and statistics. Diodes, BJTs, LASERS.

5161. MATERIALS AND DEVICES II. (4 cr; prereq 5151 or #) Introduction to fundamental physical properties of device structures and dielectrics. Metal semiconductor contacts, MOS structures, fiber optics, superconductors.

5162. SOLID-STATE TRANSDUCERS. (3 cr; prereq IT student or grad IT major, 3060, 3111, Phys 3501 or #) Design and operation of solid state devices used for transducing physical and chemical signals.

5202. ANALOG COMMUNICATION. (3 cr; prereq upper div EE major or grad IT major, 3012, Stat 3091 or #)

Selected topics in analog communication systems: amplitude and frequency modulation. Spectral analysis and effect of noise in modulation systems. Detection.

5203. DIGITAL COMMUNICATION. (3 cr; prereq upper div EE major or grad IT major, 3012, 5202, Stat 3091 or #)

Selected topics in pulse and digital communication systems: pulse modulation systems, pulse-code modulation. Data-transmission systems including phase-shift keying and frequency-shift keying. Effect of noise. Coding.

5240. ANALOG COMMUNICATIONS LABORATORY. (1 cr; prereq 3402 or ¶3402, ¶5202)

5241. DIGITAL COMMUNICATIONS LABORATORY. (1 cr; prereq 3402 or ¶3402, ¶5203)

5253. LINEAR CONTROL SYSTEMS. (3 cr; prereq upper div EE major or grad IT major, 3012 or #) Modeling, characteristics, and performance of feedback control systems. Stability, root-locus, and frequency-response methods. Compensator design.

5255. DIGITAL CONTROL SYSTEMS. (3 cr; prereq upper div EE major or grad IT major, 3351, 3352 or equiv, 5002 or ¶5002 or #)

Time- and frequency-domain analysis of discrete-time and digital control systems. Data conversion and interfacing. Digital computers as control system components. Software and hardware considerations in digital control system design.

5290. DIGITAL CONTROL SYSTEMS LABORATORY. (1 cr; prereq 3402 or ¶3402, ¶5255)

5291. LINEAR CONTROL SYSTEMS LABORATORY. (1 cr; prereq 3402 or ¶3402, ¶5253)

5300. ELECTROMECHANICS. (4 cr; prereq upper div EE major or grad IT major, 3011, 3110)

Principles of electromechanical energy conversion with applications to actuators, transducers, and rotating machines. Performance characteristics derived from analytical models of AC and DC machines.

5310. ELECTRIC POWER SYSTEMS. (4 cr; prereq IT student or grad IT major, 3402 or ¶3402, 5300 or #)

Introduction to power system engineering. Modeling of power-system components: transformers, synchronous generators, transmission lines, cables, and circuit breakers. Describing equations for power networks. Solution techniques for load-flow and fault studies. Power system relaying.

5315. ELECTROMECHANICS IN ROBOTICS. (3 cr; prereq upper div EE major, 3012, 5300 or #)

Modeling of mechanical system elements. Sensors and encoders for speed and position control. Mathematical modeling and control of DC-, "brushless" DC-, induction-, and stepper-motors in incremental motion systems. Torsional resonances and optimum design in high performance systems. Design examples.

5322. ELECTROMECHANICAL PROCESSES AND DEVICES. (4 cr; prereq IT student or grad IT major, 3402 or ¶3402, 5300 or #)

Principles of electromechanical energy conversion. Modeling of rotating machines. Computer-aided steady-state analysis of DC and AC machines. Special purpose devices: single-phase machines, linear machines, stepper motors. Solid-state motor control.

5355. MICROPROCESSOR INTERFACING AND SYSTEM DESIGN. (4 cr; prereq upper div EE major or grad IT major, 3351, 3352, 3402 or ¶3402 or #)

Microprocessor interfacing. Memory design. Exception handling. Parallel and serial input/output: techniques and devices. Bus arbitration control and multimaster systems. Direct memory access. Designing dynamic RAM memory systems. Memory management. Integral lab.

5470. DIRECTED STUDY. (Cr ar [may be repeated for cr]; prereq Δ)

Studies of approved topics, theoretical or experimental in nature.

Courses Acceptable for Satisfaction of Either Major or Minor Requirements

5505. ANALOG INTEGRATED CIRCUIT DESIGN. (3 cr; prereq grad student or #)

Review of MOS fabrication technology and device-level models. Basic equations and higher-order effects. Noise. Basic CMOS building blocks: current mirrors, differential pairs, transconductance amplifiers, etc. Unbuffered operational amplifiers; single-stage, Miller-compensated and folded-cascode. Output stages and comparators.

5506. ANALOG CIRCUITS FOR SIGNAL PROCESSING. (3 cr; prereq 5505, grad student or #)

Review of filter types and Laplace and Fourier transforms; time and frequency-domain concepts; approximation methods (Butterworth, Chebyshev, etc.); frequency transformations. Ideal and non-ideal operational amplifiers. Switched-capacitor filters: biquads and higher-order filters. Switched-capacitor gain stages, rectifiers, and oscillators.

5511. DIGITAL FILTERING AND SIGNAL PROCESSING. (3 cr; prereq grad IT major, 5002 or #)

Review of theory of linear shift-invariant, discrete-time systems (z-transform, discrete-time Fourier transform, sampling, discrete Fourier transform); interpolation and decimation; fast Fourier transform and fast convolution; finite-impulse-response filter design approaches and techniques; infinite-impulse-response filter design approaches and techniques; quantization.

Graduate Programs

5512. ADAPTIVE DIGITAL FILTER THEORY.

(3 cr; prereq grad IT major, 5511, 5702 or #)
Review of partial characterization of discrete-time random processes, correlation matrix eigenstructure; auto regressive modeling; FIR Wiener filter theory; linear prediction; least squares; LMS algorithm (transient and steady state behavior); RLS algorithm; lattice structure.

5515. FAST FOURIER TRANSFORM AND CONVOLUTION ALGORITHMS. (3 cr; prereq 5002 or #)

Theory and implementation of fast algorithms for Discrete Fourier Transform and convolution, including both one-dimensional and multi-dimensional cases.

5560. BIOMEDICAL INSTRUMENTATION. (4 cr; prereq #)

Biological signal sources. Electrodes, microelectrodes, other transducers. Characteristics of amplifiers for biomedical applications. Noise in biological signals. Filtering, recording, and display. Protection of patients from electrical hazards. Experiments in neural and muscle stimulation, EKG and EMG recording, neuron simulation, filtering and low-noise amplifiers.

5571. VLSI DESIGN I. (3 cr; prereq EE or CSci or Phys grad student or #)

CMOS switch model, stick diagrams, restoring logic, and steering circuits. Process flows, layout design rules, and latch-up avoidance. Parasitic resistance and capacitance, delay models, design optimization, and worst-case design. Dynamic circuit techniques, including precharging, Domino CMOS, multiple-phase clocking, charge sharing, clock generation, and synchronization failure. Subsystem design, including multiplexers, registers, decoders, PLAs, finite state machines, adders, and function units.

5572. VLSI DESIGN II. (3 cr; prereq 5571 or #)

Design methodologies, switch-level simulation, symbolic layout, and compaction. CMOS fault models, scan design, signature analysis, and built-in test. Computational unit design, including arithmetic-logic units, counters, fast multipliers, and barrel shifters. Memory architectures, RAM and ROM cells, sense amplifiers, content-addressable memory, and hardware stack. VLSI system case studies.

5573. VLSI DESIGN III. (3 cr; prereq 5572 or #)

Register files, busing structures, pipelining, and fine-grained parallelism. Control structures based on random logic, PLAs and ROMs. Multi-level control schemes and microsequencer design. RISC architectures, including overlapped register windows, delayed branching, pipeline interlocks, and hardware-software trade-offs. Memory management units and cache memory design. VLSI system case studies.

5574-5575†. COMPUTER-AIDED VLSI DESIGN LABORATORY.

(3 cr per qtr; prereq IT sr or IT adult spec or grad IT major, # and 5571 or ¶5571 for 5574, 5574 and 5572 or ¶5572 for 5575)
Creative use of design aids in parameter extraction, schematic capture, chip layout, channel-routing, maze-routing, multi-level simulation, and artwork verification. Complete design of integrated circuits in MOS and bipolar technologies. Designs evaluated by computer simulation.

5576. VLSI MODELING AND PROCESSING. (3 cr; prereq 5572 or #)

Advanced modeling and processing; arithmetic considerations. Algorithmically specialized processors: locality, pipelining, and interconnection patterns. Special algorithms for signal processing, finite element problems, and tree search (optimization).

5604. INTRODUCTION TO MICROWAVE ENGINEERING. (3 cr; prereq EE sr or grad IT major, 3111 or equiv)

Review of Maxwell's equations, wave equation, transmission lines. Circuit theory of waveguiding systems. Transmission lines and lumped elements, conventional and planar structures. Impedance transformation and matching. Passive devices. Resonators. Filters.

5605. MICROWAVE DEVICES AND CIRCUIT APPLICATIONS. (3 cr; prereq 3111, 5604 or equiv or #)

Two-terminal devices, including varactors, p-i-n diodes, step-recovery diodes, Gunn devices and Impatt diodes for device physics and circuit applications as detectors, mixers, frequency converters, amplifiers, and oscillators. Three-terminal devices, including FETs and Heterostructure Bipolar Transistors, device physics and circuit applications in amplifiers, oscillators, mixers, and frequency converters.

5606. ANTENNA THEORY AND DESIGN. (3 cr; prereq 3111 or #)

Fundamentals of antenna design for transmission and reception at radio and microwave frequencies. Antenna analysis techniques. Antenna applications including linear, loop, microstrip, aperture, and traveling wave antennas; broad band antennas and antenna arrays.

5620. ENGINEERING ACOUSTICS. (4 cr; prereq sr in IT or #)

Radiation and reception of acoustic waves. Acoustic sensors. Waveguides, cavities, and wave filters. Acousto-electric analogies and transducers. Methods of linear acoustic wave system theory applied to underwater sound, speech processing, and imaging.

5625. FOURIER OPTICS. (4 cr; prereq 3011, 3111 or #)

Fourier analysis of optical systems and images with applications to spatial filtering, optical information processing, and holography, Fresnel and Fraunhofer diffraction. Current topics such as speckle interferometry, hybrid (optical-digital) information processing systems, and computer-generated holograms.

5630. CONTEMPORARY OPTICS. (4 cr; prereq 3111 or Phys 5024 or #)

Current developments in optics. Theory of lasers and their applications in holography, nonlinear optics, etc. Nonlinear optics. Optics of anisotropic media. Theory of image formation and spatial filtering. Properties of optical detectors.

5631. PHOTONIC DEVICES. (3 cr; prereq EE sr or grad IT major, 5630 or 5661)

Optical properties of semiconductors, light-emitting diodes, lasers, and photodetectors.

5634. PHYSICAL OPTICS: APPLICATIONS AND TECHNIQUES. (3 cr; prereq 5625 or #)

Applications of interference, diffraction, and polarization in optical systems. Diffractive optical elements and microlenses. Volume diffraction in color and reflection holograms. Interferometry in astronomy and spectroscopy. Optical pattern recognition and optical computing.

5635. OPTICAL SYSTEM DESIGN. (3 cr; prereq IT sr or grad IT major)

Elementary or paraxial optics. Non-paraxial, exact ray tracing. Energy considerations in instrument design. Fourier optics and image quality. Design examples: telescopes, microscopes, diffraction-limited lenses, projectors, and scientific instruments.

5636. OPTICAL FIBER COMMUNICATION. (3 cr; prereq 3011, 3111 or #)

Components and systems aspects of optical fiber communication. Modes of optical fibers. Signal degradation and dispersion. Optical sources and detectors. Digital and analog transmission systems. Direct detection and coherent detection.

5650. PHYSICAL METHODS IN SOLID STATE MATERIALS I. (3 cr; prereq EE sr or adult spec or grad student, 3111)

Basic concepts in classical and statistical mechanics relevant to properties of solid state materials. Hamiltonian dynamics, statistical ensembles, phase space, partition function, classical and quantum statistics, relation between statistical mechanics and thermodynamics, Boltzmann transport theory.

5651. PHYSICAL METHODS IN SOLID STATE MATERIALS II. (3 cr; prereq 5650 or #)

Application of quantum theory to solid state materials. Schrödinger's equation, one-dimensional problems, angular momentum, central forces, scattering, spin, atomic and chemical structure. Crystal structure in solids, lattice vibrations and phonons, energy bands.

5652. PHYSICAL METHODS IN SOLID STATE MATERIALS III. (3 cr; prereq 5651 or #)

Physical properties of solid state materials. Properties of insulators and doped semiconductors, transport and scattering in semiconductors, Hall and thermal effects, quasi-Fermi levels, generation and recombination. Conduction in metals, superconductivity. Magnetic properties of materials. Amorphous materials.

5661. SEMICONDUCTOR PROPERTIES AND DEVICES I. (3 cr; prereq EE sr or adult spec or grad student, 5650, 3111 or #)

Principles and properties of semiconductor devices. Semiconductor materials, statistics, and transport. Aspects of transport in p-n junctions, heterojunctions.

5662. SEMICONDUCTOR PROPERTIES AND DEVICES II. (3 cr; prereq EE sr or adult spec or grad student, 5661)

Principles and properties of semiconductor devices. Charge control in different FETs, transport, modeling. Bipolar transistor models (Ebers-Moll, Gummel-Poon), heterostructure bipolar transistors. Special devices.

5666-5667. MAGNETIC PROPERTIES OF MATERIALS AND APPLICATIONS. (3 cr per qtr; prereq #)

5666: Magnetic measurement techniques, physical principles of magnetism, and properties of magnetic materials with applications. 5667: Physical principles of crystalline and induced magnetic anisotropy, magnetostriction, magnetic domains and the magnetization process, fine particles and thin films and magnetization dynamics.

5669. MAGNETIC RECORDING. (3 cr; prereq #)

Review of fundamental magnetics concepts relevant to magnetic recording. Introduction to basic models of longitudinal and perpendicular magnetic recording and reproduction processes. Comparison of design, fabrication, and performance of conventional and thin film heads, tapes, disks, and recording systems.

5670. BASIC MICROELECTRONICS. (3 cr, 5670-5672†; prereq EE sr or adult spec or grad student)

Experimental and theoretical studies of the basic physical processes used in microelectronic device fabrication. Transistor and integrated-circuit layout, fabrication, and evaluation.

5672. BASIC MICROELECTRONICS

LABORATORY. (1 cr; prereq IT sr or adult spec or grad student, 5670 or ¶5670)

Students fabricate a polysilicon gate, single-layer metal, NMOS chip, performing about 80% of processing, including photolithography, diffusion, oxidation, and etching. In-process measurement results compared with final electrical test results. Simple circuits used to estimate technology performance.

5673. ADVANCED MICROELECTRONICS. (3 cr; prereq IT sr or adult spec or grad IT student, 5670, 5672 or ¶5672)

Integration of unit processes into a fabrication technology; physics and chemistry of advanced techniques such as molecular beam epitaxy, electron beam lithography, and reactive ion etching.

5680. PRINCIPLES OF THIN FILM

TECHNOLOGY. (4 cr; prereq IT sr or grad IT major)

Introduction to principles of fabrication, characterization, and processing of thin films for engineering applications. High-vacuum systems, thin film deposition techniques, energetics and kinetics of thin film formation, and electrical, dielectric, magnetic, optical, and piezoelectric properties of thin films. Lab.

5700. INFORMATION THEORY AND CODING. (3 cr; prereq Stat 3091 or #, IT sr or EE adult spec or grad student)

Discrete information sources and channels, source encoding, the binary channel and Shannon's second theorem. Block codes for the binary channel.

5702. STOCHASTIC PROCESSES AND OPTIMUM FILTERING. (3 cr; prereq Stat 3091, grad standing or #)

Stochastic processes, linear system response to stochastic inputs. Gaussian process, Markov process. Linear filtering, maximum-likelihood estimate, stochastic control.

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5712. KALMAN FILTERING AND APPLICATIONS.

(3 cr; prereq grad student, 5702, Stat 3091 or #)

Mathematical description of random signals; response of linear systems to random inputs. Discrete Kalman filter; applications. Continuous Kalman filter; smoothing; nonlinear extensions.

5750. TOPICS IN LINEAR SYSTEMS. (3 cr; prereq grad student, Math 5242 or #)

State variable and input/output models of linear systems. Controllability, observability, stability, minimality, and structure. State variable feedback and observers.

5751. LINEAR OPTIMAL CONTROL. (3 cr; prereq grad IT major, 5750, Math 5243 or Math 5243 or #)

Time- and frequency-domain models of multiple-input-multiple-output systems. Linear-quadratic and linear-quadratic-Gaussian problems. Properties of linear-quadratic and linear-quadratic-Gaussian regulators. Output feedback and separation theorem.

5752. COMPUTER-AIDED DESIGN OF CONTROL SYSTEMS. (3 cr; prereq grad IT major, 5751 or #)

Development of control system design problem. Frequency response techniques in design of single-input-single-output and multiple-input-multiple-output control systems. Robust control concepts. Computer-aided design tools, application in design of single-input-single-output and multiple-input-multiple-output control systems with robust performance.

5760. BIOLOGICAL SYSTEM MODELING AND ANALYSIS. (4 cr; prereq #)

Purposes of biological system modeling; advantages, limitations, and special problems. Models of nerve excitation and propagation. Biological control systems: respiratory system, cardiovascular system. Sensory organs and various theories of perception. Limbs and locomotion.

5802. ELECTRIC POWER SYSTEM ANALYSIS.

(3 cr; prereq grad IT major or #)
Formulating equations for describing electric power networks. Advanced computer methods for large-scale electric power systems. Application to power-flow, faulted system calculations, and stability studies.

5803-5804. POWER GENERATION, OPERATION, AND CONTROL. (3 cr per qtr; prereq grad IT major, 5802 or #)

Economic dispatch of generation units, transmission system loss models, unit scheduling via dynamic programming and Lagrange relaxation algorithms, fuel and hydro scheduling via linear programming and transportation algorithms, energy production costing algorithms, evaluation of energy transactions between suppliers, energy management systems, real time control of generating units, system security evaluation, state estimation techniques, optimal power flow algorithms.

5805. ELECTRIC POWER SYSTEM ENGINEERING. (3 cr; prereq grad IT major or #)

Control of large power systems. Power system overvoltages and transients caused by faults, switching surges, and lightning. AC and DC electric power transmission and distribution; overhead and underground. Environmental impact of electrical energy systems. Current research topics.

5807. POWER SYSTEM PROTECTION. (3 cr; prereq grad IT major or #)

Fundamentals of fault condition calculations, modern power system circuit breakers and interrupt devices. Sensing transducers for input to protection relays, differential principle, time-overcurrent protection; directional and distance sensing, backup protection. System grounding principles, generator protection, and transformer, reactor, and shunt capacitor protection. Bus and line protection.

5814. SWITCHED MODE POWER ELECTRONICS I. (3 cr; prereq IT sr or IT adult spec or grad IT major, 3061, 3402 or #)

Overview of power capabilities and switching speeds of power semiconductor devices. Generic converter topologies and regulation techniques. Application and design of generic circuits such as switching power supplies, inverter devices for motors, battery chargers, uninterruptible power supplies, wind/photovoltaic inverters.

5815. SWITCHED MODE POWER ELECTRONICS II. (3 cr; prereq IT sr or IT adult spec or grad IT major, 5814 or #)

Limitations and methods of increasing power capabilities of switching devices. Device physics, switching characteristics, gate/base drives, stress reduction and loss considerations in using devices such as BJTs, MOSFETs, Gate-Turn-Off Thyristors. Future developments. Passive components and circuit layout in switched mode power electronics.

5816. SWITCHED MODE POWER ELECTRONICS LABORATORY. (2 cr; prereq IT sr or IT adult spec or grad IT major, 5815 or #)

Switching characteristics of power semiconductor devices. Gate/base drives and snubbers. DC to DC converter circuits. Design and control of a switching power supply. Drives for DC-, induction-, "brushless" DC-, and stepper-motors. Battery chargers and uninterruptible power supplies. Other residential and industrial applications.

5820. ELECTROMECHANICAL SYSTEM DYNAMICS. (3 cr; prereq #)

Electromechanical transducers and rotating machines with emphasis on their dynamic performance in systems. State models of machines. Computer-aided analysis of typical transient operations. Small-signal analysis. Transient stability of power systems. Electromechanical components in control systems. Engineering applications.

5825. FINITE-ELEMENT METHODS IN ELECTRICAL ENGINEERING. (3 cr; prereq #, grad IT major or EE sr)

Finite-element methods for solving electromagnetic field problems. Electric circuit approach to finite-element analysis. Engineering applications selected from two-dimensional problems in electrostatics, magnetostatics, and electric conduction. Computer implementation.

5851. APPLIED SWITCHING THEORY. (3 cr; prereq 3351, 3352 or #)

Review of traditional logic design methods; algorithmic state machine method; synthesis of sequential synchronous and asynchronous machines; synthesis by programmable devices; linear sequential circuits; Von Neumann architectures; register transfer language; hardware description in RTL.

5852-5853. COMPUTER ORGANIZATION AND DESIGN I-II. (3 cr per qtr; prereq 3351, 3352, ¶5851)

Digital computer organization; register-level simulation; control unit design; microprogramming; memory organization. Input-output technique; arithmetic unit design; features of larger computers.

5854. ADVANCED COMPUTER NETWORKS. (3 cr; prereq grad IT major or EE adult spec student, CSci 5211 or #)

International Standards Organization (ISO) network architecture; topology analysis; data communication; satellite and packet radio networks; distributed systems and case studies.

5858. COMPUTER ARCHITECTURE. (3 cr; prereq IT sr or adult spec or IT grad student, 5853 or #)

Conventional and unconventional uniprocessor system design options. Impact of software on system architecture. Instruction set selection and architectural consequences. Memory systems, including segmentation, paging, and cache memories. Control unit design. Object manipulation structures. Examples from current and historically important designs.

5860. MICROCOMPUTER ARCHITECTURE. (4 cr; prereq grad IT major, 5355 or #)

Advanced microprocessor organization, 16- and 32-bit microprocessors, microprocessor bus structures, exception processing, interrupts, and virtual memory. Coprocessor organizations and multiprocessor systems. Design for testability. Integral lab.

5865. CODING TECHNIQUES AND APPLICATIONS. (3 cr; prereq grad IT major or #)

Linear error detecting/correcting codes, application to computers, polynomial description of codes, cyclic codes, encoder and decoder circuits, application to magnetic tapes, random test vector generation for self-test, signature analysis for data compression.

5952. SPECIAL TOPICS IN ELECTRICAL ENGINEERING. (1-3 cr; prereq grad IT major or adult spec or #)

Topics vary according to needs and staff.

8060. ADVANCED BIPOLAR TRANSISTOR THEORY. (3 cr; prereq 5660 or 5661 or #)

Recent developments in device modeling with emphasis on bipolar junction transistors. High-level effects in base and collector regions and their interrelationship.

8090. ELECTRONICS SEMINAR. (Cr ar [may be repeated for cr]; prereq #)

Current literature; individual assignments.

8100-8101. ADVANCED ENGINEERING ELECTROMAGNETICS. (3 cr per qtr; prereq 5604, 5605, 5606, #)

Maxwell equations, boundary conditions, power and energy. Electrical properties of matter. General electromagnetic theorems and principles. Maxwell equation solution in rectangular, cylindrical, and spherical coordinates. Model synthesis of three-dimensional dyadic Green functions. Methods for obtaining approximate analytical solutions: asymptotics, geometrical theory of diffraction. Application to propagation and scattering problems.

8110-8111. PLASMA PHYSICS. (3 cr per qtr; prereq 5652 or equiv, #)

Plasma theory: electron and ion orbits, self-consistent solutions, Maxwell-Boltzmann transport equation, introduction to magnetohydrodynamics. Collision phenomena: introduction to the theory of collision, basic collision processes, methods of measurement. Topics: theory of breakdown of gases, types of discharges, emission of radiation by free electrons in a plasma.

8120-8121. FUNDAMENTALS OF ACOUSTICS. (3 cr per qtr; prereq #)

Vibrations of system of mass-points. Extension to strings and membranes, acoustic elements, equations of elasticity and waves in solid media, plates, and rods. Motion of compressible fluids and the acoustic equations, solutions of the wave equation, acoustic radiation, transmission, diffraction, etc. Waves in inhomogeneous media, ray acoustics and nonlinear effects. Radiation pressure and shock waves.

8140. SEMINAR: PLASMA PHYSICS. (Cr ar [may be repeated for cr]; prereq #)

Current literature; individual assignments.

8143. SEMINAR: MODERN OPTICS. (Cr ar [may be repeated for cr]; prereq #)

Current literature; individual assignments.

8153-8154. PROPERTIES OF SEMICONDUCTORS. (3 cr per qtr; prereq #)

Application of modern solid-state theory to study of specific semiconductor materials. Influence of band structure and scattering mechanisms upon the electrical, optical, thermal, and thermoelectric properties. Plasma effects in semiconductors at low and high frequency. Mathematical treatments of generation-recombination kinetics, carrier injection, drift and diffusion. Use of semiconductor properties in devices, especially devices of current importance.

8160. QUANTUM ELECTRONICS. (3 cr; prereq 5630, #)

Properties of quantum systems: energy levels of atoms, molecules, and magnetic ions in crystals. Interaction of radiation with matter. Stimulated emission. Ammonia masers. Paramagnetic resonance. Three-level solid-state microwave masers, cavity and traveling wave. Noise properties. Optical masers: resonator properties and pumping methods. Solid-state spectroscopy. Gas optical masers.

Graduate Programs

8164. QUANTUM ELECTRONICS II (GUIDED WAVE OPTICS). (3 cr; prereq 5630, grad IT major or #)

Planar optical wave guides and optical fibers, ray and wave analysis. Nonlinearities, nonlinear devices, modulators, switches, solitons, optical fiber amplifiers, and active planar amplifiers.

8170. FLUCTUATION PHENOMENA. (3 cr; prereq #)

Theory with applications to electrical engineering. Circuit noise, vacuum-tube noise and semiconductor noise, influence upon performance of amplifiers, mixers, solid-state devices, detectors, and sensitive measuring equipment.

8180. ADVANCED ANALOG INTEGRATED CIRCUITS. (3 cr; prereq grad IT major or #)

Analysis and design of monolithic operational amplifiers; gain-bandwidth considerations; analysis of noise in integrated circuits and corresponding low-noise integrated circuit design; switched capacitor filters; analog switches and voltage references; analog-to-digital conversion techniques.

8181. ADVANCED DIGITAL INTEGRATED CIRCUITS. (3 cr; prereq grad IT major or #)

Analysis and design of bipolar, MOS, and BiCMOS digital integrated circuits based on device physics and integrated circuit technologies. Digital device design based on physical operating principles. Fabrication processes, design, and modeling. Semiconductor memories including SRAM, DRAM, EPROM.

8190. SEMINAR: QUANTUM ELECTRONICS.

(Cr ar [may be repeated for cr]; prereq #)
Current literature; individual assignments.

8191. SEMINAR: SURFACE PHYSICS. (Cr ar [may be repeated for cr]; prereq #)

Current literature; individual assignments.

8192. SEMINAR: MAGNETICS. (Cr ar [may be repeated for cr]; prereq #)

Current literature; individual assignments.

8203-8204. SIGNAL DETECTION AND ESTIMATION THEORY WITH APPLICATIONS.

(3 cr per qtr; prereq 5702 or #)
Risk theory approach to detection and estimation, random process representation, signal parameter estimation. Waveform estimation; detection of phase, frequency, and delay in signals. Applications to communications and radar-sonar signal design and processing.

8205. IMAGE PROCESSING AND APPLICATIONS.

(3 cr; prereq grad student, 5002, 5700 or #)
Two-dimensional digital filtering and transforms, application to image enhancement, restoration, compression and segmentation.

8207. VLSI SIGNAL PROCESSING. (3 cr; prereq grad IT major, 5571 or #)

Pipelined and parallel architectures for non-recursive and recursive digital filters, adaptive filters, dynamic programming problems, and two-dimensional systems; software multiprocessor implementations; bit-parallel, bit-serial, and nibble-serial arithmetic processors in two's complement and redundant number systems; VLSI implementation examples; systolic array design; computer-aided design of signal processing integrated circuits.

8211. CODING THEORY. (3 cr; prereq 5700 or #)

Error correcting codes; cyclic codes, finite fields, and BCH codes; majority logic decoding; burst error correction, convolutional codes.

8220. TOPICS IN STATISTICAL THEORY OF COMMUNICATION. (3 cr [may be repeated for cr with #]; prereq 5700, 5702 or #)

Selected special topics associated with recent advances in statistical communication theory.

8240. SEMINAR: COMMUNICATION. (Cr ar [may be repeated for cr]; prereq #)

Current literature; individual assignments.

8250-8251-8252. ADVANCED CONTROL TOPICS.

(3 cr per qtr; prereq #)
Adaptive and learning systems, discrete systems, invariance, optimum control of deterministic and stochastic processes, modeling of physical systems, and stability of dynamical systems.

8257, 8258. ADVANCED SYSTEMS THEORY I, II.

(3 cr per qtr; prereq grad IT major, #)
Generalized linear systems: applications, structural properties, computational approaches, classification, functorial behavior, and synthesis.

8260. TOPICS IN NONLINEAR SYSTEMS. (3 cr; prereq #)

Current topics in stability analysis of nonlinear systems, design of controllers for nonlinear systems, discrete-time and stochastic nonlinear systems.

8290. SEMINAR: CONTROL THEORY. (Cr ar [may be repeated for cr]; prereq #)

Current literature; individual assignments.

8291. SEMINAR: SYSTEM THEORY. (Cr ar [may be repeated for cr]; prereq #)

Current literature; individual assignments.

8300-8301. ADVANCED POWER-SYSTEM TOPICS.

(3 cr per qtr; prereq 5802 or #)
Power-system design and operation. Steady-state and transient stability limits. Economic operation of interconnected systems. Surge phenomena and ferroresonance conditions on transmission lines. Power system control. Reliability considerations. Future trends in power systems.

8305. SPARSE MATRIX METHODS IN POWER SYSTEM ANALYSIS. (3 cr; prereq 5802, grad IT major or #)

Solving sets of equations that involve large sparse matrices. Sparse matrix storage, ordering schemes, application to power flow, short circuit calculation, optimal power flow, and state estimation.

8340. SEMINAR: ELECTRIC POWER. (Cr ar [may be repeated for cr]; prereq #)

Current literature, individual assignments in the areas of power systems and electromechanics.

8342. POWER ELECTRONICS: UTILITY APPLICATIONS. (3 cr; prereq 5814, grad IT major or #)

Impact of power electronics loads on power quality. Passive and active filters. Active input current wave shaping. HVDC transmission. Static VAR control, energy storage systems. Interconnecting photovoltaic and wind generators. Static phase shifters and circuit breakers for flexible AC transmission (FACTS).

8352. FAULT DIAGNOSIS AND RELIABLE DESIGN. (3 cr; prereq #)

Generation of fault tests for combinational and sequential machines; experiments on sequential machines; simulation techniques; redundancy techniques; linear sequential circuits and codes; current topics.

8353. SEQUENTIAL CIRCUIT THEORY. (3 cr; prereq #)

Analysis and synthesis of asynchronous sequential circuits; algebra of partitions; simplification of incompletely specified sequential machines; state assignments; current topics.

8359. COMPUTING WITH NEURAL NETWORKS. (3 cr; prereq EE or Math or CSci grad student or #)

Neural networks as computation model. Relationship to AI, statistics, and algorithmic computing. Neural network models and learning rules. Applications to associative recognition/retrieval, optimization, expert systems. Software/hardware implementations and scaling issues.

8362. ADVANCED COMPUTER ARCHITECTURE. (3 cr; prereq grad IT major, 8355, 8356 or #)

High-speed uniprocessor design. Amdahl's Law. Static (VLIW) and dynamic (scoreboarding, Tomasulo's algorithm, multithreading) instruction scheduling techniques, multiple instruction issue (superscalar). Pipelining and pipeline design, vector units, interrupts and interrupt handling. Branch handling strategies. Performance evaluation and benchmarking.

8363-8364. PARALLEL PROCESSING I, II. (3 cr per qtr; prereq grad IT major, 5858 or #)

Parallel computer organization and architecture; shared and distributed memory architectures; synchronization techniques; static and dynamic scheduling; hardware/software interaction in parallel systems; parallel system software and compilers; example parallel machines and performance evaluation; I/O, networks, and secure computer design.

8390. COMPUTER SYSTEMS SEMINAR. (Cr ar [may be repeated for cr]; prereq #)

Current literature; individual assignments.

8450. SPECIAL INVESTIGATIONS. (1-4 cr [may be repeated for cr]; prereq #)

Studies of approved topics, theoretical or experimental in nature.

8451. ADVANCED TOPICS IN ELECTRICAL ENGINEERING. (Cr ar [may be repeated for cr]; prereq #)

Topics vary according to needs and available staff.

8460. PLAN B PROJECT. (4 cr [no cr toward PhD];

may be taken once to satisfy requirement for Plan B master's degree, may appear on master's program but may not be applied toward 20-cr minimum in major field; prereq #)

Project topic(s) arranged between student and adviser. Written report(s).

8461. PLAN B PROJECT. (2-4 cr [no cr toward PhD];

may be taken once to supplement Plan B project(s), may not be applied toward 20-cr minimum in major field; prereq 8460, #)

Written report.

8490-8491-8492. GRADUATE SEMINAR. (1 cr per qtr [may be repeated for cr]; prereq grad student or staff)

Recent developments in electrical engineering and related disciplines.

Elementary Education

See Curriculum and Instruction.

English

Professor: Shirley N. Garner, *chair*; Madelon Sprengnether, *director, creative writing program*; Chester G. Anderson; Kent Bales; Michael Dennis Browne; Thomas S. Clayton; Geneviève J. Escure; Peter E. Firchow; Philip G. Furia; Edward M. Griffin; Patricia Hampl; Michael Hancher; Gordon D. Hirsch; Karen N. Hoyle; Klaus P. Jankofsky¹; Richard J. Kelly; Calvin B. Kendall; Andrew MacLeish; Toni A. H. McNaron; Marcia Pankake; Peter J. Reed; Donald Ross, Jr.; Marty Roth; Robert Solotaroff; Ellen J. Stekert; David J. Wallace; Joel C. Weinsheimer

Associate Professor: Rita Copeland, *director of graduate studies*; Christopher Anson; Lillian Bridwell Bowles; Robert L. Brown, Jr.; Maria Damon; Maria J. Fitzgerald; Arthur I. Geffen; David B. Haley; Helen E. Hoy; Archibald I. Leyasmeyer; Ellen Messer-Davidow; Valerie J. Miner; John W. Mowitz; Paula Rabinowitz; Angelita D. Reyes; Charles J. Sugnet; John S. Wright

Assistant Professor: Andrew Elfenbein; Josephine D. Lee; David B. Luke; Asha Varadharajan; John A. Watkins

Other: Stephanie C. Van D'Elden

¹ University of Minnesota, Duluth

Graduate Programs

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered¹—M.A. (Plan B only) and Ph.D.

Curriculum—Course requirements for the Ph.D. program are broadly defined, allowing the student to shape a personal program of study. The English program encourages and supports interdisciplinary work. Four emphases are available in the master's program: language and literature; literary genre; English language and linguistics; and writing. The M.A. programs in literary genre and in writing may be completed through Continuing Education and Extension, which schedules mainly late afternoon and evening classes.

Admission to the Program—Holders of a bachelor's degree may apply either to the master's program or to the doctoral program. An M.A. degree can be gained en route to the Ph.D. degree. Admission to the master's program ordinarily is restricted to those having immediate career objectives for which an M.A. in English is important. However, M.A. candidates who wish to continue their studies may apply for admission to the Ph.D. program.

Prerequisites for Admission—A minimum of 16 credits in English, 12 of which must be at the upper division level, is required. The courses should be widely distributed.

Special Application Requirements—Three letters of recommendation; scores from the General Test of the Graduate Record Examination; a short essay explaining scholarly, professional, and personal goals and reason for choosing the University of Minnesota; and a writing sample, such as a course paper, are required. Applications to the master's emphasis in writing are reviewed by the writing faculty; these applications should include a substantial portfolio of writing in place of the usual writing sample. Candidates for all degrees

are admitted fall quarter only; all materials must be received by January 10.

Master's Degree Requirements—The minimum requirement is 44 credits (normally 11 courses).

For the *master's degree with an emphasis on language and literature—the degree program with an historical emphasis*—coursework must include at least 36 credits (nine courses) in English, of which 8 credits (two courses) are at the 8xxx level, including 4 credits (one course) at the seminar level; 8 credits (two courses) in related fields outside of English; and three Plan B papers.

For the *master's degree with an emphasis on literary genre—the degree program with a literary problems or theoretical emphasis*—coursework must include Engl 8012; 4 credits (one course) in English language or English linguistics; 16 credits (four courses) in literary genres, such as poetry, the novel, drama, literary theory, and nonfictional prose (three of the four courses to be devoted to the same genre); 8 credits (two courses) in related fields outside of English; three elective courses in English or related fields; and three Plan B papers.

For the *master's degree with an emphasis on English language and linguistics*, coursework must include at least 44 credits (eleven courses), of which at least 24 credits (six courses) are in English (specifically including Engl 5815, Engl 5851, and Engl 5843) and at least 8 credits (two courses) are in related fields outside of English; and three Plan B papers.

For the *master's degree with an emphasis on writing*, coursework must include at least 36 credits (nine courses) in English—of which 20 credits (five courses) are in writing (including one seminar), and 16 credits (four courses) are in language and literature; 8 credits (two courses) in related fields outside of English; and two Plan B projects. With permission of the writing program director, a substantial creative project may be used to fulfill the Plan B requirement.

The written examination for the master's program (all emphases except English language and linguistics) is administered

¹ A master of fine arts (M.F.A.) program in creative writing has been submitted to the regents for approval and may be in force beginning fall quarter 1995.

twice a year, in the fall and the spring. The written examination for the emphasis in English language and linguistics is administered separately.

Doctoral Degree Requirements—The following courses are required: Engl 8011 and 8012, preferably during the first year of doctoral study; four courses, distributed among broad areas; four additional English courses in a focused area of emphasis; and two extra-departmental courses related to the area of emphasis. Students are encouraged to enroll in additional courses as appropriate.

All doctoral students must take a preliminary written examination and a preliminary oral examination; both are based on a reading list of approximately 50 to 75 works defining a research program that the student constructs in consultation with his or her examining committee. A dissertation and a final oral examination in defense of the dissertation complete the program.

Language Requirements—For the master's program, a reading knowledge of one classical or modern language approved by the director of graduate studies is required. For the doctorate, a thorough reading knowledge of one classical or modern language approved by the director of graduate studies, or a reading knowledge of two such languages, is required.

Minor Requirements for Students

Majoring in Other Fields—A minimum of 16 undergraduate credits in English literature is a prerequisite for undertaking a minor in English.

For a master's program minor, a minimum of 16 graduate credits in English is required. For a doctoral program minor, a minimum of 20 graduate credits in English is required. Students should consult the director of graduate studies for advice in selecting courses.

For Further Information and

Applications—Contact the director of graduate studies, Department of English, University of Minnesota, 205 Lind Hall, 207 Church Street S.E., Minneapolis, MN 55455 (612/625-3882; fax 612/625-8565).

Engl 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Engl 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

English (Engl)

Recent course offerings typically include many specialized courses under the "seminar," "topics," and "studies" numbers. For a current listing of these courses, contact the director of graduate studies.

5131. RENAISSANCE POETRY. (4 cr; prereq grad student or Engl undergrad major or Δ; offered alt yrs)

Watkins

Historical and intellectual background; poetic theory; major figures, including Wyatt, Sidney, Spenser, Donne, Herbert, and Jonson.

5133. NINETEENTH-CENTURY BRITISH

POETRY. (4 cr; prereq grad student or Engl undergrad major or Δ; offered alt yrs) Elfenbein

Historical and intellectual background; poetic theory; major figures, including Wordsworth, Coleridge, Keats, R. Browning, E. B. Browning, Tennyson, and Arnold.

5151. EIGHTEENTH-CENTURY ENGLISH

NOVEL. (4 cr; prereq grad student or Engl undergrad major or Δ) Weinsheimer

Novels by such authors as Defoe, Richardson, Fielding, Smollett, Sterne, and Austen.

5152. NINETEENTH-CENTURY ENGLISH

NOVEL. (4 cr; prereq grad student or Engl undergrad major or Δ) Hirsch

Novels by such authors as Scott, Dickens, the Brontës, Thackeray, Eliot, and Hardy.

5153. TWENTIETH-CENTURY ENGLISH NOVEL.

(4 cr; prereq grad student or Engl undergrad major or Δ) Reed

Novels by such modern authors as Conrad, Ford, Joyce, Woolf, Lawrence, Forster, Cary, and Waugh.

5171. ENGLISH DRAMA TO THE TIME OF

SHAKESPEARE. (4 cr; prereq 3241 or 3242, grad student or Engl undergrad major or Δ; offered alt yrs)

Mystery plays, moralities, interludes, academic and court plays; plays of Kyd, Marlowe, Lyly, Greene, and Peele.

5172. JACOBEAN AND CAROLINE DRAMA. (4 cr;

prereq 3241 or 3242, grad student or Engl undergrad major or Δ; offered when feasible)

5173. RESTORATION AND 18TH-CENTURY

DRAMA. (4 cr; prereq 3241 or 3242, grad student or Engl undergrad major or Δ) Haley

The heroic play, tragedy, comedy of manners, and sentimental comedy.

Graduate Programs

5174. MODERN DRAMA, 1880-1920. (4 cr; prereq grad student or Engl undergrad major or Δ; offered alt yrs) Leyasmeyer
Beginnings of modern realism, naturalism, and expressionism in English and Continental drama.

5175. MODERN DRAMA SINCE 1920. (4 cr; prereq grad student or Engl undergrad major or Δ; offered alt yrs) Leyasmeyer
Survey of chief dramatists, English, American, and Continental.

5211. OLD ENGLISH (ANGLO-SAXON). (5 cr; prereq grad student or Engl undergrad major or Δ) Kendall
Introductory study of the language to A.D. 1150. Selected readings in prose and poetry. Some attention to the culture of the Anglo-Saxons.

5212. READINGS IN OLD ENGLISH PROSE AND VERSE. (4 cr; prereq 5211, grad student or Engl undergrad major or Δ)
Critical reading of texts, introduction to versification.

5213. BEOWULF. (4 cr; prereq 5211, grad student or Engl undergrad major or Δ) Kendall
Introduction to the Old English poem, with reading of considerable portions of text.

5215. MAJOR TYPES OF MIDDLE ENGLISH LITERATURE. (4 cr; prereq 5221, grad student or Engl undergrad major or Δ) Copeland, Wallace
Readings in Middle English, in romance, lyric, allegory, and devotional prose.

5221. CHAUCER. (5 cr; prereq grad student or Engl undergrad major or Δ) MacLeish, Wallace
Reading of Chaucer's works and introduction to Chaucer's language. Prerequisite for all courses in Middle English literature (5215-5222).

5261. MILTON. (4 cr; prereq grad student or Engl undergrad major or Δ) McNaron
Paradise Lost, *Samson Agonistes*, minor poems, *Areopagitica*, and often, though not always, *Paradise Regained*.

5363, 5364. JAMES JOYCE. (4 cr per qtr; prereq grad student or Engl undergrad major or Δ) Anderson
5363: Life and early works, particularly *Dubliners*, *A Portrait of the Artist as a Young Man*, and the first four episodes of *Ulysses*. 5364: *Ulysses* and *Finnegans Wake*.

5414. CONTEMPORARY AMERICAN LITERATURE. (4 cr; prereq grad student or Engl undergrad major or Δ)
Important authors, intellectual currents, movements, conventions, genres, and themes since 1940.

5431, 5432, 5433. AMERICAN POETRY. (4 cr per qtr; prereq grad student or Engl undergrad major or Δ) Bales, Damon, Furia, Geffen, Griffin
5431: Beginnings to 1890—Typical authors: Taylor, Poe, Whitman, Bryant, Dickinson. 5432: 1890-1940—Frost, Stevens, Pound, Moore, Hughes, Williams, Stein. 5433: Since 1940—Lowell, Ginsberg, Plath, Rich, Kaufmann, Baraka, Brooks.

5451, 5452. AMERICAN NOVEL. (4 cr; prereq grad student or Engl undergrad major or Δ) Bales, Geffen, Griffin, Ross, Roth
Typical authors: Hawthorne, Melville, Stowe, Twain, James, Dreiser, Cather, Hemingway, Fitzgerald, Faulkner.

5471. AMERICAN DRAMA. (4 cr; prereq grad student or Engl undergrad major or Δ) Geffen
From 1914 to present. Typical playwrights: O'Neill, Rice, Hellman, Wilder, Miller, Williams, Odets, Wilson.

5481, 5482, 5483. FOLKLORE. (4 cr per qtr; prereq 5481 or 5482 or # for 5483, grad student or Engl undergrad major or Δ) Stekert
5481: Folklore genres such as proverbs, oral prose narratives (tales and legends), foodways, and games. Outline of the history of folklore. 5482: Manner in which folklore is transmitted and changed with concentration on how folklore functions in literature, the mass media, and everyday activity. Emphasis on folk customs, festivals, heroes, humor, and medicine. 5483: Training in collection of folklore materials.

5486, 5487. INTRODUCTION TO ANGLO- AND AFRICAN-AMERICAN FOLKSONG. (4 cr per qtr; prereq 5486 or # for 5487, grad student or Engl undergrad major or Δ; offered alt yrs) Stekert
5486: Introduction to Anglo- and Afro-American folksong: basic elements of the folksong with emphasis on how folksongs change over time and space; concentration on such genres as ballads, blues, broadsides, lyric, and sentimental and topical songs. 5487: Development of Anglo- and Afro-American folksong: how these two streams of American folksong influenced one another as well as the "folksong revival."

5593. THE AFRO-AMERICAN NOVEL. (4 cr, §Afro 5593; prereq grad student or Engl undergrad major or Δ; offered alt yrs) Wright
Contextual readings of 19th- and 20th-century black novelists such as Charles Chesnut, James Weldon Johnson, Zora Neale Hurston, Richard Wright, Chester Himes, Ann Petry, James Baldwin, John Williams, Toni Morrison, and Ishmael Reed.

5597. THE HARLEM RENAISSANCE. (4 cr, §Afro 5597; prereq grad student or Engl undergrad major or Δ; offered alt yrs) Wright
Multidisciplinary review of Harlem Renaissance of Jazz Age: literature, popular culture, visual arts, political journalism, and black and white figures such as Jean Toomer, Claude McKay, Langston Hughes, Bessie Smith, DuBose Heyward, Carl Van Vechten, Eugene O'Neill, and Marcus Garvey.

5620. BRITISH AND AMERICAN WOMEN WRITERS. (4 cr per qtr; prereq grad student or Engl undergrad major or Δ; offered alt yrs) Garner, McNaron, Sprengnether, staff
Readings of one or more women writers, perhaps working at various times within various forms. Writers specified in the *Class Schedule*.

5651. TECHNIQUES OF POETRY. (4 cr; prereq grad student or Engl undergrad major or Δ)
Analysis of poetry. Form and sound; meter, stanza, euphony, free verse.

5671. THEORY OF THE NOVEL. (4 cr; prereq grad student or Engl undergrad major or Δ) Firchow
Readings in theoretical criticism of the novel with application to selected British and American fiction.

5711. CLASSICS OF LITERARY CRITICISM. (4 cr, §3711, §CICv 3711, §CICv 5711; prereq grad student or Engl undergrad major or Δ) Copeland, Hancher
Principles of criticism as expressed and used in selected major works in classic critical tradition by such writers as Plato, Aristotle, Horace, Longinus, Sidney, Dryden, Johnson, Hume, Coleridge, and Eliot.

5712. LITERARY CRITICISM: PLATO TO DRYDEN. (4 cr; prereq grad student or Engl undergrad major or Δ; offered alt yrs)
A survey, in English translation, of basic texts in Roman and Greek criticism; representative texts of English neoclassical criticism up to 1700.

5713. LITERARY CRITICISM: POPE TO ELIOT. (4 cr; prereq 5712 or #, grad student or Engl undergrad major or Δ; offered when feasible)

5714. MODERN AND CONTEMPORARY CRITICAL THEORY. (4 cr; prereq grad student or Engl undergrad major or Δ) Mowitz
Readings in modern and postmodern literary criticism, with attention to contemporary movements, theory, and practice.

5811. CELTIC WORLD. (4 cr; prereq grad student or Engl undergrad major or Δ; offered alt yrs)
Survey of history, folklore, and literature of the six Celtic countries: Brittany, Cornwall, Ireland, Isle of Man, Scotland, and Wales.

5815. HISTORY OF THE ENGLISH LANGUAGE. (4 cr; prereq grad student or Engl undergrad major or Δ) MacLeish
The development of the English language from Old to Early Modern English: phonology, morphology, and syntax.

5831. DEVELOPMENT OF AMERICAN ENGLISH. (4 cr; prereq grad student or Engl undergrad major or Δ; offered alt yrs)
History of the English language in the United States; significant regional variation.

5843. AMERICAN SOCIAL DIALECTS. (4 cr; prereq grad student or Engl undergrad major or Δ) Escure
Methods for and results of investigating social and class variation in American English; emphasis on urban dialects.

5851. STRUCTURE OF MODERN ENGLISH. (4 cr, §3851; prereq grad student or Engl undergrad major or Δ) Anson, Bridwell-Bowles, Brown, Escure
Survey of modern English grammar dealing with English phonology, syntax, and semantics; variations and change in English.

5852-5853-5854. MODERN IRISH LANGUAGE. (5 cr per qtr; prereq grad student or Engl undergrad major or Δ for 5852) Stenson

Grammatical structures of modern Irish dialect of Connemara, Co. Galway; development of skills in both oral and written language: vocabulary, manipulation of grammatical structures, speaking, listening, reading and writing practice; modern Gaelic culture.

5860. STUDIES IN THE ENGLISH LANGUAGE. (4 cr; prereq 5851 or #, grad student or Engl undergrad major or Δ)
Topic (English phonology, syntax, or semantics) specified in *Class Schedule*.

5862. WORLD ENGLISHES. (4 cr; prereq grad student or Engl undergrad major or Δ) Escure
Development, significance, and linguistic characteristics of varieties of English spoken in non-western countries (Caribbean, Central America, Africa, Asia). Pidgins, creoles, and local standards included with reference to issues of cultural identity and language nativization.

5871. THE LANGUAGE OF LITERATURE. (4 cr; prereq grad student or Engl undergrad major or Δ; offered alt yrs) Anson
The place of linguistic analysis in a theory of literary criticism; stylistic analysis in Europe and America since 1920; examination of theories of linguistic description relevant to critical analysis; applications to texts in prose and poetry.

5910. TOPICS IN ENGLISH AND NORTH AMERICAN LITERATURE. (4 cr; prereq grad student or Engl undergrad major or Δ)
Topics specified in *Class Schedule*.

5920. TOPICS IN ANGLOPHONE LITERATURE. (4 cr; prereq grad student or Engl undergrad major or Δ)
Topics specified in *Class Schedule*.

5940. FIGURES IN ENGLISH AND NORTH AMERICAN LITERATURE. (4 cr; prereq grad student or Engl undergrad major or Δ)
Figures specified in *Class Schedule*.

5950. FIGURES IN ANGLOPHONE LITERATURE. (4 cr; prereq grad student or Engl undergrad major or Δ)
Figures specified in *Class Schedule*.

8011. INTRODUCTION TO ADVANCED LITERARY STUDY. (4 cr)
Ends and methods of literary research, including professional literary criticism, analytical bibliography, and textual criticism, with attention to basic reference works, critical and scholarly journals, bibliographies of broad and narrow literary subjects, and forms of presenting results of critical and scholarly investigation.

8012. PROBLEMS IN LITERARY HISTORY AND THEORY. (4 cr) Bales, Messer-Davidow, Mowitz, Rabinowitz, Weinsheimer
Approaches to practical and theoretical problems of literary history and genre.

8050. STUDIES IN SPECIAL SUBJECTS. (2-4 cr [max 12 cr])
Topics specified in *Class Schedule*.

Graduate Programs

8111 through 8119. PROSEMINARS. (4 cr each)
Wide reading in the literature of a given period or subject designed to prepare graduate students for work in other graduate courses or seminars. Attention to relevant scholarship or criticism.

8111. *PROSEMINAR IN MEDIEVAL STUDIES* (Copeland)

8112. *PROSEMINAR IN RENAISSANCE STUDIES* (Watkins)

8115. *PROSEMINAR IN THE ENGLISH ROMANTIC MOVEMENT* (Elfenbein)

8116. *PROSEMINAR IN VICTORIAN STUDIES* (Hirsch)

8117. *PROSEMINAR IN EARLY AMERICAN LITERATURE* (Griffin)

8118. *PROSEMINAR IN 19TH-CENTURY AMERICAN LITERATURE* (Bales, Ross)

8119. *PROSEMINAR IN 20TH-CENTURY BRITISH AND AMERICAN LITERATURE* (Hoy, Solotaroff)

8210 through 8810. SEMINARS. (4 cr each)
Descriptive title specified in the *Class Schedule*.

8210. *MEDIEVAL STUDIES* (Copeland, Kendall, Wallace)

8220. *CHAUCER* (Wallace)

8230. *RENAISSANCE STUDIES* (Watkins)

8240. *SHAKESPEARE* (Clayton, Garner)

8250. *SEVENTEENTH-CENTURY STUDIES* (Haley)

8310. *STUDIES IN THE ENGLISH ROMANTIC MOVEMENT* (Elfenbein, Luke)

8330. *VICTORIAN STUDIES* (Hancher, Hirsch)

8480. *STUDIES IN FOLKLORE* (Stekert)

8510. *STUDIES IN EARLY AMERICAN LITERATURE* (Griffin)

8530. *STUDIES IN 19TH-CENTURY AMERICAN LITERATURE* (Ross, Roth)

8590. *STUDIES IN AFRO-AMERICAN LITERATURE* (Wright)

8610. *STUDIES IN 20TH-CENTURY BRITISH AND AMERICAN LITERATURE* (Furia, Hoy, McNaron, Solotaroff)

8650. *STUDIES IN POETRY* (Damon, Furia)

8670. *STUDIES IN PROSE FICTION* (Solotaroff)

8690. *STUDIES IN DRAMA*

8710. *STUDIES IN CRITICISM* (Anderson, Hancher, Messer-Davidow, Weinsheimer)

8720. *STUDIES IN FEMINIST CRITICISM* (Rabinowitz, Sprengnether)

8810. *STUDIES IN THE ENGLISH LANGUAGE* (Anson, Bridwell-Bowles, Brown, Escure, MacLeish)

8970. *INDEPENDENT READING.* (1-15 cr; prereq #, Δ)

English Creative and Professional Writing (EngW)

5101, 5102, 5103. ADVANCED FICTION WRITING. (4 cr per qtr; prereq Engl grad student or Δ) Fitzgerald, Miner

Advanced workshop for students with considerable experience in writing fiction.

5105, 5106, 5107. ADVANCED POETRY WRITING.

(4 cr per qtr; prereq Engl grad student or Δ) Browne
Advanced workshop for students with considerable experience in writing poetry. Opportunity for students to open their work to new possibilities and to read widely in contemporary poetry and poetics.

5110. TOPICS IN ADVANCED FICTION WRITING.

(4 cr; prereq grad student or Δ) Fitzgerald, Miner
Workshops by Edelstein-Keller visiting writers. See the *Class Schedule* for particular topics.

5120. TOPICS IN ADVANCED POETRY WRITING.

(4 cr; prereq Engl grad student or Δ) Hampl, Browne
Special workshops by Edelstein-Keller visiting writers. See the *Class Schedule* for particular topics.

5130. TOPICS IN ADVANCED CREATIVE WRITING.

(4 cr; prereq Engl grad student or Δ)
Workshop in areas other than fiction, poetry, and nonfiction.

5201, 5202. MEMOIR WRITING. (4 cr per qtr; prereq Δ) Hampl

Autobiographical prose writing. Students read numerous memoirs, consider aspects of memory and imagination and the memoir genre, and write their own autobiographical pieces.

5204, 5205. ADVANCED PLAYWRITING. (4 cr per qtr; prereq Engl or theatre arts grad student or Δ)

Advanced workshop for students with creative writing experience and interest in writing for stage or screen. Step-by-step creation of short script; field trips to local productions.

5210. TOPICS IN ADVANCED NONFICTION WRITING.

(4 cr; prereq Engl grad student or Δ) Sprengnether, Sugnet
Special topics in essay writing, such as arts reviewing, writing about public affairs, and writing in personal voice. See the *Class Schedule* for particular topics.

5310, 5320. READING AS WRITERS. (4 cr per qtr; prereq Engl grad student or Δ)

Fitzgerald, Miner, Sprengnether, Sugnet
Special topics. Open to graduate and advanced undergraduate students in literature, as well as to creative writing students. See the *Class Schedule* for particular topics.

5401. INTRODUCTION TO PROFESSIONAL EDITING. (4 cr) Marquit, Ready
Beginning editing, from substantive editing to nature of editor-writer relationship: manuscript reading, author queries, rewrite and style, some discussion of copy editing. Editing awareness and skills developed by working on varied writing samples.

5402. ADVANCED EDITING. (4 cr; prereq EngW 5401, #, Δ) Marquit
For students with advanced editing competence to further advance their skills. Workshop/seminar: editing long text and fiction, children's literature, translations, and indexes.

5501. MINNESOTA WRITING PROJECT INSTITUTE. (4 cr; prereq writing teacher [K-college] eligible for grad cr through Extension; requires nomination and competitive selection by board of Minnesota Writing Project)
Summer workshop in which participants reflect on own writing processes as they produce essays and examine current pedagogical theory and practice through readings and demonstrations.

5502. MINNESOTA WRITING PROJECT OPEN INSTITUTE. (3 cr; prereq writing teacher [K-college] eligible for grad cr through Extension)
Summer workshop in which participants reflect on own writing processes as they produce essays and examine current pedagogical theory and practice through readings and demonstrations.

5570. MINNESOTA WRITING PROJECT: DIRECTED STUDIES. (1-4 cr)
Workshops in which writing teachers investigate current theories of writing and writing pedagogy.

5970. DIRECTED STUDY IN WRITING. (1-4 cr; prereq #, Δ, □)
Projects in writing poetry, fiction, drama, and nonfiction, or study of ways to improve writing.

8110. WRITING OF FICTION. (4 cr; prereq Δ) Burns
Writing of fiction with focus on full-length book, e.g., a novel or collection of short stories. Some common assignments, but each student works on individual project.

8120. WRITING OF POETRY. (4 cr; prereq Δ) Browne
Writing of poetry with focus on the exploration and practice of various styles. Some common assignments, but each student works on individual project.

8130. CREATIVE WRITING SEMINAR. (4 cr; prereq Δ) Hamp
Advanced workshop in areas that do not fit into fiction or poetry categories exclusively. Complements 8110 and 8120.

English as a Second Language (ESL)

Professor: Elaine E. Tarone, *director of graduate studies;* Andrew D. Cohen; Jeanette Gundel

Associate Professor: Bruce T. Downing; Amy L. Sheldon; Nancy Stenson

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.A. (Plan A and Plan B).

Curriculum—The program offers a master's degree for those wishing to teach English as a second or foreign language to adults. The major emphasis is on preparation in the field of linguistics. Elective coursework allows students to specialize in a variety of areas, including second-language acquisition, English for special purposes, computer-assisted instruction, and materials development.

Prerequisites for Admission—A bachelor's degree in the liberal arts or sciences with a strong academic record is required.

Special Application Requirements—Scores from the General (Aptitude) Test of the Graduate Record Examination, three letters of reference, and a statement of the applicant's research interests in the field are required. Non-native speakers of English must submit scores (minimum 550) from the Test of English as a Foreign Language (TOEFL). Students may begin the program fall quarter or first summer session. Applications for both admission dates are due on March 15. Applications for financial aid must be submitted by January 15.

Master's Degree Requirements—ESL 5721, 5722, Ling 5001, 5002, 5301, 5701, 5741, 5742, and additional elective coursework are required. See the English as a Second Language Program brochure for details. A final oral examination is required.

Language Requirement—Proficiency, demonstrated by examination or coursework, in one language not native to the student is required.

Graduate Programs

Minor Requirements for Students

Majoring in Other Fields—ESL 5721, Ling 5001, 5301, 5741, and 5742 are required.

Prospective minors must be approved by the program to be granted the status of minor. A minimum grade point average of 3.20 is required for approval.

For Further Information and

Applications—Contact the Program in English as a Second Language, University of Minnesota, 192 Klæber Court, 320 16th Avenue S.E., Minneapolis, MN 55455 (612/624-3331; fax 612/625-2312).

ESL 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

5721. ENGLISH AS A SECOND LANGUAGE: METHODS. (4 cr; prereq Ling 3001 or Ling 5001 or #) Teaching methods.

5722. ENGLISH AS A SECOND LANGUAGE: PRACTICUM. (4 cr; prereq major or minor in ESL, 5721, #; S-N only)
Observation of and practice in teaching English as a second language.

5723. ENGLISH AS A SECOND LANGUAGE: MATERIALS. (3 cr; prereq 5721, 5722, #)
Evaluation and preparation of teaching materials.

8751. ENGLISH FOR SPECIAL PURPOSES. (4 cr; prereq 5741, 5742 or #)
Critical review of the literature. Investigation of types of English used in fields such as engineering, nursing, and business.

Program Requirements

ESL 5721. English as a Second Language: Methods (Cohen, Tarone)

ESL 5722. English as a Second Language: Practicum (Cohen, Tarone)

Ling 5001. Introduction to Linguistics (Gundel, Hutchinson)

Ling 5002. Linguistic Analysis (Gundel, Kac, Miranda, Stenson)

Ling 5301. Phonetics (Stemberger)

Ling 5701. Introduction to Second-Language Acquisition (Cohen, Sheldon, Tarone)

Ling 5741-5742. Linguistic Description of Modern English (Downing, Gundel, Tarone)

Suggested Electives

Structure of a foreign language (not English)—See language department listings.

CI 5362. Introduction to Instructional Computer Programming

CI 5656. Reading and Writing in a Second Language (Tedick)

CI 5657. Speaking and Listening in a Second Language (Jorstad)

CI 5658. Second Language Testing, Assessment, and Evaluation (Jorstad, Tedick)

CI 5662. Critical Issues in Second Language Curriculum (Lange, Tedick)

EPsy 5150. Social Psychology of Education (Johnson)

ESL 5723. English as a Second Language: Materials

(Tarone)

ESL 8751. English for Special Purposes (Tarone)

LgTT 5101. Technology in the Language Classroom

(Stenson)

Ling 5201. Introduction to Syntax (Downing, Gundel,

Hutchinson, Kac)

Ling 5302. Introduction to Phonology (Stemberger)

Ling 5702. Second-Language Acquisition (Cohen,

Sheldon, Tarone)

Ling 5821. Sociolinguistics (Downing, Klee)

Ling 8731. Research Methods in Language Acquisition

(Cohen, Tarone)

Psy 5054. Psychology of Language (Fletcher)

Spch 5411. Small Group Communication Theory

(Hewes, Poole)

Spch 5451. Intercultural Communication

Entomology (Ent)

Professor: Mark E. Ascerno, *head*; Ann M. Fallon; Richard L. Jones; William E. Miller; Roger D. Moon; Edward B. Radcliffe; David W. Ragsdale; David D. Walgenbach

Associate Professor: Ralph W. Holzenthal, *director of graduate studies*; David A. Andow; Timothy J. Kurti; Karen A. Mesce; Kenneth R. Ostlie;

Assistant Professor: William D. Hutchison; Steven A. Katovich; Vera Aber Krischik; Marla Spivak

Research Associate: Robert L. Meagher; Susan J. Weller

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—This program is administered within the Department of Entomology. Fundamental research areas such as ecology, molecular genetics, microbiology, physiology, and systematics are available, as well as specialized or applied areas such as apiculture, behavioral chemicals, biological control, economic entomology, host-plant resistance, integrated pest management, and insects related to forests, livestock and humans, plant diseases, stored products, and urban areas.

Prerequisites for Admission—A bachelor's degree with a major in a biological science is a prerequisite. Preference is given to students with a broad background in the basic sciences.

Special Application Requirements—Three letters of recommendation are required from persons well acquainted with the student's academic record. Graduate Record Examination scores are recommended, but not required. Students are admitted each quarter.

Degree Requirements—Requirements for the master's and doctoral degrees beyond the Graduate School's requirements include a core curriculum of fundamental entomology courses and two credits of Graduate Seminar. Additional requirements are flexible and are determined by the student in consultation with the adviser and other members of the student's advisory committee. Master's Plan A is recommended for all master's students contemplating a career in entomological research. Written and oral preliminary examinations and final oral examinations are required for all degrees.

Language Requirements—None.

Minor Requirements for Students Majoring in Other Fields—Requirements are flexible and are determined by the student in consultation with the director of graduate studies in entomology.

For Further Information and Applications—Contact the Department of Entomology, University of Minnesota, 219 Hodson Hall, 1980 Folwell Avenue, St. Paul, MN 55108 (612/624-3636; fax 612/625-5299).

Ent 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Ent 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Ent 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5010f. INSECT MORPHOLOGY. (5 cr; prereq 3005 or #; offered alt yrs) Holzenthal
Comparative study of insect structure within evolutionary and phylogenetic perspective.

5020f. INSECT TAXONOMY. (5 cr; prereq 3005 or equiv) Holzenthal
Identification of families of adult insects; evolution and classification of insects; techniques of collecting and curating insects; principles of phylogeny reconstruction.

5030w. INSECT PHYSIOLOGY. (3 cr; prereq #: BioC 5001, 5002 or MdBc 5100 recommended) Kurtti, Mesce
Essential processes of insects. Includes nerve and muscle mechanisms, energy metabolism, respiration, nutrition and digestion, excretion, regulation and interactions of processes, sensory mechanisms and behavior; reproductive behavior, embryology, and postembryonic development of insects.

5040f. INSECT ECOLOGY. (4 cr; prereq Biol 5041 or EBB 5122 or #) Andow
Synthetic analysis of causes of insect diversity and of fluctuations in insect abundance. Focus on abiotic, biotic, and evolutionary mechanisms influencing insect populations and communities.

5210w. INSECT PEST MANAGEMENT. (4 cr; prereq 1005 or #)
Management of insect, mite, and weed populations by integration of various methods and techniques (including biotic agents, host plant resistance, artificial measures, and cultural practices) as harmonious systems that, in context of associated environment and population dynamics, maintain subeconomic pest densities.

5215s. INSECTS IN RELATION TO PLANT DISEASES. (3 cr; prereq 1 entomology course, 1 plant pathology course or #; offered alt yrs) Ragsdale
Insect transmission and dissemination of plant pathogens; development of plant-insect relationships; habits of principal insect vectors.

5250s. FOREST AND SHADE TREE ENTOMOLOGY. (4 cr; prereq any 2 courses among the forestry, zoological, botanical, biological and/or agricultural sciences)
Lectures and lab concerning ecology and population management of forest and shade tree insects, with emphasis on tree factors and integrated control.

5275f. MEDICAL ENTOMOLOGY. (3 cr; prereq 3005 recommended; offered alt yrs) Fallon, Kurtti, Moon
Biology of arthropod vectors of human disease. Disease transmission and host, vector, and pathogen interactions.

5280w. LIVESTOCK ENTOMOLOGY. (4 cr) Moon
Biology and management of insects, mites, and ticks that affect domestic livestock and pets.

5310w. SAMPLING BIOLOGICAL POPULATIONS. (4 cr; prereq Stat 5021 or equiv; offered alt yrs) Moon
Design of sampling plans for study of field and lab populations of living organisms. Sampling distributions and techniques for detecting and coping with aggregation. Randomization, required sample size, and optimal resource allocation within alternative sampling designs.

5320f. ECOLOGY OF AGRICULTURE. (4 cr; prereq 1 course in biol or environmental studies at 3xxx or equiv or #) Andow
Ecological perspective on post-industrial agriculture; origins of agriculture, social functions, and ecology of contemporary and extinct agricultural systems. Soils, plant development, pest ecology, forage quality, animal production, and food quality as an interactive network.

Graduate Programs

5350f. INSECT PATHOLOGY. (3 cr; prereq 5030; offered alt yrs) Kurtti

Survey of major pathogenic microorganisms that cause diseases in insects; routes of infection of insects; lab propagation of disease agents; factors in application of disease to control of pest insects with safety considerations.

5360. AQUATIC ENTOMOLOGY. (3 cr; prereq 3005 or equiv or #; offered alt yrs and Itasca summer session I) Holzenthal

Taxonomy and natural history of aquatic insects, including their importance in aquatic ecology, resource management, recreation, and conservation. Family-level identification. Field trips to local aquatic habitats. Collection required.

5370s. PRINCIPLES OF SYSTEMATICS. (3 cr; prereq 3005 or equiv, 5020; offered alt yrs) Holzenthal

Theoretical and practical procedures of systematic entomology, including phylogeny reconstruction, classification, systematic literature, zoological nomenclature, and presentation of systematic research results.

5480w. INVERTEBRATE NEUROBIOLOGY. (2 cr) Mesce

Principles and concepts underlying cellular bases of behavior and "systems" neuroscience. Particular invertebrate preparations discussed.

5900f,s. BASIC ENTOMOLOGY. (Cr ar; prereq #) Staff

Opportunity to make up certain deficiencies in biological background.

5910f,w,s. SPECIAL PROBLEMS IN ENTOMOLOGY. (Cr ar; prereq #)

Individual field, lab, or library studies in various aspects of entomology.

5920. SPECIAL LECTURES IN ENTOMOLOGY. (Cr ar)

Lectures and/or labs in special fields of entomological research given by a visiting scholar or regular staff member.

8040f. ADVANCED INSECT GENETICS. (3 cr; prereq basic course in genetics, 5030 or #; offered alt yrs) Fallon

Survey of molecular genetic techniques and their applications, with emphasis on insect species other than *Drosophila*. Application of genetic techniques to physiological processes.

8050f. TOXICOLOGY. (3 cr; prereq 15 cr incl 1005 or equiv or #, inorganic and organic chemistry; offered alt yrs) Fallon
Chemistry, physiological action, toxicology of insecticides.

8200. COLLOQUIUM IN APICULTURE. (1-3 cr; prereq 3005, 5200 or #) Spivak

Lectures by instructor; lectures, research reports, and critiques by students on pheromones, pollination, nutrition, diseases, communication, foraging behavior, honey, caste determination.

8240f,w,s. COLLOQUIUM IN INSECT ECOLOGY.

(1-2 cr; prereq 5040 or #) Andow
Advanced topics.

8300f,w,s. GRADUATE SEMINAR. (1 cr; prereq #) Ragsdale

Oral and written reports on and discussion by students of selected topics from current literature in entomology.

8500f,w,s. RESEARCH IN ENTOMOLOGY. (Cr ar; prereq #) Staff

Environmental Health (PubH)

Professor: Jack S. Mandel, *director of graduate studies;* Donald E. Barber; Sagar M. Goyal; Jordan L. Holtzman; Irving J. Pflug; Sheldon B. Sparber; Donald Vesley; James H. Vincent

Adjunct Professor: Paul W. Willard

Associate Professor: Ian A. Greaves, *head;* Susan G. Gerberich; Robert W. Gibson; Maria K. Hordinsky; Rita B. Messing; Rexford D. Singer; Deborah L. Swackhamer

Clinical Associate Professor: Alan P. Bender

Assistant Professor: Patricia M. McGovern; Fay M. Thompson; Elizabeth V. Wattenberg

Adjunct Assistant Professor: Thomas C. Jetzer; Jeffrey H. Mandel; Marian C. Marbury; Charles E. McJilton

Instructor: Debra K. Olson

Research Associate: Timothy R. Church

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Emphases include environmental epidemiology, environmental health chemistry, environmental toxicology, general environmental health, industrial hygiene, injury prevention and control, institutional environmental health, occupational epidemiology, occupational health nursing, occupational injury prevention and safety, and occupational medicine.

Prerequisites for Admission—A bachelor's degree, including coursework in biological, chemical, or physical sciences or engineering, is required. Prerequisites depend on requirements of specialty area within the degree program.

Special Application Requirements—

Graduate Record Examination scores, a letter describing the applicant's professional objectives, and three letters of recommendation are required.

Master's Degree Requirements—The program requires a minimum of 11 months of study. Most specialty tracks require two years to complete. Students are required to complete PubH 5156, 5158, 5159, 5250, and 5261 or 5267. Other core courses from the area of emphasis in the major are also required and are expected to include courses in biostatistics and epidemiology. An oral final examination is required.

Doctoral Degree Requirements—

Candidacy for the Ph.D. program requires completion of the master's degree (or the equivalent) in environmental health.

Language Requirements—For the master's degree, none. For the doctoral degree, reading ability in a foreign language or additional coursework is required at the discretion of the adviser.

For Further Information and

Applications—Contact the Student Services Center, School of Public Health, University of Minnesota, Box 819 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (612/626-3500 or 1/800/774-8636; fax 612/626-6931; e-mail sph-uofm@greg2.sph.umn.edu).

PubH 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

PubH 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

PubH 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

*Note—*Courses in environmental health are listed and described under Public Health later in this bulletin. See PubH 5150 to 5281 and 8150 to 8269.

Epidemiology (PubH)

Professor: Russell V. Luepker, *head*; John D. Potter, *director of graduate studies*; Henry Blackburn; Stanley L. Diesch; Aaron R. Folsom; Laël Gatewood; David R. Jacobs, Jr.; Robert W. Jeffery; Robert L. Kane; Harry A. Lando; Arthur S. Leon; Jack Mandel; David M. Murray; Cheryl L. Perry; Phyllis L. Pirie; R. Ashley Robinson; David G. Thawley

Associate Professor: Richard S. Crow; Patricia J. Elmer; John R. Finnegan, Jr.; Jean L. Forster; Robert W. Gibson; Richard H. Grimm; Lawrence H. Kushi; Alan R. Lifson; Paul G. McGovern; Joseph P. Neglia; Frank S. Rhame; Stephen S. Rich; Leslie L. Robison; Thomas A. Sellers; Alexander C. Wagenaar; Carolyn L. Williams

Adjunct Associate Professor: Alan P. Bender; Michael T. Osterholm

Assistant Professor: Kristin E. Anderson; Robert M. Bostick; John M. Flack; Myron D. Gross; Rhonda J. Jones-Webb; Leslie L. Lytle; George Maldonado; Eyal Shahar; Mark Wolfson; Wei Zheng

Adjunct Assistant Professor: Richard N. Danila

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—The division offers basic and advanced instruction for students planning teaching, research, or administrative careers in epidemiology. Courses are also available to students from other public health and health-related programs.

Students may select areas of concentration appropriate to their academic interests and career objectives, including the epidemiology of cancer, epidemiology of infectious diseases, epidemiology of cardiovascular diseases, nutritional epidemiology, and behavioral epidemiology. In addition to the required public health courses, students may select courses from a wide range of areas such as anthropology, biochemistry, computer science (public health), genetics, microbiology, pathology, physiology, and sociology. A detailed description of the course of study and a more comprehensive list of elective courses may be obtained by writing to the director of graduate studies.

Graduate Programs

Prerequisites for Admission—For the master's program, a strong undergraduate background in biological and physical sciences and high scholastic achievement are desirable.

For the doctoral program, applicants must have received a master's degree. Applicants who have not yet completed a master's degree in epidemiology are usually admitted, initially, to the master's program in epidemiology, where they must demonstrate their research capability. Because positions in the program are relatively limited, selection of students is competitive with respect to academic background and experience presented.

Special Application Requirements—The following materials are required by the department: an acceptable score on the Graduate Record Examination (test results should be forwarded to the department); a minimum of three letters of recommendation from faculty or work supervisors with knowledge of the applicant's scholastic and professional capabilities and potential; and a two-page statement of goals and objectives for seeking a career in epidemiology.

In addition to the above materials, applicants for the Ph.D. program must submit evidence of their capability in or potential for original research.

M.S. and Ph.D. students should begin their studies in the fall quarter. Applications must be completed by February 28 of the same year.

Master's Degree Requirements—The M.S. degree program is designed to prepare students for careers in teaching, research and program development, administration and evaluation in health agencies, medical institutions, regulatory agencies, and industry. The two-year program includes advanced coursework in the basic medical sciences. Students who have a graduate degree in a health-related field or a professional degree such as an M.D., D.D.S., or D.V.M. may complete the program in one year. Students usually complete the curriculum under Plan B. A complete list of

degree program requirements may be obtained from the director of graduate studies. Students take an oral final examination.

Doctoral Degree Requirements—The doctoral program is designed to help students develop proficiency in epidemiologic investigations as a preparation for careers in service, research, or teaching in health agencies and institutions. The program includes advanced coursework, with electives chosen according to the individual's background, interests, and needs. Students participate in ongoing field research designed to provide increasingly complex experiences commensurate with their development. The thesis should be based on an original field investigation of acceptable complexity and sophistication.

Language Requirements—None.

Minor Requirements for Students Majoring in Other Fields

For the master's degree, a minimum of 9 credits selected by the minor adviser on the basis of the student's major field of study is required. For the doctoral degree, a minimum of 20 credits selected by the minor adviser on the basis of the student's major field of study is required.

For Further Information and

Applications—Contact the Student Services Center, School of Public Health, University of Minnesota, Box 819 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (612/626-3500 or 1/800/774-8636; fax 612/626-6931; e-mail sph-uofm@greg2.sph.umn.edu).

PubH 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

PubH 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

PubH 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Note—Courses in epidemiology are listed and described in the Public Health section of this bulletin. See PubH 5330 to 5399 and 8330 to 8389.

Experimental Surgery

See Surgery.

Family Education

See Vocational and Technical Education.

Family Practice and Community Health (FPCH)

Professor: Edward W. Ciriacy, *head*; John T. Kelly, *director of graduate studies*; Carole J. Bland; Roger S. Mazze; Vernon E. Weckwerth

Associate Professor: Donald S. Asp; Edmond J. Coleman; Dwenda K. Gjerdingen; Harold R. Ireton; Joseph M. Keenan; Richard L. Reed; Sharon B. Satterfield

Assistant Professor: Donald R. Houge; Michael H. Miner; Leon J. Nesvacil; James J. Pattee; Sonia E. Patten; Beatrice E. Robinson; B. R. Simon Rosser; Harold C. Seim

Instructor: S. Margretta Dwyer

Lecturer: Faruk Abuzzahab

Other: Walter O. Bocking; Michael E. Metz

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.S. (Plan B only).

Curriculum—Studies focus on the discipline of family medicine and on academic skills.

Prerequisites for Admission—Applicants must have completed an M.D. or D.O. degree.

Special Application Requirements—Applicants must meet with a department adviser to obtain a letter of endorsement, which must be submitted with the formal application. Students are admitted each quarter.

Master's Degree Requirements—A minimum of 20 credits from the major field is required. Nonclinical courses must make up a minimum of 50% of the credits in the major. If the total number of credits presented in the major is 30 or fewer, however, a minimum of 16 credits must be in nonclinical courses. For the minor, at least 9 credits are required. Courses may be taken

from more than one department if they are relevant to the major and form a coherent sequence related to the minor. All courses included in the minor must be nonclinical, and must be taken on the A-F grading system. In lieu of choosing a minor, students may elect to present at least 8 credits in a number of related nonclinical fields outside the major. A final oral examination is required.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Family Practice and Community Health, 6-240 Phillips-Wangensteen Building (Box 381 Mayo), University of Minnesota, 516 Delaware Street S.E., Minneapolis, MN 55455 (612/624-2622).

Note—The courses listed below are described in the broadest outline to convey the character of the work. Coursework in fields related to family practice and community health is also available in other departments of the University.

5251. CROSS-CULTURAL MEDICINE AND INTERNATIONAL HEALTH. (Cr ar; prereq family practice residency or #) Patten, staff
Concepts of illness and healing within different cultural contexts; efficacy of systems of healing other than biomedicine; interaction of cultural and biological factors in disease and illness; population-based health, illness, disease.

5345-5346. ANALYSIS OF INSTRUCTION AND EDUCATIONAL EVALUATION. (3 cr per qtr; prereq #)
5345: Curriculum design: from identifying course goals to building course goals to building course, teacher, or learner evaluations. 5346: Acquiring effective teaching strategies, including lecture, demonstration, small-group discussion, clinical teaching, and computer-assisted instruction.

5504. MEDICAL ETHICS. (2 cr) Daly
Reading and discussion of major ethical issues relevant to the practice of medicine. Critical review of case studies to gain experience in solving medical ethics problems.

5555. SEXUAL COUNSELING FOR FAMILY PHYSICIANS. (2 cr; prereq medical school completion)
Coleman, staff
Assessment of and therapy for sexual dysfunction problems that arise in clinical practice of primary care physicians.

Graduate Programs

5563. CLINICAL NEUROPSYCHO-PHARMACOLOGY. (2 cr; prereq FPCH residency)

Abuzzahab
Identification, diagnosis, treatment, and follow-up of major psychiatric disorders. Emphasis on the neuro-psycho-pharmacological approach, identification of psychoactive drugs, contraindications, side effects, and long-term management of patients.

5564. FAMILY PRACTICE SEMINAR. (1-3 cr) Staff
Knowledge, skills, and attitudes in biomedical and behavioral sciences that form foundation for academic discipline of family medicine; medical decision making, common problems and procedures, family theory and assessment, clinical pharmacy, and human sexuality.

5570. PRACTICUM IN COUNSELING. (1 cr; prereq completion of 1st-yr residency) Kelly
Basic techniques of short-term counseling. Lectures, classroom exercises, and actual counseling contact.

5582. PRACTICE MANAGEMENT WORKSHOP.

(2 cr; prereq completion of 1st-yr residency or #) Ciriacy, staff
Practical counsel and information on day-to-day management of medical clinics including economic and legal aspects; community and hospital relations; human relations; types of practice opportunities. Two-day workshop with department faculty and community specialists on concepts relevant to effective management of a family practice clinic.

5583. PERSONAL AND FINANCIAL PLANNING.

(2 cr) Seim
Personal and financial planning. Includes an overview of life insurance, equity investments, and real estate. Pros and cons of these methods of personal investments, sources of information about them, and their history.

5596. INTRODUCTION TO INTERCULTURAL/INTERNATIONAL MEDICINE. (4.5 cr; prereq 3rd- or 4th-yr med student or FPCH resident; apply at least 3 months ahead) Staff

Didactic and field experience program during four-week period. Combines clinical activity and involvement in ongoing field-based research. Conducted in conjunction with Indian Health Services.

5598. INTRODUCTION TO PHYSICIAN'S ROLE IN NURSING HOMES. (2 cr) Ciriacy, staff

Roles of nursing home staff. Helps medical fellows become comfortable in nursing homes.

5651. INTERDISCIPLINARY HEALTH CARE OF ELDERLY PEOPLE. (1 cr; prereq candidate for or recipient of grad degree in health science) Boulton

Assessment and treatment of common conditions that affect elderly people. Presented by faculties of different health science disciplines.

5843. DISEASE PREVENTION AND HEALTH PROMOTION: AN APPRAISAL OF GOALS AND TECHNIQUES IN FAMILY PRACTICE. (2 cr; prereq MD) Staff

Role of family physician in development, operation, and research of office-based prevention/promotion activities. Presentation and discussions with leaders in this field.

5903. COMMUNITY HEALTH. (Cr ar; prereq #)

Lindblom, Staff
Practical experience in delivery of health care in urban or rural communities.

5904. COMMUNITY HEALTH. (2 cr; prereq 2nd- or 3rd-yr residency or #)

Introduction to concepts of community health. In-depth look at community health activities in Minnesota. Tools and techniques for the study of contemporary health problems in the state. Strategies to meet community health needs.

5950. CLINICAL ISSUES IN HUMAN SEXUALITY.

(3 cr; prereq enrollment in health sciences grad programs in CSPP, Psych, PubH, SW or FSoS or #) Coleman
Clinical issues, assessment techniques, and treatment techniques pertaining to common sexual problems.

5952-5953-5954. PRACTICUM IN SEXUAL COUNSELING. (3-6 cr per qtr; prereq #; offered when feasible) Coleman

5955. DIRECTED STUDY. (1-15 cr; prereq #, qualified students may register with # for work on a tutorial basis) Kelly

5956. HUMAN SEXUALITY THROUGHOUT THE LIFE CYCLE FOR THE PRIMARY CARE PHYSICIAN. (3 cr; prereq # and college-level intro course in human sexuality; offered alt years) Metz

Developmental aspects of sexuality throughout the life cycle examined from such theories as psychodynamics and social role theory, with emphasis on significance of psychosocial aspects of sexuality for the primary care physician.

5957. FEMALE SEXUALITY. (3 cr; offered alt yrs) Satterfield

Lectures and discussions on basic aspects of the female experience of sexuality.

5958. SMALL GROUP PROCESS. (3 cr; prereq #)

Coleman
Group dynamics; various schools of group process and therapy active today. Experiential and cognitive methods used.

5960. BASIC RESEARCH METHODS SEMINAR AND PRACTICUM. (4 cr) Kelly

Basic inquiry skills. Topics suitable for the advancement of family practice research.

5962. CLINICAL HYPNOSIS WORKSHOP. (1-2 cr per workshop; prereq #) Houge

New departures and/or new applications from the behavioral science area of clinical practice. Lectures, workshops, and conferences.

5967. INTRODUCTION TO HEALTH DATA SYSTEMS. (Cr ar; prereq completion of 1st-yr residency or #)

Machine-readable databases and decision support systems relevant to community health.

5972, 5973, 5974. RESEARCH METHODS IN FAMILY MEDICINE I, II, III. (2 cr per qtr; prereq FPCH grad student or #) Staff
 Research design and methodology, biostatistics, epidemiology, and demography. Steps necessary to formulate a question, determine its significance, develop an appropriate methodology, implement and complete a study, analyze data, and report findings in peer-reviewed literature.

8201. CLINICAL FAMILY MEDICINE. (Cr ar) Ciriacy, staff
 Supervised care for patients of all ages on a continuous, primary, preventive, and general diagnostic basis. Diagnosis, methods of treatment, and problem-solving devices for the benefit of the patient and family are emphasized with particular emphasis on health hazard appraisal. New and refined methods of recording, documentation, and retrieval of clinical data.

8202. FAMILIES IN LOSS, GRIEF: RECOVERY RESOURCES. (2 cr; prereq #) Seim

8204. SEMINAR: QUANTITATIVE STRATEGIES IN HEALTH CARE PRACTICE AND RESEARCH. (2 cr; prereq #) Weckwerth
 Review of elementary statistical methods for both description and inference. Use of workbooks to identify and sharpen skills. Application of elementary decision making with emphasis on sensitivity/specificity and decision errors. Elementary literature critiques. Students make presentation and write paper, based on one or more journal articles, explaining an application to patient care of a strategy.

8205. MEDICAL RECORDS SYSTEMS. (2 cr) Ciriacy
 Introduction to the problem-oriented medical record. Emphasis on forms analysis, tabulation systems, and the use of a structured medical record in health services research.

8206. SEMINAR: PSYCHOLOGY IN MEDICINE. (2 cr; offered when feasible) Ireton

8207. SEMINAR: COMMON DISEASES SEEN IN FAMILY PRACTICE. (1 cr) Ciriacy, staff

8208. FAMILY MEDICINE CONFERENCES. (1 cr) Ciriacy, staff
 Problem cases from the Family Practice Service. Diagnosis, treatment, and consideration of relevant current literature.

8209. FAMILY MEDICINE X-RAY CONFERENCE. (1 cr) Ciriacy, staff

8210. FAMILY MEDICINE GRAND ROUNDS. (1 cr) Asp, staff
 Monthly conference with each institution presenting topics.

8211. PRACTICE MANAGEMENT. (2 cr) Lindblom
 Establishment of practice, allocation of income, and professional relations.

8212. CLINICAL PSYCHIATRY ROUNDS. (1 cr; prereq 1st-yr FPCH resident) Kelly
 Medical fellows meet with a teaching psychiatrist to review cases, preferably from among patients. Topics of high clinical relevance presented and discussed.

8215. SEMINAR: PSYCHOSOMATIC MEDICINE. (2 cr; prereq completion of 1st-yr residency or #) Kelly
 Concept of multicausality of disease including biologic, psychologic, and social factors that may predispose, precipitate, or aggravate disease. Theoretical models of psychosomatic disease and concept of "symptom choice" by patients. Methods of recognition, quantification, and treatment including pharmacal therapy and psychotherapy.

8216. PEDIATRIC PSYCHOLOGY. (2 cr; prereq completion of 1st-yr residency or #; offered when feasible) Ireton

8217. SEMINAR IN COUNSELING. (2 cr; prereq 5567, 8215 or #) Kelly
 Skills and strategies for performing short-term supportive counseling in family practice setting. Patient selection. Skills applicable to beginning, middle, and end of counseling. Strategies for working with patients presenting different types of problems seen by the family physician.

8223. INTRODUCTION TO GERONTOLOGY AND GERIATRIC MEDICINE. (2 cr; prereq completion of 1st-yr residency or #) Reed
 Introduction to human aging: social, biological, and psychological aspects. Programs and policies dealing with aging. Developmental and holistic approaches to the aging process and health care.

8224. COMMUNITY MENTAL HEALTH SEMINAR. (1 cr; required for 3rd-yr residents; prereq completion of 2nd-yr residency) Kelly
 Background material in a given area of community mental health followed by a community experience in that particular area and sharing of experiences with other residents at the training center. Split-time experience for the resident during which experience in medical sociology is made available.

8225. MEDICAL SOCIOLOGY. (3 cr; offered when feasible) Staff

8226. MEDICAL SOCIOLOGY SEMINAR. (2 cr; prereq physician or sociology grad student; offered when feasible) Staff

8228. SEMINAR: INTERDISCIPLINARY HEALTH. (2 cr; prereq #) Kelly

8240. COMMUNITY RESOURCES. (2 cr) Kelly
 Discussions with representatives of selected community agencies.

8242. ECONOMICS OF HEALTH CARE DELIVERY SYSTEMS. (3 cr; offered when feasible) Staff

8243. FAMILY MEDICINE IN THE RURAL AREA. (Cr ar; prereq #) Lindblom
 Problems specific to rural areas such as physician distribution, use of allied health personnel, initial emergency treatment, referral patterns.

Graduate Programs

8250. QUANTITATIVE STRATEGIES IN HEALTH CARE PRACTICE AND RESEARCH II. (2 cr [1 addtl cr available]; prereq 8204) Weckwerth

Presumptive review of elementary descriptive and inferential quantitative methods; models for decision making; evaluation; logic tree; critique of literature. Major output: designing in-practice study of test, treatment, service, or method of choice to show outcome effect on patients.

8582. PRACTICE MANAGEMENT II. (2 cr; prereq 3rd-yr residency, 5581; offered when feasible) Lindblom

8253. RESEARCH PROBLEMS. (Cr ar; prereq #)

Kelly

Under supervision of faculty member.

Family Social Science (FSoS)

Professor: Harold D. Grotevant, *head*; M. Janice Hogan, *director of graduate studies*; Jean Bauer; Pauline Boss; William J. Doherty; M. Geraldine Gage (*emeritus*); Mary E. Heltsley; David H. Olson; Kathryn D. Rettig; Paul C. Rosenblatt; Shirley Zimmerman

Associate Professor: Rose M. Brewer; Sharon M. Danes; Daniel F. Detzner; James W. Maddock; Joan M. Patterson; Marlene S. Stum

Other: Philip L. Colgan; William J. Goodman

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Family social science is a multidisciplinary program that offers an integrated program of study in the areas of family relationships, family therapy, and family policy, economics, and family resource management. The program uses the knowledge of various social sciences to study the family as a system and its interaction with other social systems. The goals of graduate training include emphasizing theory, research, and application (e.g., family life education, marriage and family therapy, family policy, family decision making). Marriage and family therapy is not available at the master's level.

Prerequisites for Admission—Minimum requirements for admission to the master's and doctoral programs include two family courses; at least one course in economics, political science, government, or public

policy; one course in sociology, anthropology, or human geography; one psychology course; and one statistics course.

It is further recommended that students have one research methods course, one course in calculus, experience working with families through paid employment or volunteer work, and evidence of interest in research and in the development of research competence, particularly for students applying for the Ph.D. program.

Students may apply for admission to the Ph.D. program after completing either a bachelor's degree or a master's degree.

Special Application Requirements—Consult the *Family Social Science Graduate Handbook* or the director of graduate studies. The application deadline is December 15 for admission fall quarter of the following year.

Degree Requirements—Consult the *Family Social Science Graduate Handbook* or the director of graduate studies.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Family Social Science, University of Minnesota, 290 McNeal Hall, 1985 Buford Avenue, St. Paul, MN 55108 (612/625-3116 or 612/625-1900; fax 612/625-4227).

FSoS 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

FSoS 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

FSoS 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5001. HUMAN SEXUAL BEHAVIOR. (5 cr; prereq 90 cr, 3600 or grad in social or behavioral or educational or health science or human service program or #) Maddock Multidisciplinary approach to sexual development through individual/family life cycles, emphasizing scientific knowledge to promote sexual health through individual, family, and community services; ethics and values issues.

5025. PARENTING. (4 cr; prereq 5200 or 5202) Parenting methods and child development from infancy through adolescence. Students identify differing parenting techniques, develop their own parenting approach, and conduct parenting classes.

5200. FAMILY SYSTEMS. (5 cr; prereq intro course in psych and in soc) Doherty, Olson
Advanced survey of current developments emphasizing families as complex systems of interpersonal relationships that also interact with larger social systems.

5202. FAMILY PSYCHOLOGY: THE STUDY OF CLOSE RELATIONSHIP PROCESSES. (4 cr; prereq 3600 for FSoS majors, Psy 3204 for psych majors and others) Boss
Processes of interaction and communication within families of origin, families of choice, and other close relationships. Consideration of multidisciplinary research and theory taken from psychology, sociology, and family therapy. Marriage, divorce, friendship, partnership, and being single discussed in light of theories of attraction, love, intimacy, and sexuality. Issues of fairness, altruism, equity, power, violence, and communication as central to relationship formation and dissolution. Focuses on dynamic processes of family and couple relationships within diverse social contexts.

5205. INTRODUCTION TO FAMILY RESEARCH METHODS. (4 cr; prereq 3260, 5200) Rosenblatt
Logic and philosophy of scientific method. Family research questions and objectives, standards for evaluating family research, techniques of data gathering (qualitative and quantitative methods), analysis, reporting, and writing.

5210. THE FAMILY IN WORLD PERSPECTIVE. (4 cr; prereq 3600 or 5200, intro cultural anth course or #) Rosenblatt
Comparison of kinship, marriage, family organization, the family life cycle and modes of family functioning across cultures; relationship to economic, political, religious, and other institutions, with emphasis on adaptations of the family to urbanization and industrialization.

5217. CONSUMER ECONOMICS AND POLICY. (4 cr; prereq 3260, intro course in pol sci, econ, psych, soc)
Interaction of families and global markets in consuming resources and products to maintain lifestyles. Government policies that regulate consumer products and legal processes to repair consumer damages.

5218. FAMILY FINANCIAL MANAGEMENT. (4 cr; prereq 3260 or equiv) Hogan, Rettig
Analysis of family financial management principles. Financial planning of savings, investments; credit, mortgages; taxation; life, disability, health, property insurances; public, private pension; estate planning.

5220. FAMILY ECONOMICS. (4 cr; prereq 3260 or #) Rettig
Variations in family income, saving, spending, and decision making related to socioeconomic factors. Conceptual development and research on economic problems of families.

5230. INDEPENDENT STUDY IN FAMILY SOCIAL SCIENCE. (1-5 cr [max 16 cr])
Independent reading or research under faculty supervision.

5240. SPECIAL TOPICS IN FAMILY SOCIAL SCIENCE. (2-6 cr per qtr [max 16 cr]; prereq determined by instructor, specific for each topic)
Review of research and discussion. See the *Class Schedule* for topics.

5241. LEGAL-ECONOMIC CONTROVERSIES IN FAMILY LIFE. (4 cr; prereq 3260 or 3600 or 5200 or #) Rettig
Interdisciplinary seminar on legal-economic controversies across family life span for diverse family forms. Alternative family definitions and living arrangements; premarital and marital contracts; alternative means of parenting; income, support, and debt issues; property transfer at death and divorce; decision making for health, and long-term care.

5242. DEATH AND OTHER LOSSES. (3 cr; prereq 3600 or 5200 or #) Rosenblatt
Individual and family reactions to dying, death, and other losses or potential losses from perspective of theories of grief work, family systems, others.

5251. AGING FAMILIES. (4 cr; prereq 3600 or 5200 or SW 5024 or #) Detzner
Aging families as complex developing systems interacting with changing social structure. Marital relationships, role changes, and family care-giving issues.

5252. AGING, FAMILY, AND SOCIETY. (4 cr; prereq 3600 or 5210 or SW 5024 or #) Detzner
Elderly populations from diverse cultures examined within context of individual life history, family systems, and social structure.

5253. HUMANITIES, AGING, AND FAMILY LIVING. (4 cr; prereq 3600 or 5200 or SW 5024 or #)
Aging and family living from literature and film perspectives.

5255. APPROACHES TO FAMILY POLICY. (4 cr; prereq 3260 or 3600, SW 3202 or #) Zimmerman
Interrelationship between families and social policy in welfare, housing, health care, family law, education, and social services.

5256. FAMILY POLICY: AN INTERNATIONAL PERSPECTIVE. (4 cr; prereq 5210 or 5252 or 5255 or #) Zimmerman
Comparison of different countries' policy choices and actions in areas directly affecting families: health, education, social services, income maintenance, employment and the work force, taxation; values and traditions such policies represent.

5260. DYNAMICS OF FAMILY DECISION MAKING. (4 cr; prereq 3260 or #) Rettig
Conceptual models of decision making and resource management. Review and critique of current research and literature.

5500. RACIAL AND ETHNIC DIVERSITY IN FAMILIES. (4 cr; prereq 3600)
Overview of family issues of various American racial and ethnic populations. Study of research and case studies; individual projects to develop and enrich understanding of cultural diversity.

Graduate Programs

8200. SEMINAR: RESEARCH AND

INTERPRETATION. (3 cr; offered alt yrs) Rosenblatt
Helps students develop skills in design and interpretation of research relevant to the family; published and contrived examples; discussion of research on applied problems; practicum in generation of research designs.

8203. FAMILY STRESS, COPING, AND ADAPTATION. (4 cr; offered alt yrs) Boss

Theories related to family development, structure, and behavior in response to social and psychological stress. Normal and dysfunctional family behavior. Emphasis on research and intervention for family stress or crisis.

8205. QUALITATIVE FAMILY RESEARCH. (3 cr; prereq 8255) Rosenblatt

Intensive examination of role of qualitative methods in social sciences. Data collection techniques; participant observation; informant interviewing; document analysis; sampling; field relations and rapport; ethical issues; reliability and validity of qualitative data; role of theory in field studies. Students conduct qualitative study.

8214. THEORIES OF MARITAL AND FAMILY THERAPY. (4 cr; prereq 8255) Boss, Doherty

Comprehensive review and critique of major theories of marital and family therapy with emphasis on clinical integration of these models.

8215. CLINICAL ISSUES IN MARITAL AND FAMILY THERAPY. (4 cr; prereq 8214) Doherty

Issues such as divorce, sexual dysfunction, enrichment, and chemical dependence, using research and theory to determine clinical strategies.

8216. MARITAL AND FAMILY ASSESSMENT. (4 cr; offered alt yrs) Olson

Overview and experience administering and interpreting a variety of marital and family assessment tools.

8217. CLINICAL INTERVENTIONS FOR SEXUAL PROBLEMS. (3 cr; prereq human service or health science grad student, 5001 or #; offered alt yrs) Maddock

Rationales for sexual health care in clinical settings and methods of intervention into sex-related problems of various populations, with focus on assessment, behavioral change techniques, and specialized therapy approaches.

8221. INTERNSHIP IN TEACHING COLLEGE-LEVEL FAMILY COURSES I. (4 cr; prereq 12 cr FSoS; offered alt yrs) Detzner, Maddock, Rettig

Theoretical course on learning styles, teaching techniques, curriculum development, and family life education. Students develop philosophy of teaching/learning inclusive of race, class, and gender differences. Practical teaching issues analyzed: course content, objectives, syllabi development, formal/informal teaching techniques, and student evaluation.

8222. INTERNSHIP IN TEACHING COLLEGE-LEVEL FAMILY COURSES II. (2 cr; prereq 12 cr FSoS) Detzner, Maddock, Rettig

Practice-teaching course. Students assist in planning 3xxx course, participate in its teaching, and construct method for evaluation of student performance.

8223. INTERNSHIP IN TEACHING COLLEGE-LEVEL FAMILY COURSES III. (2 cr; prereq 12 cr FSoS) Detzner, Maddock, Rettig

Students plan, teach, and evaluate student performance in 1xxx course under supervision and mentoring of faculty. Videotaped self-assessment of teaching.

8230. DIRECTED STUDY IN FAMILY SOCIAL SCIENCE. (1-7 cr; prereq #)

8231. SEMINAR IN GENDER ROLES. (3 cr; offered when feasible) Hogan

8242. VALUE THEORIES AND RESEARCH IN FAMILY SOCIAL SCIENCE. (4 cr; prereq 5200, 5260 or equiv or #; offered alt yrs) Rettig

Review and critique of theories and research on values and valuing processes in families.

8251. PROBLEMS: FAMILY SOCIAL SCIENCE. (1-5 cr; prereq #)

8255. CONCEPTUAL FRAMEWORKS IN THE FAMILY. (4 cr; prereq 5200 or equiv, #) Boss, Doherty

Required of all first-year graduate students in family social science. Overview and theoretical orientation to family field.

8256. GENERAL SYSTEMS THEORY AND FAMILY SYSTEMS. (4 cr; prereq 8255, FSoS grad student or #; offered alt yrs) Maddock

Theoretical concepts and principles of systems/ecosystems and their application to family theory, research, and practice.

8257. FAMILY THEORY DEVELOPMENT. (3 cr; prereq 8255; offered alt yrs) Olson

Meta-analysis, inductive and deductive approaches, and qualitative and quantitative approaches to developing family theory.

8258. RESEARCH AND THEORY IN FAMILY ECONOMICS/MANAGEMENT. (4 cr; prereq 5220, 5260 or #; offered alt yrs) Rettig

Review and critique of theories and research in family resource management with emphasis on human resources.

8260. FAMILY DECISION MAKING. (4 cr; prereq 5260 or #; offered when feasible) Hogan, Rettig

8261, 8262. PROCESS SEMINAR FOR FAMILY: I, II. (2 cr per qtr; prereq #)

Required of all first-year family social science students (orientation to graduate program); not open to other students.

8266. FAMILY RESEARCH METHODOLOGY I. (4 cr; prereq 8255; offered alt yrs) Olson

Various research approaches, research design, and instrument development used to study the family. Students design and conduct pilot research projects. (First of two courses.)

8267. FAMILY RESEARCH METHODOLOGY II. (4 cr; prereq 8266; offered alt yrs) Olson

Data reduction and analysis. Students complete and present pilot research projects.

8270. PRACTICUM IN FAMILY RESEARCH.

(1-5 cr; prereq #)

Supervised family research.

8317-8318. FAMILY OF ORIGIN: I, II. (2 cr per qtr; prereq family therapy intern) AAMFT-approved clinical faculty

In-depth study of each intern's family of origin in process setting of fellow interns and clinical family therapy supervisor.

8319. ETHICAL AND LEGAL ISSUES IN MARITAL AND FAMILY THERAPY. (4 cr; prereq 8214, 8215 or #; offered alt yrs) Boss, Doherty, Maddock

Major issues—ranging from general social issues (e.g., feminism), to legal concerns (e.g., reporting laws), to specific client situations (e.g., sexual exploitation by therapists)—explored from a systemic perspective.

8500, 8501, 8502. FAMILY THERAPY**PRACTICUM: I, II, III.** (4 cr per qtr; prereq 8255, official acceptance into AAMFT-accredited training program, #) Boss, Doherty, Goodman, Maddock, Olson
Clinical experiences in preparation for internship; focus on integrating theory with skills in presence of families.**8551-8552-8553†. INTERNSHIP IN MARITAL AND FAMILY THERAPY: I-II-III.** (7 cr per qtr; prereq 8214, 8215, #) Boss, Doherty, Goodman, Maddock
Participation in actual marital and family therapy clinical practice in approved community setting with on-site supervision (one to one) plus on-campus supervision (group setting with fellow interns).**Feminist Studies***Professor:* Terence Ball (political science); Karlyn K. Campbell (speech-communication); Sara Evans (history); Patricia Faunce (women's studies; psychology); Mary L. Fellows (law); Shirley Garner (English); Barbara A. Hanawalt (history); Sunny Hansen (educational psychology); Ruth-Ellen Joeres (German); Indira Y. Junghare (South and Southwest Asian Studies); Barbara Knudson (international studies); Sally G. Kohlstedt (history of science and technology); Barbara Laslett (sociology); Elaine Tyler May (American studies); M. J. Maynes (history); Toni McNaron (English; women's studies); Jeylan Mortimer (sociology); Barbara Nelson (Humphrey Institute); Susan J. Noakes (French and Italian); Anne C. Petersen (child development); Jean Quam (social work); Martin Roth (English); Naomi Scheman (philosophy; women's studies); Madelon Sprengnether (English); Billie J. Wahlstrom (rhetoric)*Associate Professor:* Angelita D. Reyes (women's studies, *director of graduate studies*); Lisa Albrecht (General College); Ronald Aminzade (sociology); Maria Minich Brewer (French and Italian); Rose M. Brewer (women's studies; Afro-American and African studies); Lillian S. Bridwell-Bowles (English); Maria Damon (English); Mary Dietz (political science); Lois Erickson (educational psychology); Susan Geiger (women's studies); Helen E. Hoy (English); Linda Jones (social work); Amy Katz Kaminsky (women's studies); Mary Jo

Kane (kinesiology and leisure studies); Helen Q. Kivnick (social work); Mary M. Lay (rhetoric); Dorothy Loeffler (University Counseling Services); Helen E. Longino (women's studies); Richard W. McCormick (German); Ellen R. Messer-Davidow (English); Carol A. Miller (American studies); Valerie J. Miner (English); Joanna O'Connell (Spanish and Portuguese); Gianna Pomata (history); Riv-Ellen Prell (American studies); Paula Rabinowitz (American Studies); Gloria Goodwin Raheja (anthropology); Julia Robinson (architecture); Hanna Schissler (German; history); Amy Sheldon (linguistics); Eileen B. Sivert (French and Italian); Janet Spector (anthropology); Constance Sullivan (Spanish and Portuguese); Caroline Turner (educational policy and administration); Ann B. Waltner (history); Gayle Graham Yates (American studies); Jacquelyn Zita (women's studies)

Assistant Professor: Lisa J. Disch (political science); Lisette E. Josephides (anthropology); Lisa A. Norling (history); Jean M. O'Brien-Keohoe (history); Jennifer L. Pierce (sociology); Asha Varadharajan (English)*Research Fellow:* Cynthia L. Myntti (public affairs)*Lecturer:* Doris G. Marquit (women's studies)**Course of Study**—Minor in feminist studies, applicable to master's (M.A. and M.S.) and doctoral programs.**Curriculum**—A structured interdisciplinary graduate minor in feminist studies is offered in conjunction with the Center for Advanced Feminist Studies (CAFS). The program focuses on the acquisition of skills and competencies in four general areas: interdisciplinary knowledge of women and gender; feminist theories and methods; competency in feminist research in a specific field; feminist practice through teaching or internships.**Prerequisites for Admission**—Admission to the CAFS graduate minor is contingent upon prior admission to a master's or doctoral degree-granting program within the Graduate School.**Special Application Requirements**—Completion of application form, due February 1 for consideration for acceptance into the minor program in the following academic year. Applications received after February 1 are considered as space allows. It is anticipated that no more than fifteen students will be admitted into this minor each year. CAFS does not require an undergraduate major or minor in Women's

Graduate Programs

Studies as a prerequisite for admission to the minor program. However, applicants are expected to show general knowledge of feminist scholarship as evidenced, for example, in some combination of previous coursework, research, writing, or organizational experience.

Minor Requirements—A sequence of two core seminars in feminist theory and methods is required of all students in the program. In addition, M.A. students must take two electives, for a total of 16 credits, for a minor. Doctoral students take two additional seminars, in feminist research and writing, and one elective, for a total of 20 credits for a minor.

Language Requirements—None specific to the minor program.

For Further Information and Applications—Contact the Center for Advanced Feminist Studies, University of Minnesota, 496 Ford Hall, 224 Church Street S.E., Minneapolis, MN 55455 (612/624-6310; fax 612/626-1697).

Women's Studies (WoSt)

5100, 5200, 5300, 5400, 5500, 5600. TOPICS IN WOMEN'S STUDIES. (4 cr per qtr [max 12 cr]) Topics specified in the *Class Schedule*.

5101. HISTORY OF WESTERN FEMINISM. (4 cr; prereq 1001, 1002; offered alt yrs) Feminist thought and movements; feminist politics since 1790, especially in the United States and Great Britain; other international references.

5102. CURRENT FEMINIST SCHOLARSHIP. (4 cr; prereq 1001, 1002 or grad student or #; offered alt yrs) Current scholarship dealing with feminist ideas and issues.

5103. FEMINIST PEDAGOGY. (4 cr; prereq 8 cr WoSt or #) Albrecht, Geiger, McNaron, Scheman, Zita Theory and practice of feminist teaching and learning as system of inquiry, emphasizing challenges raised by diversity of women's experiences and perspectives.

5106. THE CULTURAL CONSTRUCTION OF SEX, GENDER, AND SEXUALITY. (4 cr; prereq Center for Advanced Feminist Studies student or undergrad with 12 cr WoSt or #) Messer-Davidow, Zita Euro-American concepts of sex, gender, and sexuality in representative texts and images from 17th century to present. Critical and source materials from literary and cultural studies, history, biology, anthropology, psychology, and sociology.

5107. FEMINIST CRITICISM OF CONCEPTS OF THE SELF. (4 cr; prereq 12 cr WoSt courses or substantial work in philosophy, religious studies, social sciences or psychology or #; offered alt yrs) Messer-Davidow, Scheman

Traditional views, and feminist alternatives to them, concerning the self and related notions such as human nature, individualism, and transcendence, as expressed in philosophy, religion, morality, politics, art, and psychology.

5201. THE OLDER WOMAN: A FEMINIST PERSPECTIVE. (4 cr; prereq 12 cr WoSt or substantial work in social sciences or psychology) Quam Changing roles of older women in our society. Societal, health, economic, familial, emotional, sexual, and political concerns unique to older women.

5202. FEMINIST THERAPIES. (4 cr) Faunce Exploration of sexism in theoretical views of women and in therapy; alternative views and therapeutic approaches for women.

5203. WOMEN, FEMINISM, AND POWER. (4 cr; prereq 12 cr WoSt or #) Faunce Feminist conceptualizations of power, including personal power, empowerment, spirituality, networking, civil disobedience, holism, and utopias.

5205. WOMEN: A SENSE OF IDENTITY. (4 cr, §3205) Loeffler Sex roles (societal expectations, personal values, and personal behaviors). Application of success analysis, strength identification, communication training, goal setting, and behavior rehearsal to affirm and develop women's potential.

5206. WOMEN AND MADNESS IN HISTORY AND LITERATURE. (4 cr; prereq at least a jr) Joeres Prescriptive application of label "madness" to women since 19th century. Readings in literature, case studies, and critical and theoretical texts.

5305. WOMEN AND REPRESENTATION IN EUROPE. (4 cr; prereq 12 cr literature or feminist theory; offered alt yrs) Kaminsky Ways in which women and gender are represented in various cultural discourses, including fiction, drama, poetry, painting, music, medicine, and science in Europe.

5308H. WOMEN WRITERS OF AFRICA AND LATIN AMERICA. (4 cr, §5308; prereq 8 cr WoSt or Latin Amer St or African St or #) Kaminsky Novels, short stories, poetry, and/or drama by contemporary African and Latin American women in context of gender analysis and history of colonialism.

5401. WOMEN, COLONIALISM, AND UNDERDEVELOPMENT. (4 cr) Geiger Impact of colonial domination and economic underdevelopment on lives of women in Third World, strategies used by women to resist, survive, and overcome oppressive conditions.

5402. WOMEN IN CONTEMPORARY AMERICAN RELIGION. (4 cr; prereq 1001, 1002 or grad student or #) Yates

Present-day American women's spiritual consciousness and participation in religious institutions and religious movements. New forms of women's spiritual/religious knowledge and beliefs; quests for and expressions of them; their history and sources.

5501. WOMEN AND THE LAW. (4 cr) Balos, Fellows
The legal system as it relates to women. Areas of criminal law, welfare law, employment law, corporate law, alternative delivery systems for legal service, and legal education.**5502. WOMEN AND PUBLIC POLICY.** (4 cr; prereq 1001, 1002 or #) Jones, Nelson

Survey of social problems and public policy issues of special significance to women in United States. Macropolitical, social, and economic forces shaping women's experiences as policy makers, administrators, citizens, and clients.

5601. GENDER AND CLASS. (4 cr; prereq grad student or 12 cr WoSt incl 1001 or 1002 for undergrad, #) Laslett, Maynes

Interactions between gender roles and social class in historical and comparative perspective; introduction to concepts and methods of gender and class analysis, women's work and economic systems, domestic work, social reproduction, feminism, socialism.

5602. WORKING CLASS WOMEN'S LIVES. (4 cr, \$5304; prereq 12 cr WoSt or #; offered alt yrs) McNaron, Rabinowitz

Social, historical, economic, and ideological influences/effects of women's participation in wage labor. Multidisciplinary study of impact of class, race, ethnicity, and gender on employment issues; protective legislation, job segregation, comparable worth, trade unions; women's experiences in workplace, child-rearing, and family life.

5970. DIRECTED STUDY. (1-5 cr per qtr [max 12 cr]; prereq #, Δ, CLA approval)**8101. INTELLECTUAL HISTORY OF FEMINISM.**

(4 cr; prereq #) Evans, Waltner
Survey of Western feminist thought from Enlightenment to 1980; emphasis on United States.

8102. FEMINIST LITERARY CRITICISM. (4 cr; prereq #) Kaminsky

Key concepts and approaches in current feminist literary theory and criticism: survey of topics and international perspectives.

8103. FEMINIST THEORIES IN THE SOCIAL SCIENCES. (4 cr) Geiger

Recent disciplinary and interdisciplinary feminist theories in social sciences; major developments and issues; perspectives from disciplines; national and international conceptual frameworks.

8510. FEMINIST THEORY AND METHOD. (4 cr; prereq #) Dietz, Maynes, Rabinowitz

Multidisciplinary methods, feminist theories; frameworks for feminist work; differences between feminist and traditional research; development of skills for challenging assumptions in methods and theories that define traditional fields.

8511. FEMINIST THEORY AND METHOD. (4 cr; prereq 5810, #) Disch, Messer-Davidow
Continuation of 8510.**8610. TOPICS IN FEMINIST STUDIES.** (4 cr; prereq 8 cr grad-level WoSt or substantial work in topic area or #)

Selected topics in interdisciplinary feminist research and scholarship.

8710. FEMINIST RESEARCH. (4 cr; prereq 8511, #) Geiger, Spector

Examination and comparison of feminist research methods in several disciplinary and interdisciplinary contexts. Students explain and examine their own research and other feminist research in their field, and learn about and criticize feminist research methods in other fields.

8910. FEMINIST WRITING SEMINAR. (1-4 cr; prereq 8511, passed prelims in degree-granting program, #) Albrecht, Bridwell-Bowles, Joeres

Enables students to write chapter or comparable segment of writing, e.g., draft of Plan B paper; trains students in critical evaluation of feminist writing in variety of disciplines; encourages clear and thoughtful written expression of feminist scholarly ideas and concepts.

8970. DIRECTED STUDY. (1-8 cr; prereq completion of courses approved by faculty supervisor and director of graduate studies)

Allows students to register for independent readings with appropriate program faculty.

Fisheries (FW)

Professor: Ira R. Adelman, *head, director of graduate studies;* Yosef Cohen; Anne Kapuscinski; Daniel A. Panshin; George R. Spangler

Associate Professor: Mary G. Henry; Peter W. Sorensen; Bruce C. Vondracek

Adjunct Associate Professor: Gerald T. Ankley; Barry A. Costa-Pierce; Clayton J. Edwards; James G. Seelye

Assistant Professor: Raymond M. Newman

Adjunct Assistant Professor: Charles S. Anderson; Cecil A. Jennings; Donald L. Pereira

Research Associate: Carl Richards¹

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

¹ University of Minnesota, Duluth

Graduate Programs

Curriculum—This program is administered within the Department of Fisheries and Wildlife. Areas of emphasis include fish ecology, physiology, behavior, and genetics; fish population dynamics; computer modeling; stream ecology; aquaculture; aquatic toxicology; and fishery management.

Prerequisites for Admission—Prospective students are expected to have a basic background in the biological sciences. Some experience in fisheries or aquatic science is desirable, but not required. A strong background in physical sciences, chemistry, mathematics, statistics, and computer use is recommended. For admission to the Ph.D., a master's degree is recommended.

Special Application Requirements—Three letters of recommendation from persons able to evaluate the applicant's academic and professional experience and results from the Graduate Record Examination (GRE) General Test are required. When registering for the GRE, prospective students should list the fishery sciences major field code (0106). Applications are accepted at any time. However, because the faculty reviews most applications in late January for admission the following fall, applications should be sent before January 1.

Master's Degree Requirements—Plan A is recommended, although Plan B may be pursued with the consent of the advisory committee. The Plan A thesis should be on a subject within the areas of emphasis. Coursework requirements are flexible, but typically include courses in fisheries, limnology or aquatic biology, statistics and biometrics, computer science, and related subjects. Programs may include a traditional minor or coursework in a related field. An oral preliminary examination is required as well as a final seminar and oral defense of the thesis or Plan B papers.

Doctoral Degree Requirements—The doctoral program includes a major research effort in the areas of emphasis, resulting in a written dissertation. It also includes advanced coursework in fisheries, limnology

or aquatic ecology, and related subjects. Students must present a public lecture describing the thesis findings.

Language Requirements—No foreign language is required for either the master's or doctoral degree, except when the advisory committee determines that a foreign language is needed to support the student's research objectives.

For Further Information and Applications—Contact the Fisheries Program, Department of Fisheries and Wildlife, University of Minnesota, 200 Hodson Hall, 1980 Folwell Avenue, St. Paul, MN 55108 (612/624-3600).

FW 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

FW 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

FW 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5279. SPECIAL LECTURES IN FISHERIES. (Cr ar; offered when feasible)

5455. AQUACULTURE. (3 cr; prereq Biol 1009, 1103, 1106 or equiv, Chem 1001-2 or Chem 1004-5 or equiv or #; offered alt yrs) Kapuscinski
Role of aquaculture in resource management and world food production; institutional and economic considerations; principles of husbandry of aquatic organisms; interactions between fish metabolism and water quality; nutrition and energetics; fish health and genetics.

5459. FISH PHYSIOLOGY. (4 cr; prereq EEB 5136 or EEB 5156 or AnSc 3301 or #) Sorensen
Relationships among fish physiology, fish behavior, and the aquatic environment. Ionic and osmotic balance, gas exchange, locomotion, orientation and migration, reproduction, endocrinology, growth, and stress.

5460. POLLUTION IMPACTS ON AQUATIC SYSTEMS. (3 cr; prereq Biol 5041, EEB 5601, Chem 1004, Chem 1005, Chem 3301, Chem 3305 or #; offered alt yrs) Henry
Pollution assessment approaches, biological effects, fate and flow of contaminants in aquatic systems, and major types of pollutants.

5461. THE BEHAVIOR OF FISHES. (3 cr; prereq 5459 or EEB 3111 or #; offered alt yrs) Sorensen
Organismal and sub-organismal perspectives of fish behavior. Feeding behavior and optimal foraging theory; learning and intelligence; genetic, neural, and endocrine bases of behavior; communication; orientation and navigation; schooling and shoaling; reproduction; and application of understanding of behavior to harvest, management, and conservation.

5601. ASSESSMENT AND MANAGEMENT OF VERTEBRATE POPULATIONS. (5 cr; prereq Math 1251 or Math 1142, Stat 3011 or equiv) Spangler
Conceptual models of populations, description of population characteristics, and computer-assisted estimation of population parameters for purpose of management.

5603. ECOLOGY AND MANAGEMENT OF FISH AND WILDLIFE HABITATS. (4 cr; prereq 5601, grad student or #) Jordan
Ecological analysis of environmental factors as they influence distribution, abundance, and productivity of terrestrial and aquatic vertebrates. Factors that humans do or can influence. Includes three or four afternoon or Saturday morning field trips.

5604. FISHERY AND WILDLIFE MANAGEMENT. (4 cr; prereq 5601 or #) Newman
Basic understanding of fisheries and wildlife management with emphasis on managed species of interest. Tactics and strategies. Role of strategic planning in directing and redirecting management actions; tools of management and assessment of their efficacy.

5620. GEOGRAPHICAL INFORMATION SYSTEMS (GIS) FOR FISHERIES, WILDLIFE, AND BIOLOGICAL CONSERVATION. (4 cr; prereq Biol 5041) Cohen
Hands-on experience with GIS as tool for understanding, analysis, and management of ecological systems. ARC-INFO as applied to problems in fisheries, wildlife, and biological conservation.

5701f, 5702w. SENIOR PROJECT. (1, 2 cr; prereq FW sr or grad student or #) Cooper
Problem-solving training. Management problem identification and analysis design, information and data gathering and analysis, and oral and written problem reporting. Problem selection influenced by guest speakers, resource agency contacts, and group discussions; topic is contemporary fisheries and wildlife management issue.

8100. SEMINAR. (Cr ar) Staff
Lectures by and discussions with faculty members, visiting scholars, and graduate students on current topics.

8200. SEMINAR. (Cr ar) Staff
Oral and written reports and discussion by students on selected topics from current literature in fisheries biology and management. Lectures by and discussions with faculty members and visiting specialists.

8364.* RESEARCH IN FISHERIES BIOLOGY. (Cr ar; prereq fisheries grad student) Staff

8448. FISHERY SCIENCE. (4 cr; prereq fisheries grad student or #; offered alt yrs) Spangler
Applications of ecological theory to the study and manipulation of fish populations; dynamics of growth, mortality, and yield of fish stocks; simulation applied to management problems.

8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES. (3 cr; prereq #) Kapuscinski, Smith
Seminar on current conservation biology issues; genetic, demographic, and environmental analysis and management of populations; ecosystem conservation; case studies of species conservation strategies.

8459. STREAM AND RIVER ECOLOGY. (4 cr; prereq EBB 5601 or equiv or #; offered alt yrs) Newman
Introduction to structure and dynamics of running waters from an ecosystem perspective. Historical perspective, basic hydrology and fluvial geomorphology, terrestrial-aquatic interactions, detrital dynamics, metabolism, drift, trophic relations, biotic and abiotic interactions, ecosystem experiments and natural alterations, stability and succession, and ecosystem dynamics in a watershed perspective. One field trip.

8460. FISH HABITATS AND RESTORATION. (3 cr; prereq Biol 5041 or equiv, grad student or #; offered alt yrs) Vondracek
Mechanisms underlying physiology and behavior that shape fish community structure in specific north temperate habitats; current techniques and planning procedures for restoration of lakes and streams.

8579. ECOSYSTEM ANALYSIS AND SIMULATIONS: A NUMERICAL APPROACH. (5 cr; prereq 1 qtr calculus, 1 qtr statistics, some exposure to computers; offered alt yrs) Cohen
Systems analysis methods (e.g., state-space models, transfer functions) and numerical simulations in ecology and fisheries/wildlife management. Presentation of data in time and frequency domains; interpretation of results.

NRES 5575. WETLANDS CONSERVATION

See Ecology for other relevant courses.

Fluid Mechanics

Regents' Professor: Rutherford Aris (chemical engineering); Daniel D. Joseph (aerospace engineering and mechanics); James B. Serrin, Jr. (mathematics)

Professor: Roger E. A. Arndt (civil engineering), *chair*; Cesar Farell (civil engineering), *director of graduate studies*; Gordon S. Beavers (aerospace engineering and mechanics); Roger L. Fosdick (aerospace engineering and mechanics); Richard J. Goldstein (mechanical engineering); Thomas S. Lundgren (aerospace engineering and mechanics); Christopher W. Macosko (chemical engineering); Gary Parker (civil engineering); Suhas V. Patankar (mechanical engineering); L. Edward Scriven (chemical engineering); Terry W. Simon (mechanical engineering); Charles C. S. Song (civil engineering); Ephraim M. Sparrow (mechanical engineering); Tayfun E. Tezduyar (aerospace engineering and mechanics); Matthew Tirrell (chemical engineering); Hans F. Weinberger (mathematics); Theodore A. Wilson (aerospace engineering and mechanics)

Associate Professor: John S. Gulliver (civil engineering); Charles J. Scott (mechanical engineering); Vaughan R. Voller (civil engineering)

Graduate Programs

Assistant Professor: Amy E. Alving (aerospace engineering and mechanics); Ellen K. Longmire (aerospace engineering and mechanics)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—The fluid mechanics program is interdisciplinary, with the curriculum based on courses offered in several engineering and scientific disciplines. Research areas include aero-acoustics, boundary layer flow, cavitation, rheology, bluff body aerodynamics, wind engineering, atmospheric contaminant dispersion, hydro- and aeroelasticity, numerical methods, meteorology, geophysical fluid dynamics, capillary hydrodynamics, flow in porous media, and spray technology. The program offers students maximum flexibility in the choice of courses.

Prerequisites for Admission—Candidates for admission normally have completed undergraduate work in one of the following related fields: aerospace engineering, chemical engineering, civil engineering, mathematics, mechanical engineering, or physics. The Fluid Mechanics Subcommittee considers any applicant whose scientific and engineering training is adequate to prepare them to pursue the program.

Special Application Requirements—Students are admitted each quarter.

Master's Degree Requirements—Coursework should normally be selected from science and engineering courses that are particularly relevant to the various fields of interest in fluid mechanics. The minor or related field should consist of a reasonable collection of courses that support the major program. The final examination requirement is identical to that required of a master's student in the thesis or project adviser's home department.

Doctoral Degree Requirements—The program provides maximum flexibility in course selection. It is desirable, however,

that at least 9 8xxx credits be selected from at least three of the several graduate programs from which the fluid mechanics graduate faculty is drawn. The minor or supporting program should consist of any reasonable collection of courses that supports the major program and should be approved by the adviser and the director of graduate studies.

Language Requirements—Students must meet the language requirements of the thesis or project adviser's home department.

For Further Information and Applications—Contact the Fluid Mechanics Program, St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Mississippi River at Third Avenue S.E., Minneapolis, MN 55414 (612/627-4010).

FIMe 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

FIMe 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

FIMe 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

AEM 5200. KINEMATICS AND DYNAMICS OF FLUID FLOW. (4 cr; prereq upper div IT or grad IT student, 3036, Math 3331 or Math 3252)

AEM 5202. VISCOUS FLOW. (4 cr; prereq 5200, upper div IT or grad IT student)

AEM 5204. SHOCK WAVES AND COMPRESSIBLE FLUID FLOW. (4 cr; prereq 5200, upper div IT or grad IT student)

AEM 5206. AERODYNAMICS OF LIFTING SURFACES. (4 cr; prereq 5200, CSci 3101 or CSci 3104)

AEM 5240. RAREFIED GAS DYNAMICS. (4 cr; prereq IT or grad IT student, 5201 or Δ)

AEM 8201-8202-8203. FLUID MECHANICS I-III. (4 cr per qtr; prereq undergrad fluid mechanics and vector analysis)

AEM 8209. ROTATING FLUIDS. (3 cr; prereq background in fluid mechanics especially boundary layer theory)

AEM 8216-8217. THEORY OF TURBULENCE I, II. (3 cr per qtr; prereq 8202)

AEM 8240. PERTURBATION METHODS IN FLUID MECHANICS. (3 cr; prereq 8202 or #)

CE 5401. WATER RESOURCES ENGINEERING. (4 cr; prereq 3400 or #, IT or grad student)

CE 5402. COMPUTATIONAL HYDRAULICS. (4 cr; prereq 5401, CSci 3101 or #, IT or grad student)

CE 5405. HYDROLOGY AND HYDROLOGIC DESIGN. (4 cr; prereq 5401 or #, IT or grad student)

CE 5410. OPEN CHANNEL HYDRAULICS. (4 cr; prereq 3400, 5401 or #, IT or grad student)

CE 5435. INTERMEDIATE FLUID MECHANICS WITH APPLICATIONS. (4 cr; prereq 3400, IT or grad student)

CE 5505. WATER QUALITY ENGINEERING. (4 cr; prereq Chem 1005, #, IT upper div student)

CE 8401. INTRODUCTION TO ENVIRONMENTAL BOUNDARY LAYER THEORY. (4 cr; prereq 5435 or #)

CE 8402. INTRODUCTION TO THE THEORY AND MEASUREMENT OF TURBULENT FLOWS. (4 cr; prereq 8401 or #)

CE 8413.* MECHANICS OF SEDIMENT TRANSPORT. (3 cr; prereq 5410 or #)

CE 8415. HYDROPOWER DEVELOPMENT. (3 cr; prereq 5405)

CE 8425.* ADVANCED GROUNDWATER MECHANICS I. (4 cr; prereq 5425 or #)

CE 8430. LAKE AND RESERVOIR HYDRODYNAMICS. (3 cr; prereq #)

CE 8435. SPECIAL TOPICS IN HYDRODYNAMIC THEORY. (3 cr; prereq #)

CE 8440. FLOW EFFECTS ON STRUCTURES. (4 cr; prereq 5435 or #)

ChEn 5102. PRINCIPLES OF CHEMICAL ENGINEERING II. (4 cr; prereq 5001, 5101)

ChEn 8101. INTERMEDIATE FLUID MECHANICS. (3 cr; prereq 5103, #)

ChEn 8102. PROBLEMS IN FLUID MECHANICS. (3 cr; prereq 8101)

ChEn 8104. INTERFACES AND INTERFACIAL PHENOMENA. (3 cr; prereq 8101; offered alt yrs)

ChEn 8105. PRINCIPLES AND APPLICATIONS OF RHEOLOGY. (3 cr; prereq 8101, 8103; offered alt yrs)

ChEn 8601-8602-8603. MOLECULAR THEORY OF EQUILIBRIUM AND NONEQUILIBRIUM PROCESSES. (3 cr per qtr)

Math 8430-8431-8432. MATHEMATICAL THEORY OF FLUID DYNAMICS. (3 cr per qtr; prereq 5573, 5602 or #)

ME 5344. THERMODYNAMICS OF FLUID FLOW. (4 cr, §AEM 5201; prereq CE 3400 or AEM 3200, IT or grad student)

ME 5443.* TURBOMACHINERY. (4-5 cr; prereq 3301 or equiv, IT or grad student)

ME 8326. BOILING HEAT TRANSFER AND MULTIPHASE FLOW. (3 cr; prereq 5342 or #)

ME 8331.* CONVECTION. (3 cr; prereq 5342)

ME 8351. COMPUTATION OF FLUID FLOW AND HEAT TRANSFER. (3 cr; prereq 5342)

ME 8352. ADVANCED COMPUTATION OF FLUID FLOW AND HEAT TRANSFER. (3 cr; prereq 8351 or #)

Phys 8163-8164.* PLASMA PHYSICS. (3 cr per qtr; prereq 5162)

Food Science (FScN)

Professor: Francis F. Busta, *head*; Edmund A. Zottola, *director of graduate studies*; Paul B. Addis; William M. Breene; Agnes S. Csallany; Eugenia A. Davis; Richard J. Epley; R. Gary Fulcher; Joan Gordon; Theodore P. Labuza; Larry L. McKay; Howard A. Morris (*emeritus*); Irving J. Pflug; Gary A. Reineccius; Dennis A. Savaiano; Joanne L. Slavin; David E. Smith; Sita R. Tatini; Joseph J. Warthesen

Associate Professor: Elaine H. Asp; Linda J. Brady; Craig A. Hassel; H. William Schafer; Zata M. Vickers

Assistant Professor: Eric D. Bastian; Mrinal Bhattacharya; Joellen M. Feirtag; Chang-Ho Park

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Students may emphasize the chemistry, engineering, microbiology, sensory aspects, nutrition, or technology of food products.

Prerequisites for Admission—Superior applicants with an undergraduate major in any physical or biological science usually have completed the necessary prerequisites. The minimum requirements are general chemistry, organic chemistry with laboratory, physics with laboratory, and calculus. If preparation appears inadequate, certain additional courses may be required after admission.

Special Application Requirements—Submission of scores from the General (Aptitude) Test of the Graduate Record Examination is required. Submission of three letters of reference is also required whether or not the prospective student is applying for financial assistance. Students are admitted each quarter.

Master's Degree Requirements—Coursework in each of five program areas is required so that students develop a depth and

Graduate Programs

breadth of knowledge in the field. The five program areas and the appropriate courses (equivalents may be substituted) are: (1) Chemistry—minimum of 5 credits from among FScN 5110, 5312, 5314, 8311, 8312, 8315, 8403; (2) Engineering—a minimum of 5 credits from among FScN 5135, 5555, 8322, AgEn 5140; (3) Technology—a minimum of 4 credits from among FScN 5320, 5512, 5522, 5523, 5530, 5540, 5550, 5562; (4) Microbiology—a minimum of 5 credits from among FScN 5120, 5122, 5123, 5320, 8322, 8323, 8324; and (5) Consumer Issues—a minimum of 3 credits from among FScN 5360, 5390, 5404, 5474, 5524, 5643. In addition, 1 credit of FScN 8205 is required. Familiarity with nutrition, as demonstrated through completion of a course equivalent to FScN 1612, as a minimum, is required.

Master of science candidates may exceed the 40% limit on transfer of CEE credits customarily permitted in the Graduate School. Students wishing to do so must consult the director of graduate studies for further instructions.

The minor may be chosen from a variety of fields including biochemistry, business administration, chemistry, chemical engineering, economics, industrial engineering, marketing, microbiology, nutrition, physiology, public health, and technical communication. A final oral examination is required; a final written examination may be required at the discretion of the graduate faculty.

Doctoral Degree Requirements—In addition to the coursework requirement for the M.S. degree, students should complete at least 5 credits in each of two program areas. The minor may be chosen from among the fields suggested for the master's degree minor.

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—For the master's degree, a minimum of 11 credits selected from two of the five program areas.

For the doctoral degree, a minimum of 20 credits from three of the five program areas. These courses should be chosen in consultation with the director of graduate studies.

For Further Information and Applications—Contact the Graduate Program in Food Science, University of Minnesota, 225 Food Science and Nutrition, 1334 Eckles Avenue, St. Paul, MN 55108 (612/624-1290).

FScN 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

FScN 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

FScN 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5110. FOOD CHEMISTRY. (4 cr; prereq 3102, BioC 3031 or Biol 5001) Csallany
Chemical structures and functional properties of food components in relation to their roles as parts of complex biochemical systems and as modified by environmental and processing factors.

5111. INDEPENDENT STUDY IN FOOD SCIENCE AND NUTRITION. (1-5 cr [may be repeated for cr]; prereq Δ) Staff
Individual lab or library research in some area related to food science or nutrition.

5120. FOOD MICROBIOLOGY. (5 cr; prereq 1102, 3112, VPB 3103 or MicB 5105 or #) Tatini, Zottola
Relationship of environment to occurrence, growth, and survival of microorganisms in foods; methods of evaluation, mechanisms to control, genera and species of importance, control of foodborne pathogens and toxins. Enumeration, isolation, and identification of microbes in foods.

5122. CONTROL SYSTEMS IN FOOD MICROBIOLOGY. (2 cr; prereq 5120) Zottola
Control and destruction of microorganisms in foods; hazard analysis; critical control points; chemical, physical, and microbiological considerations in cleaning and sanitizing food contact surfaces and equipment; microbiological criteria for raw and processed foods; sampling methodologies.

5123. FOOD FERMENTATIONS AND BIOTECHNOLOGY. (3 cr; prereq 5120) McKay
Food fermentation processes; characteristics of microorganisms involved in food fermentations and production of food ingredients; composition and factors influencing activity of starter cultures; microbiology of natural and controlled fermentations; properties of lactic bacteriophages and methods of control during dairy fermentations.

5135. FOOD ENGINEERING UNIT OPERATIONS.

(5 cr; prereq 1102 or ¶1102, Math 1142, Phys 1042, Phys 1046) Bhattacharya
Principles and food system applications of the following unit operations: fluid flow, heat transfer, drying, evaporation, contact equilibrium (distillation, extraction, crystallization, and membrane processes), and mechanical separation (filtration, centrifugation, sedimentation, and sieving).

5312. INSTRUMENTAL ANALYSIS OF FOODS.

(3 cr; prereq 3112, 5110) Davis, Reineccius
Application of instrumental methods of analysis to the examination of food products.

5314. PHYSICOCHEMISTRY OF FOODS. (4 cr; prereq 5110) Davis

Characterization of crystalline systems, gels, emulsions, and foams; functionality of food macromolecules in these systems.

5316. QUANTITATIVE LIGHT MICROSCOPY IN AGRICULTURE AND FOOD RESEARCH. (4 cr; prereq Biol 1009 or Chem 1052; offered alt yrs) Fulcher

Introduction to light microscopy and its variants. Description and applications of quantitative instruments for characterizing cell, tissue, and other raw or processed materials. Digital image analysis, scanning microspectrophotometry, and laser scanning microscopy.

5360. SENSORY EVALUATION OF FOOD

QUALITY. (4 cr; prereq 3102, Stat 3012 or Stat 5021; offered alt yrs) Vickers

Fundamentals of sensory perception. Test designs and methods used in studying the sensory quality of foods.

5380. FOOD PACKAGING. (3 cr; prereq 1102, 3102, Phys 1042; offered alt yrs) Willson

Basics of packaging materials; principles of packaging development and product protection as applied to foods.

5390. INTRODUCTION TO FOOD LAW. (4 cr; prereq 1102 or #) Labuza

Analysis of federal and state legal requirements and case law history affecting production, processing, packaging, marketing, and distribution of food and food products.

5404. CURRENT ISSUES IN FOOD AND

NUTRITION. (2-4 cr; prereq 15 cr food science and nutrition or #) Levine

Evaluation of popular and scientific literature as it deals with nutrition, food additives, food safety, food fads, health foods, environmental contamination, the consumer movement, naturally occurring food toxicants, processed foods, synthetic foods, organically grown foods.

5474. FOOD MARKETING ECONOMICS. (3-4 cr, §AgEc 5550; prereq AgEc 3101 or #) Asp, Senauer

Economics of food marketing in United States. Food consumption trends; consumer food behavior; food expenditure and consumption data; consumer survey methodology; food distribution and retailing system; food policy issues related to food marketing. Individual and group projects required.

5512. MEAT TECHNOLOGY. (4 cr; prereq 5110; offered alt yrs) Addis

Industrial processing of meat, fish, and poultry products, including protein functionality, thermal processing, curing, smoking, and deterioration during storage. Use of preblending and least-cost analysis in product development and formulation.

5522. TECHNOLOGY OF FLUID AND CONCENTRATED MILK PRODUCTS. (4 cr; prereq 3136, 5110) Smith

Application of scientific principles to problems involved in processing fluid and dehydrated milk systems and their control. Demonstration of basic processing operations including heating, cooling, homogenization, evaporation, drying, crystallization, and freezing.

5523. TECHNOLOGY OF FERMENTED DAIRY PRODUCTS. (4 cr; prereq 5110, 5123; offered alt yrs) Bastian**5524. SENSORY EVALUATION OF DAIRY PRODUCTS.** (1 cr; prereq 3102) Smith

Lab and commercial procedures for evaluating the sensory properties and market quality of dairy products. Cause and identification of common defects in flavor, physical properties, and appearance.

5530. INDUSTRIAL PROCESSING OF FRUITS AND VEGETABLES. (4 cr; prereq 3136, 5110, 5120, 5135) Breene

Relationship of chemical, physical, and microbiological principles to commercial processing of fruits and vegetables from procurement of raw products through preparation, preservation, packaging, storage, transportation, and merchandising. Emphasis on preservation methods involving heat sterilization, freezing, dehydration, and fermentation.

5540. FATS AND OILS CHEMISTRY AND TECHNOLOGY. (4 cr; prereq 5110; offered alt yrs) Csallany

Nature of fats and oils, their structure, composition, chemical and physical properties; raw materials for fat and oil products; extraction, refining, hydrogenization, and other industrial manipulations; handling, storage, analysis, and grading of raw materials and finished products.

5550. GRAINS: INTRODUCTION TO CEREAL CHEMISTRY AND TECHNOLOGY. (4 cr; prereq Biol 1009 or Chem 1052; offered alt yrs) Fulcher
Origins, structure, biochemistry, and cellular properties of major cereal grains as they relate to primary processing (milling) and secondary processing (production of cereal products). Relation between structure and functionality as determinants of quality in grains and grain products. Quality evaluation technologies.

5555. FREEZING AND DEHYDRATION OF FOODS. (5 cr; prereq 1102, 5135; offered alt yrs) Labuza

Principles involved in the processing, handling, and storage of frozen, dry, and intermediate moisture foods, with emphasis on the physicochemical properties of water in foods.

Graduate Programs

5562. FLAVOR TECHNOLOGY. (4 cr; prereq 1102, 5110) Reineccius
Flavor and off-flavor development in foods. Industrial production of food flavorings and their proper application to food systems.

5620. NUTRITION AND METABOLISM. (5 cr; prereq 3612 or #, Biol 5001) Brady
Physiological function and metabolic fate of carbohydrates, lipids, and proteins and their involvement in fulfilling energy needs for maintenance, growth, and work. Physiological function of vitamins and minerals.

5622. MACRONUTRIENT METABOLISM. (4 cr; prereq 3612, Biol 5001, Phsl 3051) Brady
Physiological function and metabolic fate of carbohydrates, lipids, and proteins and their involvement in fulfilling energy needs for maintenance, growth, and work.

5623. VITAMIN AND MINERAL BIOCHEMISTRY. (4 cr; prereq 3612, Biol 5001, Phsl 3051) Gallaher
Nutritional/biochemical and physiological function of essential vitamins and minerals in humans and experimental animal models.

5624. HUMAN PROTEIN AND ENERGY UTILIZATION. (4 cr; prereq 5622) Kurzer
Regulation of human protein and energy use, interactions, adaptations; critical evaluations of methods for determining requirements; technical and ethical problems in human experimentation and determination of recommended levels of intake.

5643. WORLD FOOD PROBLEMS. (3 cr, §AgEc 5790, §Agro 5200, §CAPS 5280; prereq sr or grad student; limited enrollment) Breene, Busta, Savaiano
Multidisciplinary approach to social, economic, and technical problems of feeding the world's growing population. Principles from social and economic sciences and from plant, animal, and food sciences for application to world food problems.

8101. RESEARCH SEMINAR. (1 cr; prereq #; S-N only) Staff
Seminar discussion with faculty member(s) of research progress within the group, or review and discussion of current research literature related to food science and nutrition.

8205. GENERAL SEMINAR. (1 cr; prereq #; S-N only) Staff
Presentation of topics related to food science and nutrition by staff members, graduate students, and outside speakers.

8311. FLAVOR CHEMISTRY. (3 cr; prereq 5312 or #; offered alt yrs) Reineccius
Chemistry of food flavor including biogenesis of flavor, production during processing, deterioration during storage, potentiation, duplication as an art and science, and use in food industry.

8312. REACTION KINETICS OF FOOD DETERIORATION. (3 cr; prereq Chem 5520 or #; offered alt yrs) Labuza
Review of the basis for application of chemical kinetic theory to deteriorative reactions occurring in the processing and storage of foods. Specific systems studied include hydrolytic reactions, vitamin deterioration, lipid oxidation, non-enzymatic browning, frozen reactions and moisture changes. Application of these kinetics to the study of accelerated shelf life testing of foods and choice of food packaging material based on legal requirements of nutritional labeling and open dating.

8315. FOOD PROTEINS. (3 cr; prereq 5110, 5312 or #; offered alt yrs) Davis
Principles of isolating, handling, and processing of proteins from conventional and new protein sources. Relationship of structural, functional, and interactive properties of proteins to developing and/or maintaining nutritional and aesthetic properties of products.

8322. MICROBIOLOGY AND ENGINEERING OF FOOD STERILIZATION PROCESSES. (5 cr; prereq 5120, 5122 or equiv, Stat 3081 or 5021 or equiv; offered alt yrs) Pflug
In-depth study of scientific principles and concepts in production of sterile foods including heat resistance of bacterial spores, heating and cooling of foods in containers or packages, determination of safe processes for the preservation of canned foods, and monitoring of sterilization processes.

8323. MICROBIAL STARTER CULTURES. (3 cr; prereq 5123, Biol 5001 or #; offered alt yrs) McKay
Microbiology of food starter cultures; selection, identification, and composition of starters; nutrition and metabolism, strain association and compatibility, cause and control of culture related defects; genetics, preservation, and mass production; bacteriophage in cheesemaking.

8324. MICROBIAL TOXINS AND TOXIC MICROORGANISMS IN FOODS. (4 cr; prereq 5120 or #; offered alt yrs) Tatini
Incidence and reasons for presence of various microbial toxins and toxic microorganisms in foods. Nature of toxins and mechanisms of toxicity. Biological, serological, and biochemical methods for detecting toxins. Means for control of these toxins in foods for prevention of food-borne public health hazards.

8401. INDEPENDENT STUDY: FOOD SCIENCE. (1-5 cr; prereq Δ) Staff
Independent study and written reports.

8403. ADVANCED TOPICS IN FOOD SCIENCE. (1-4 cr; prereq #) Staff
Review of recent research in food science or presentation of special topics course.

Nutr 8745. SEMINAR. (1 cr [may be repeated for cr]; prereq #) Staff

Nutr 8990. GRADUATE RESEARCH. (2-5 cr; prereq #) Staff

Forestry

Professor: Alfred D. Sullivan, *dean*; Kenneth N. Brooks, *director of graduate studies*; James L. Bowyer, *head, forest products*; Alan R. Ek, *head, forest resources*; Alvin A. Alm; Neil A. Anderson; Marvin E. Bauer; Robert A. Blanchette; Edward J. Cushing; Paul V. Ellefson; Robert W. Erickson; Roland O. Gertjeansen; Hans M. Gregersen; David F. Grigal; Wesley P. Hackett; Lewis T. Hendricks; Leo H. McAvoy, Jr.; Merle P. Meyer (*emeritus*); Carl A. Mohn; Peter B. Reich; Dietmar W. Rose; Robert H. Rouda; C. Ford Runge; Elmer L. Schmidt; Edward I. Sucoff

Associate Professor: Melvin J. Baughman; Charles R. Blinn; Thomas E. Burk; Howard M. Hoganson; Patrick H. Huelman; John L. Nieber; James A. Perry; Simo Sarkanen; J. L. David Smith; Henry A. Wells, Jr.

Assistant Professor: Dorothy H. Anderson; Stephen P. Carlson; Glenn R. Furnier; Timothy D. Larson; Steven B. Laursen; Mutombo Muvundamina; Klaus Y. Puetmann

Other: David N. Bengston; Erwin R. Berglund; Stephen M. Bratkovich; Kenneth L. Cole; Lee E. Frelich; Thomas A. Greene; Mark H. Hansen; George H. Honadle; Glenn T. Howe; Judson G. Isebrands; Rolfe A. Leary; Bailian Li; David W. Lime; David C. Lothner; Allen L. Lundgren; Thomas J. Nichols; Jacek Oleksyn; Michael E. Ostry; Donald A. Perala; Michael J. Phillips; Lloyd P. Queen; Don E. Riemenschneider; Robert T. Seavey; Nels H. Troelstrup, Jr.; Elon S. Verry

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B), M.F., and Ph.D.

Curriculum—Students normally emphasize one of the following subfields: the chemistry of lignocellulosic materials; paper and fiber products recycling; deterioration of wood; wood mechanics; structural design with wood; wood moisture interaction and drying; processing and performance of wood composites; economics of manufacturing systems; technology and processing of solid wood products; design and production of housing components; energy-efficient building construction; ecology and silviculture; ecophysiology; forest economics; genetics and tree improvement; geographic information systems; hydrology and water quality management; measurements and biometrics; policy and administration; tree physiology and tissue culture; recreation resource management;

remote sensing; and urban forestry. Faculty in forestry also offer courses in natural resources and environmental studies (NRES) listed after the forest products and forest resources courses below.

Prerequisites for Admission—Prerequisites vary by subfield. Most admitted students have earned degrees in forestry or forest products. Applicants with exceptional academic records but no forestry background are eligible; if admitted, they may complete the necessary prerequisites for advanced courses during the early stages of their graduate program. Applicants for the doctoral program should demonstrate a capacity for advanced study and independent research.

Special Application Requirements—Applications are processed on a continual basis, and students are admitted each quarter. Graduate Record Examination scores are required. Letters of recommendation are optional but highly recommended. Applicants for the doctoral program should supply the names and addresses of three people who can provide evaluations of their capacity for advanced study and independent research.

Master's Degree Requirements—M.S. (Plan B) students, in consultation with faculty members, design a program that develops competence in one or more subfields. M.S. (Plan A) students usually design a program to support their specific thesis project. Master's degree students are required to present a seminar on the thesis, Plan B project, or a topic selected in consultation with the graduate adviser. Specific requirements vary by subfield; prospective students should contact the director of graduate studies and/or a prospective faculty adviser for specific information. Students in the M.F. program are required to complete basic science courses and introductory forestry courses if not included in their undergraduate program.

The final examination is oral.

Graduate Programs

Doctoral Degree Requirements—The program is designed to insure that students gain the necessary competence in the subfield for independent research. Programs normally vary from 60 to 90 credits, not including thesis credits. Course selection and thesis proposals are developed by each student in consultation with the faculty adviser for review and approval by the forestry graduate study committee.

Language Requirements—None.

Minor Requirements for Students Majoring in Other Fields—Students who wish to minor in forestry should contact the director of graduate studies. The selection of courses for an acceptable minor is influenced by the student's background and educational objective. Minor field competence is evaluated in the oral examination.

For Further Information and Applications—Contact the Forestry Graduate Program, College of Natural Resources, University of Minnesota, 235 Natural Resources Administration Building, 2003 Upper Buford Circle, St. Paul, MN 55108 (612/624-1234; fax 612/624-8701).

Fors 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Fors 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Fors 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Forest Products (ForP)

5300.* WOOD-FLUID RELATIONS. (3 cr; prereq 1301 or #) Erickson
Moisture in wood and its relationship to density and specific gravity, shrinking and swelling, electrical properties, strength properties, thermoconductivity, absorption isotherms, dimensional stabilization, permeability and diffusion.

5301. MECHANICAL PROPERTIES. (3 cr; prereq 1301 or #) Larson
Basic mechanics and strength of materials as applied to wood products.

5302. WOOD CHEMISTRY I. (3 cr; prereq Chem 3302) Sarkanen
Molecular structure of wood cell wall. Structures, properties, and reactions of monosaccharides and derivatives; oligosaccharides. Structure, properties, and biogenesis of cellulose; cellulose derivatives; comparison with starch.

5303. WOOD DETERIORATION. (4 cr; prereq 1301 or #) Schmidt
Deterioration of wood and wood products by bacteria, fungi, insects, marine organisms, fire, and weathering; methods of preservation and preservatives used. Lecture and lab.

5304.* WOOD DRYING AND PRESERVATION PROCESSES. (4 cr; prereq 5300, 5303 or #) Erickson
Materials, equipment, processes, and technical considerations involved in industrial drying and preservative treatment of wood products. Lectures, lab exercises, and plant tours.

5305. PULP AND PAPER TECHNOLOGY. (4 cr; prereq 5300 or #) Gertjeansen
Pulping processes; fiber refining and processing; manufacture of paper; fiber and paper properties; recycling of paper; water requirements and effluent treatment. Lecture and lab.

5306. ANALYSIS OF PRODUCTION SYSTEMS. (3 cr; prereq 1301 or #; 3300 recommended) Bowyer
Engineering and economic analysis of manufacturing and distribution systems for wood-based products. Material balances, equipment selection, economic analysis, and presentation techniques.

5307. WOOD-BASE PANEL TECHNOLOGY. (4 cr; prereq 5300, 5301 or #) Gertjeansen
Design, manufacture, properties, and applications of structural and nonstructural wood-base panels. Adhesives and their application in the panel industry. Lecture and lab.

5308. WOOD MACHINING. (3 cr; prereq 1301, 1303) Bowyer
Wood machining technologies and methods; development and application of wood processing systems. Lectures, discussions, demonstrations, and company visits.

5310. PULP AND PAPER PROCESS LABORATORY. (3 cr; prereq 5305 or #) Gertjeansen, Muvundamina
Chemical and mechanical pulping, pulp preparation, secondary fiber, wet end additives. Lab problems and exercises supplemented by lectures.

5311. PULP AND PAPER PROCESS ENGINEERING CALCULATIONS I. (4 cr; AgET 3030 or CSci 3101, ChEn 5011, CE 3400, ME 3301 recommended) Rouda
Physical and chemical process engineering calculations; steady and unsteady state material and energy balances applied to pulping and papermaking processes; flowsheet and system calculations; computer-aided material and energy balances.

5312. PULP AND PAPER PROCESS ENGINEERING CALCULATIONS II. (4 cr; prereq 5311 or ChEn 5101, ¶ME 3301; AgET 3030 or CSci 3101, ChEn 5011, CE 3400 recommended) Rouda
Physical and chemical process engineering calculations; steady and unsteady state material and energy balances applied to pulping and papermaking processes; flowsheet and system calculations; computer-aided material and energy balances.

5313. PULP AND PAPER PROCESS OPERATIONS

I. (4 cr; prereq 5305, 5312, 5353, CE 3400, ME 3301, ChEn 5102 or ME 5342 or #) Rouda

Application of principles of momentum, heat, and mass transfer to unit operations in pulp and paper industry: fluid transport, filtration, sheet forming, sedimentation, drainage, pressing, heat exchange, evaporation, washing, bleaching, humidification and drying, and chemical and energy recovery. Computer simulation of multiple-stage systems.

5314. PULP AND PAPER PROCESS OPERATIONS II: PAPER MACHINE OPERATIONS, FINISHING AND CONVERTING.

(4 cr; prereq 5305, 5310, 5311, 5312, 5315, 5321, 5359, CE 3400, ME 3301, ME 5342) Wells

Theory and practice of design and operation of paper machines and associated finishing and converting equipment.

5315. PAPER ENGINEERING LABORATORY.

(2 cr; prereq 5305, 5310 or ¶5310, 5312 or #; 5306 recommended) Rouda

Experiments that illustrate and apply the principles of momentum, heat, and mass transfer. Operation and performance optimization of pilot-plant paper machine. Process engineering studies of industrial production systems.

5316. COATED PRODUCT DEVELOPMENT.

(2 cr; prereq 5359) Wells

Coating process and products (primarily paper) associated with process components of coating; theory, techniques, and procedures for formulating and applying coatings; properties of coated products and their uses.

5318. PULP AND PAPER PROCESS DYNAMICS AND CONTROL.

(3 cr; prereq 5305, 5310, 5311, 5312, 5315, CE 3400, ME 3301, ¶ME 5342 or #) Wells

Theory and practice of process control in pulp and paper industry; sensors, control equipment and algorithms, final control elements; applications to industrial pulp and paper manufacturing and quality control; applications of SPC and SQC; available hardware and software.

5320. BIOLOGICAL AND ENVIRONMENTAL SCIENCE OF PULP AND PAPER.

(4 cr; prereq sr or grad student in ForP) Schmidt

Environmental impacts related to biology and chemistry of pulp and paper processes; treatment of process effluents and discharges; governmental regulations and industry compliance; theory, design, and operation of equipment for treatment or prevention of environmental effects; biochemistry of pulp and paper aquatic systems; advances in biological pulping and papermaking.

5321. MATERIAL SCIENCE OF PAPER: PAPER AND FIBER PHYSICS AND PROPERTIES.

(4 cr; prereq 5305, 5310, 5311, 5312, 5315, CE 3400, ¶Chem 5520, ME 3301, ME 5342 or #) Muvundamina

Advances in understanding response of fibers subjected to various operations of papermaking processes: mechanisms acting in stock preparation, refining, wet-end operations, web consolidation, and drying; analysis of corresponding influences on fiber, pulp suspension, and paper properties; challenges placed on end products by changing raw materials and requirements, including introduction of recycled pulp in paper products.

5350. WOODY TISSUE MICROTECHNIQUE. (2 cr; offered when feasible)

5353. WOOD CHEMISTRY II.

(3 cr; prereq 5302) Sarkanen

Composition, distribution, and structures of hemicelluloses and their interactions with cellulose; biosynthesis, structure, and analytical degradation of lignin; delignification of wood; pulp bleaching chemistry; lignin biodegradation.

5355.* MECHANICS AND STRUCTURAL DESIGN WITH WOOD PRODUCTS.

(4 cr; prereq 5301) Larson
Mechanical behavior of lumber, plywood, and particleboard applied to structural considerations in building construction. Lecture and lab.

5359. SURFACE AND COLLOID CHEMISTRY OF PAPERMAKING.

(3 cr; prereq 5361 or #, Chem 3302, Chem 5520) Muvundamina

Principles of surface and colloid chemistry applied to basic problems in pulp and paper manufacturing operations and product uses.

5361. ADHESION AND ADHESIVES.

(3 cr; prereq Chem 3302, Chem 5520) Sarkanen
Scope and utility of adhesive applications; fundamental nature of adhesion; ideal adhesive joint; conformations of linear polymers; statistical thermodynamics and polymer adsorption onto adherend surface; adhesives in common use; mechanical properties of adhesive joints.

5405. PAPER IN TODAY'S WORLD.

(3 cr, §5305) Erickson, Gertjejenen
Primarily to enable elementary and secondary school teachers to prepare unit on pulp and paper for elementary through senior high school science classes. Lectures, labs, and demonstrations on pulp and paper manufacturing, properties and characteristics of paper, uses for paper, recycling with pulp, and paper equipment, including a pilot plant paper machine. Written report required for graduate credit.

8300.* RESEARCH PROBLEMS.

(Cr ar)

8301.* RESEARCH PROBLEMS.

(Cr ar)

8303. ADVANCED TOPICS IN PANEL PRODUCTS TECHNOLOGY.

(2 cr; prereq 5307) Gertjejenen

Advanced treatment of selected topics in panel products technology: particle and fiber processing; additives; the press cycle; design of panels for specific end uses. Lectures and lab.

8304. ADVANCED TOPICS IN WOOD DRYING.

(3 cr; prereq 5304) Erickson
Rheological behavior of first-dried solid wood; significance of creep to stress-strain pattern, shrinkage and degrade development in lumber drying; interpretation and evaluation of schedules, processes, primary and auxiliary equipment used in commercial drying processes; energy considerations in drying processes.

8306. SEMINAR: FOREST PRODUCTS.

(2 cr) Staff
Assigned topics, papers, and oral presentations.

Graduate Programs

8307. ADVANCES AND METHODS IN FOREST PRODUCTS PATHOLOGY AND PRESERVATION. (3 cr; prereq 5303, 5304 or #) Schmidt
Principles in wood protection and methods of evaluating preservatives with emphasis on international developments.

Forest Resources (FR)

5100. SILVICULTURE. (4 cr; prereq for FR majors: Itasca Session, 1100, 3104; for nonmajors: 3104 or equiv, #) Puettmann
Introduction to silvics, forest regeneration and site preparation techniques, intermediate silvicultural practices, silvicultural systems.

5101. FIELD SILVICULTURE. (4 cr; prereq 5100, Δ; offered at Cloquet) Nichols
Regeneration surveys, plantation inspection, site preparation and reforestation prescription. Practice in marking for thinning and determining effect on stands. Compartment examination and prescription. Written and oral reports.

5102. FOREST WILDLIFE HABITAT MANAGEMENT. (1 cr; prereq 5100, FW 3052, §5101; offered at Cloquet) Jordon
Forest vegetation management techniques for developing and maintaining wildlife habitat; vegetation dynamics, habitat requirements, and silvicultural techniques.

5104. FOREST ECOLOGY. (4 cr; prereq 8 cr biol, 4 cr chem) Sucoff
Ecological concepts and principles as basis for conservation and management of forest ecosystems.

5110. FORESTRY APPLICATIONS OF MICROCOMPUTERS. (4 cr; prereq Stat 3011, AgET 3030 or equiv) Blinn, Burk
Use of commercial microcomputer software to solve forestry problems; applications programming; workings of hardware components. Hands-on access to microcomputers and lectures.

5114. FOREST HYDROLOGY. (4 cr; prereq 3103, Biol 1009, Chem 1052, Geo 1001, Math 1142, Phys 1001 or #) Brooks
Introduction to the hydrologic cycle and hydrologic processes. Effects of forest management activities on water yield, storm flow, and water quality.

5115. FOREST HYDROLOGY, FIELD APPLICATIONS. (2 cr; prereq 5114 or #) Brooks
Use of hydrologic instrumentation needed to measure precipitation, streamflow, infiltration capacity, soil moisture, air temperature, evaporation, and selected water quality constituents. Collection and interpretation of hydrologic information needed to evaluate forest-use impacts on water quantity and quality.

5120. TREE PHYSIOLOGY. (3 cr; prereq Chem 1001 or Chem 1004, 10 cr biol)
Genetic variation in forest trees, its underlying causes, and its use in forestry. Tree growth, nutrition, and water relations. Environmental and internal regulation of growth. Plant biochemistry and photo-chemistry. Physiology related to silviculturally and ecologically significant phenomena.

5126. SILVICULTURE; SOIL-SITE RELATIONSHIPS. (2 cr; prereq 1122, 5100, Δ; offered at Cloquet) Grigal
Field examination of forest soils and their relationship to site productivity and forest management.

5130. GEOGRAPHIC INFORMATION SYSTEMS IN NATURAL RESOURCE ANALYSIS. (2 cr; prereq sr or grad student or #) Queen
Introduction to application of Geographic Information Systems to natural resource and regional planning studies; theory and technical points, emphasizing applications; hands-on microcomputer experience; performance of case study, including map digitizing, data processing, and generation of map products.

5142. TROPICAL FOREST ECOLOGY. (3-4 cr; prereq 1 ecology course at 3xxx or higher) Reich
Ecological principles related to form, function, and development of wet and dry tropical forests, at organismal, community, and ecosystem scales. Succession, productivity, biodiversity, sustainability, agroforestry, and management alternatives. Natural distribution of forest types; causes, consequences, and extent of deforestation.

5146. DYNAMICS OF GLOBAL CHANGE: PLANT ECOLOGY. (3-4 cr; prereq 1 plant ecology or plant physiology course a 3xxx or higher) Reich
Implications of global change upon wild and cultivated vegetation, including forests, grasslands, and agricultural ecosystems. Responses at ecosystem, community, organismal, and physiological scales. Potential climate change; elevated atmospheric concentrations of carbon dioxide, ozone, and other trace gasses; acid deposition; and other pollutants.

5152.* FOREST GENETICS. (3 cr; prereq Biol 1103, Stat 3011) Mohn
Genetic variation of forest-tree species and underlying principles; application of plant breeding principles to forestry.

5153.* ADVANCED FOREST HYDROLOGY. (4 cr; prereq 3220, 5114 or #) Brooks
Current hydrologic problems associated with management of forested watersheds. Analytical methods to evaluate vegetation management effects on quantity and quality of runoff.

5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS. (3 cr; prereq grad student, #; given at Itasca) Sucoff
Plant identification, plant dynamics, land survey, tree measurement.

5200. AERIAL PHOTO INTERPRETATION. (3 cr) Bauer
Types, characteristics, procurement, preparation, viewing, and interpretation of color, black-and-white, and color infrared aerial photographs; basic aerial photography; introduction to mapping; applications to resource surveys.

5202. REMOTE SENSING: FIELD

APPLICATIONS. (2 cr; prereq 5200, 5212; offered at Cloquet) Bauer

For inventorying, mapping, and monitoring forest and natural resources.

5212. NATURAL RESOURCES INVENTORY. (4 cr; prereq Itasca Session, 3201, AgET 3030 or equiv computer programming course with FORTRAN or BASIC, Math 1142 or Math 1211, Stat 3011 or Stat 5021) Burk

Measurement of stand variables, forest products, forest growth and yield. Elementary statistics. Sampling methods for estimating characteristics of natural resources and resource use for management decision making. Lecture and lab.

5215. FOREST FIRE MANAGEMENT. (2 cr; prereq 1100, Itasca Session, 3103, 5100 or #) Cole
Concepts, principles, and techniques of fire control and use in wild land management.

5222. FOREST RESOURCES INVENTORY. (2 cr; prereq 5212; offered at Cloquet) Ek
Field application of sampling methods for estimating natural resources characteristics for inventory, appraisal, and monitoring purposes.

5225. DIRECTED STUDY EXPERIENCE. (1-5 cr; prereq jr or sr or grad student, #)
Opportunity to pursue experiences not available under independent study or extra credit registration. In consultation with adviser for project, student develops prospectus and completes progress and final reports on project.

5226. FOREST ECONOMICS AND PLANNING.

(5 cr; prereq Ag Econ 1101 or Econ 1101 or #)

Gregersen, Rose

Conduct and interpretation of economic analysis, forest planning concepts, principles, and techniques of forest regulation.

5231. RANGE MANAGEMENT. (3 cr; prereq Biol

1103 or #) Brooks

Important range plants; range livestock; range management methods and improvements; public grazing land administration; relationship of livestock grazing to wildlife, forest, watershed, and recreation management on public and private range lands.

5233.* PRINCIPLES OF OUTDOOR RECREATION

PLANNING. (3 cr; prereq 5232 or #, Stat 3011, Stat

5021 or Soc 3801) D Anderson, Lime

Planning methodologies. Survey instruments and observational techniques for data gathering; analysis of information gathered and of data generated by computer mapping techniques; use of GIS information in planning recreational uses and in understanding trade-offs between choices; selection of appropriate planning strategies for public involvement processes in recreation resource planning.

5236. FOREST RECREATION PLANNING. (1 cr;

prereq 5232, Δ; offered at Cloquet) D Anderson
Recreation area and site planning, examples and managerial concerns. Fieldwork and presentation.

5240. NATURAL RESOURCE POLICY AND

ADMINISTRATION. (3 cr; prereq AgEc 1101 or Econ 1101, AgEc 1102 or Econ 1102, Pol 1001, Rhet 1151)

Ellefson

Basic concepts of political and administrative processes important to development of natural resource policies and programs. Focus on policy processes, agenda setting, political decision rules, strategies for achieving agreement, participants in policy development, public means of implementing policies, and case examples.

5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES. (3 cr; prereq 5240 or #) Ellefson

Advanced concepts of political and administrative processes important to development of natural resource policies and programs. Issue creation and agenda setting theories, incremental decision-making styles, role of analysis and analytical information, actions of major policy participants (e.g., courts, legislatures, interest groups, media), program planning, budgeting and staffing, and evaluation of natural resource case studies.

5248. HARVESTING AND ENGINEERING. (3 cr;

prereq 3300 or CE 3100, Δ; offered at Cloquet) Staff
Introduction to harvesting systems, relationship to forest management, and the preparation and administration of timber sales. Location, construction, and maintenance of forest roads.

5250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES. (2 cr)

Gregersen, Rose

International perspective on important resource issues, including integration of natural resource, social, and economic considerations. Overviews on important issues and case studies. Term paper and/or other requirements.

5257.* RECREATION LAND POLICY. (3 cr; prereq

3232 or #; offered alt yrs) D Anderson, Lime

Policy issues affecting the use and management of lands devoted entirely or in part to recreational objectives.

5259.* ANALYSIS OF OUTDOOR RECREATION

BEHAVIOR. (3 cr; prereq 3232, RRM major or grad

student or #; offered alt yrs) D Anderson, Lime

Development of environmental framework for understanding recreation behavior; contributions of several disciplines; current cultural trends; management implications.

5262. REMOTE SENSING OF NATURAL

RESOURCES. (4 cr) Staff

Introduction to remote sensing for natural resource inventories, land use analyses, and environmental monitoring activities; photographic, thermal, multispectral, and radar sensing procedures; airborne and satellite systems; visual and computer-assisted analysis techniques. Oriented toward an interdisciplinary audience.

5264. QUANTITATIVE TECHNIQUES IN FOREST

MANAGEMENT. (3 cr; prereq 5212, 5226 or #) Rose

Forestry applications of quantitative techniques in allocation and other decision-making problems. Mathematical programming, simulation.

Graduate Programs

5403.* FUNDAMENTALS OF NATURAL RESOURCE EDUCATION. (3 cr; limited to 35 students)

For elementary school teachers. Soil, water, forest, and wildlife resources of Minnesota and biological principles and ecological implications of management. Environmental issues associated with natural resource manipulation. Outdoor teaching skills in environmental education developed through experience in metropolitan area nature centers.

5412. ADVANCED REMOTE SENSING. (4 cr; prereq 5262 or #) Bauer

Theoretical basis and practical applications of quantitative remote sensing, including spectral-biophysical relationships, radiation measurements, and spectral pattern recognition. Lectures, problems, and case studies with digital image analysis system.

5500. URBAN FOREST MANAGEMENT. (3 cr;

prereq 5100 or #) Staff

Discussion and development of basic concepts. Introduction to terminology and principles of urban tree inventory, propagation, and care; management case studies; equipment operation and costs.

5703. COLLOQUIUM IN FOREST BIOLOGY. (1-4

cr; prereq varies with topic) Furnier, staff

Specialized topics in forest biology and silviculture.

5704. COLLOQUIUM IN NATURAL RESOURCES.

(1-4 cr; prereq varies with topic) Brooks, Gregersen, staff

8100.* RESEARCH PROBLEMS: SILVICULTURE.

(Cr ar) Alm

8101.* RESEARCH PROBLEMS: FOREST-TREE

PHYSIOLOGY. (Cr ar) Sucoff

8102.* RESEARCH PROBLEMS: FOREST-TREE

GENETICS. (Cr ar) Furnier, Mohn

8103.* RESEARCH PROBLEMS: FOREST

HYDROLOGY. (Cr ar) Brooks, Perry

8104. RESEARCH PROBLEMS: FOREST

ECOLOGY. (1-8 cr) Grigal, Reich, Sucoff

8105. ADVANCED FIELD SILVICULTURE. (3 cr;

prereq 5101, #) Staff

Selected current problems and research in silviculture. Plant-soil relationships with particular reference to forest soils. Methods of forest soil investigations in the field and lab.

8106. TOPICS IN SILVICULTURE—FOREST

SOILS. (Cr ar; prereq 5100, 5 cr soils or #) Grigal

8107. SEMINAR: FOREST RESOURCES. (1 cr) Staff

Assigned topics, problem analyses, and research reports.

8108. FOUNDATIONS OF RENEWABLE

RESOURCES RESEARCH. (3 cr; prereq #; offered when feasible) Leary

8112. RESEARCH PROBLEMS: PHYSIOLOGICAL

ECOLOGY. (1-8 cr) Reich, Sucoff

Interaction between plants and their environment, focusing on mechanisms that affect whole plant, community, and ecosystem processes. Causes and consequences of variation in resource availability and stress in diverse ecosystems; relationships of resource availability and stress to plant establishment, growth, and survival; linkages between organismal, community, successional, and ecosystem processes.

8200.* RESEARCH PROBLEMS: FOREST

MANAGEMENT. (Cr ar) Blinn, Hoganson, Reed, Rose

8201.* RESEARCH PROBLEMS: FOREST

ECONOMICS. (Cr ar) Ellefson, Gregersen, Hoganson, Rose, Skok

8202.* RESEARCH PROBLEMS: FOREST

MEASUREMENTS. (Cr ar) Burk, Ek, Rose

8203.* RESEARCH PROBLEMS: FOREST

RECREATION. (Cr ar) D Anderson, Lime

8204.* RESEARCH PROBLEMS: FOREST

POLICY. (Cr ar) Baughman, Ellefson, Gregersen, Skok

8205.* RESEARCH PROBLEMS: REMOTE

SENSING. (Cr ar) Bauer, Queen

8207. ECONOMIC ANALYSIS OF FORESTRY

PROJECTS. (3 cr; prereq #) Gregersen

Public and private forestry projects; analysis of commercial profitability and application of benefit-cost analysis; preparation of feasibility studies; case studies.

8301. TEACHING PRACTICUM. (2-4 cr; prereq

permission of adviser, #) Furnier

Students develop and teach undergraduate colloquium, recitation or lab section, or extension workshop on natural resources topic. Instructor advises on development and execution of course.

Natural Resources and Environmental Studies (NRES)

5020. PLANT RESOURCE MANAGEMENT AND

THE ENVIRONMENT. (4 cr; prereq sophomore, Biol 1009, ¶3020)

World vegetation management practices, extent, and implications. Forest management, agriculture, and agroforestry; historical, current, and prospective practices and environmental and societal implications.

5100. PROBLEM SOLVING IN NATURAL

RESOURCES AND ENVIRONMENTAL STUDIES.

(5 cr; prereq 12 cr in concentration for NRES majors, FR 5232 and FR 5233 for rec resource mgmt majors, Rhet 3562, Stat 3012) D Anderson, Cooper
Solving real-world natural resources and/or environmental problem. Discussions and assignments reflect diverse aspects of problem. Oral and written presentations. Team participation.

5101. INTEGRATED NATURAL RESOURCE

PLANNING. (5 cr; prereq 5210 or FR 5212, FR 5226, FR 5240, 1 rec resource mgmt course, 1 ecol course, 1 hydrology course or #)

Application of skills from previous courses. Information and models for assessing impacts of natural resource management and trade-offs among alternative management approaches.

5210. SURVEY, MEASUREMENT, AND MODELING METHODS FOR NATURAL RESOURCES I.

(4 cr; prereq AgEt 3030 or CSci 3101 or CSci 3102 or CSci 3113 or GC 1571, Math 1142 or Math 1251, Stat 3011 or Stat 5021) Ek

Introduction to survey design, measurement concepts, and modeling methods useful in study of natural resources and environmental issues. Emphasis on data collection and analysis.

5220. SURVEY, MEASUREMENT, AND MODELING METHODS FOR NATURAL RESOURCES II.

(4 cr; prereq 5210 or FR 5212 or equiv; offered alt yrs) Burk, Ek

Advanced survey design, measurement concepts, and modeling methods for study of natural resources and environmental problems.

5225. DIRECTED STUDY EXPERIENCE. (1-5 cr; prereq jr or sr or grad student, #)

Opportunity to pursue experiences not available under independent study or extra credit registration. In consultation with adviser for project, student develops prospectus and completes progress and final reports on project.

5575. WETLANDS CONSERVATION. (4 cr; prereq EEB 3001 or EEB 3101, Biol 5041 or #; ¶3575, plus one more hr per wk)

Freshwater wetland classification, biota, current/historic status, value, and conservation strategies and ecological principles used in wetland management.

5600. PRINCIPLES OF WASTE MANAGEMENT. (4 cr; prereq Biol 1009 or Chem 1051, Stat 3011 or #)

Cooper, Holbach
Understanding issues, problems, and solutions in remedying waste stream generated by current society. Waste stream dynamics, MSW and yard waste composting, WTE incineration operation, ash disposal, recycling, landfill requirements, and direct land disposal requirements, regulatory trends, and case studies.

French and Italian

Professor: Maria F. Paganini, *chair:* Ronald F. Akehurst; Tom C. Conley; Susan J. Noakes; Joseph L. Waldauer

Associate Professor: Judith Preckshot, *director of graduate studies:* Betsy K. Barnes; Daniel Brewer; Mária M. Brewer; Ronald L. Martinez; Peter H. Robinson; Eileen B. Sivert

Assistant Professor: Susanna Ferlito; Molly B. Wieland

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—French: M.A. (Plan A and Plan B) and Ph.D.; Italian: M.A. (Plan A and Plan B).

Curriculum—Majors in French and Italian are offered.

Prerequisites for Admission—For major work, 50 upper division quarter credits or the equivalent in the major field (French or Italian), at least 20 credits of which are in literature, are required. Students in the program ordinarily find it necessary to supplement their undergraduate work with a considerable amount of independent reading.

Special Application Requirements—New students may enter in any quarter or summer term.

Master's Degree Requirements—Before registering for their first quarter of graduate work, students must consult the director of graduate studies. Students should familiarize themselves with the special requirements of the department. A final written examination (given during the third week of fall and spring quarters) and a final oral examination are required. See the department's general information bulletin for details.

Doctoral Degree Requirements—Before registering for their first quarter of graduate work, students must consult the director of graduate studies. Students entering with an M.A. degree from another institution must take a Ph.D. qualifying examination before the end of the seventh week of their second quarter. Immediately after passing the M.A. or qualifying examination, students design their programs in consultation with their advisory committees. Four topics or fields of inquiry are chosen. See the department's general information bulletin for details.

Language Requirement—Candidates for the master's degree must have a reading knowledge of at least one Romance language other than the language of their major field (for majors in French: Italian, Spanish, or Portuguese; for majors in Italian: French, Spanish, or Portuguese). Doctoral degree students must have a knowledge of Latin equivalent to at least two years of high

Graduate Programs

school study; a reading knowledge of a second Romance language; and by the end of the first year of graduate work, a reading knowledge of an additional foreign language (Italian, Portuguese, Spanish, or German). Other preparation is considered if suited to student needs. The reduction of language requirements is under review.

For Further Information and Applications—A department general information bulletin and a projection of graduate-level courses to be offered is available from the Department of French and Italian, University of Minnesota, 260 Folwell Hall, 9 Pleasant Street S.E., Minneapolis, MN 55455 (612/624-4308).

Fren 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Fren 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Fren 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Ital 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

French (Fren)

5017. COMPOSITION ET STYLISTIQUE. (4 cr; prereq 3017 or #) Staff
Translation, imitation, and composition of fiction and nonfiction, prose and poetry, using both English and French texts.

5105. TOPICS IN CRITICISM. (4 cr; prereq 3209 or above, undergrad French lit major or MA student) Staff
Introduction to current issues in critical theory.

5207. OLD FRENCH. (4 cr; prereq 3209 or above)
Akehurst
Preparation for reading medieval French texts in the original.

5219. HUMANISM AND ITALIANISM IN THE LITERATURE OF THE 16TH CENTURY. (4 cr, §Frit 5219, §Ital 5219; prereq 3209 or above)
Aspects of Italian civilization from Dante to Machiavelli that led to the Renaissance. Focus on French and Italian literary texts. Taught in English; knowledge of Italian not required.

5289. TOPICS IN AFRICAN LITERATURE. (4 cr; prereq 3209 or above) Preckshot
Francophone African and Afro-Caribbean literature in its historical, cultural, or ideological contexts.

5311. RENAISSANCE POETRY BEFORE THE PLÉIADE. (4 cr; prereq 3209 or above) Conley
The *grands rhétoriciens*, Lemaire, Marot, Saint-Gelays, Louise Labé, and others; includes study of elegy, emblem, *blason*, and *art poétique*.

5312. PLÉIADE AND BAROQUE. (4 cr; prereq 3209 or above) Conley
Ronsard, Du Bellay, and other poets of the Pléiade and the first baroque poets, including Sponde, Du Bartas, Desportes, Chassignet.

5331. FRENCH POETRY FROM D'AUBIGNÉ TO LA FONTAINE. (4 cr; prereq 3209 or above) Conley
Movement from baroque to classicism studied in the great verse creations of the 17th century.

5354. DRAMA OF THE 18TH CENTURY. (4 cr; prereq 3209 or above) Waldauer
Tragedy, drama, comedy (emphasis on comedy).

5355. NOVEL OF THE 18TH CENTURY. (4 cr; prereq 3209 or above) Waldauer
Emphasis on novels of Marivaux, Diderot, and Laclos.

5368. SHORT STORIES OF THE 19TH CENTURY. (4 cr; prereq 3209 or above) Sivert
From Charles Nodier to Villiers de l'Isle-Adam. (See 5467 for Flaubert).

5380. THE FRENCH NOVEL IN THE 20TH CENTURY. (4 cr; prereq 3209 or above) Brewer, Paganini
Includes prose texts. Novel, essay, short story, philosophical récit, autobiography.

5415. RABELAIS. (4 cr; prereq 3209 or above) Conley
Gargantua and *Pantagruel* in original text.

5457. ROUSSEAU. (4 cr; prereq 3209 or above) Waldauer

5459. DIDEROT. (4 cr; prereq 3209 or above) Waldauer

5461. BAUDELAIRE. (4 cr; prereq 3209 or above) Robinson

5465. STENDHAL. (4 cr; prereq 3209 or above) Sivert, Waldauer

5466. BALZAC. (4 cr; prereq 3209 or above) Sivert

5467. FLAUBERT. (4 cr; prereq 3209 or above) Paganini, Sivert

5471. MALLARMÉ. (4 cr; prereq 3209 or above) Robinson

5475. ZOLA AND THE NATURALISTIC NOVEL. (4 cr; prereq 3209 or above) Sivert

5486. PROUST. (4 cr; prereq 3209 or above) Paganini

5505. TOPICS IN CULTURE. (4 cr; prereq 3201 or above, knowledge of French)
Comprehensive seminar on contemporary continental theories of discourse and culture. Conceptions of language, ideology, and culture as symbolic systems.

5701. STRUCTURE OF FRENCH: PHONOLOGY. (4 cr; prereq 3014 or 3016 or #) Barnes
Advanced study of sound system of contemporary French.

5702. STRUCTURE OF FRENCH: MORPHOLOGY AND SYNTAX I. (4 cr; prereq 3016; 5701, Ling 3001 or Ling 5001 recommended) Barnes

Linguistic study of word forms of contemporary French (derivational and inflectional morphology); introduction to French syntax (linguistic study of grammar).

5703. STRUCTURE OF FRENCH: SYNTAX II. (4 cr; prereq 5702 or #)

Linguistic study of selected aspects of contemporary French syntax, such as pronouns, relative clauses, interrogatives, reflexive verbs. Some attention to syntactic features of spoken French.

5710. TOPICS IN FRENCH SOCIOLINGUISTICS.

(4 cr; prereq 3016) Wieland
Socioculturally appropriate uses of the language and regional and contextual language variation.

5800. CIEE CONTEMPORARY FILM PROGRAMS IN PARIS. (1-45 cr [undergrad], 1-15 cr [grad]; prereq 1105 or #)

Semester or year of study in film criticism and/or history with French faculty. Structural analysis, modern institutions and media, study/criticism of European and American film. Remedial courses in French available. Advanced students also may take courses at Paris universities.

5900. TOPICS IN FRENCH LITERATURE. (3-5 cr per qtr [max 15 cr]; prereq 3209 or above) Staff

5920. TOPICS IN EARLY FRENCH PROSE (800-1600). (3-5 cr per qtr; prereq 3219 or above)

5930. TOPICS IN EARLY FRENCH POETRY (800-1600). (3-5 cr per qtr; prereq 3219 or above)

5940. TOPICS IN EARLY MODERN FRENCH PROSE (1600-1900). (3-5 cr per qtr; prereq 3219 or above)

5950. TOPICS IN EARLY MODERN FRENCH POETRY (1600-1900). (3-5 cr per qtr; prereq 3219 or above)

5960. TOPICS IN MODERN FRENCH PROSE (1850-present). (3-5 cr per qtr; prereq 3219 or above)

5970. TOPICS IN MODERN FRENCH POETRY (1850-present). (3-5 cr per qtr; prereq 3219 or above)

5980. TOPICS IN FRENCH THEATRE. (3-5 cr per qtr; prereq 3219 or above)

5999. FOREIGN LANGUAGE TEACHING: THEORY AND PRACTICE. (4 cr; prereq grad student or #) Barnes, Wieland
Theoretical and practical aspects of French-language learning and teaching.

8010. SEMINAR IN POETRY. (3-5 cr per qtr [max 15 cr]) Preckshot

8030. SEMINAR IN DRAMA. (3-5 cr per qtr [max 15 cr]) Brewer, Sivert

8050. SEMINAR IN FICTION. (3-5 cr per qtr [max 15 cr]) Brewer, Paganini

8070. SEMINAR IN POETIC THEORY. (3-5 cr per qtr [max 15 cr])

8090. SEMINAR IN FILMIC ANALYSIS. (3-5 cr per qtr [max 15 cr]) Conley

8110. SEMINAR IN PROBLEMS OF MEDIEVAL WRITING. (3-5 cr per qtr [max 15 cr]) Akehurst

8120. SEMINAR IN PROBLEMS OF 16TH-CENTURY WRITING. (3-5 cr per qtr [max 15 cr]) Conley, Noakes

8130. SEMINAR IN PROBLEMS OF 17TH-CENTURY WRITING. (3-5 cr per qtr [max 15 cr])

8150. SEMINAR IN PROBLEMS OF 18TH-CENTURY WRITING. (3-5 cr per qtr [max 15 cr]) Waldauer

8170. SEMINAR IN PROBLEMS OF 19TH-CENTURY WRITING. (3-5 cr per qtr [max 15 cr]) Sivert

8190. SEMINAR IN PROBLEMS OF 20TH-CENTURY WRITING. (3-5 cr per qtr [max 15 cr]) Brewer, Paganini

8310. SEMINAR IN CRITICISM AND LITERARY THEORY. (3-5 cr per qtr [max 15 cr])

8501. METHODOLOGY AND BIBLIOGRAPHY. (4 cr) Staff

8701. HISTORY OF THE FRENCH LANGUAGE. (4 cr) Akehurst

8704. OLD PROVENÇAL. (4 cr) Akehurst
Language and literature of the troubadours.

8970. DIRECTED READINGS FOR GRADUATE STUDENTS. (1-5 cr) Staff

8980. DIRECTED TEACHING. (1-5 cr)

8990. PH.D. TOPICS. (1-7 cr per qtr; prereq PhD student in French)
For students who have completed major portion of coursework and are preparing Ph.D. exam topics. Does not fulfill degree requirements.

Italian (Ital)

5042. INTENSIVE READING OF MODERN ITALIAN NARRATIVE LITERATURE. (4 cr; prereq 3015 or 3041 or #) Schneider
Twentieth-century authors analyzed from linguistic and literary points of view to achieve high level of reading competency and understanding of contemporary Italian literary scene. Taught in Italian.

5219. HUMANISM AND ITALIANISM IN THE LITERATURE OF THE 16TH CENTURY. (4 cr, §Fren 5219, §Frit 5219; prereq 3209 or above)
Taught in English; knowledge of French and Italian not required. Aspects of Italian civilization from Dante to Machiavelli that led to the Renaissance. Focus on French and Italian literary texts.

Graduate Programs

5321. RENAISSANCE EPIC. (4 cr; prereq 3015)

Martinez
Pulci, Boiardo, Ariosto, Tasso, Folengo. Chivalric epic in Florence and Ferrara in contexts of humanism, rise of nation-state, and questions of gender. Comparative reading in other European epic traditions. English and Italian sections.

5328. ITALIAN RENAISSANCE AUTHORS. (4 cr;

prereq 3015) Martinez
Bembo, Poliziano, Machiavelli, Gaspara Stampa, Castiglione, and others. Male and female authors subject to system of court patronage and currents of humanism and anti-humanism. Taught in Italian.

5331. MODERN POETRY. (5 cr; prereq 3015)

Schneider
Crepuscular and hermetic poets from Gozzano to Ungaretti, Montale, Saba, and Quasimodo.

5337. MANZONI AND THE 19TH-CENTURY

NOVEL. (4 cr; prereq 3015 or #) Schneider
I promessi sposi; novels by Verga, Deledda, D'Annunzio, and others. Textual analysis; evolution of modern novel.

5385. TWENTIETH-CENTURY NARRATIVE. (4 cr;

prereq 3015 or #) Schneider
Evolution and analysis of modern novel and novella. Authors include Svevo, Vittorini, Calvino, and others. Taught in Italian.

5401-5402-5403. DANTE. (4 cr per qtr; prereq 3015)

Martinez
Divina Commedia and minor works. Historical approach to most important literary work in Italian. Study of cosmology, scriptural exegesis, Italian history and Roman authors (Virgil, Ovid, Boethius) on Middle Ages, and revolution due to reintroduction of Aristotle, while following Dante's pilgrim through otherworld. English and Italian sections.

5411. PETRARCH AND PETRARCHISM. (4 cr;

prereq 3015) Martinez
Life and works of most influential writer of early modern Europe. *Rime sparse* and *Secretum*. Petrarch as founder of humanism and Italian lyric tradition from Troubadors to Dante. Comparative readings in subsequent Petrarchist movements in Europe. English, and Italian sections.

5418. BOCCACCIO AND THE NOVELLA. (4 cr;

prereq 3015) Martinez
Decameron and Boccaccio's minor works; story collections in Middle Ages and Early Renaissance, from *Novellino* to *Bandello*. English and Italian sections.

5609. DANTE (IN ENGLISH). (4 cr) Martinez

5900. TOPICS IN ITALIAN LITERATURE. (4 cr;

prereq 3209 or above)

8970. DIRECTED READINGS FOR GRADUATE STUDENTS. (1-5 cr) Staff

French and Italian (FrIt)

5531. BAROQUE LITERATURE IN FRANCE AND ITALY. (4 cr; prereq at least one 3xxx or 5xxx course in literature of France or Italy)

Taught in English. Spread of the Baroque in literature through Europe. Movement from Italy, changing but rooted in particular view of the world.

Genetics

See Molecular, Cellular, Developmental Biology and Genetics.

Geography (Geog)

Professor: John S. Adams; Ward J. Barrett; Dwight A. Brown; Philip J. Gersmehl; John F. Hart; Mei-Ling Hsu; Fred E. Lukermann (*emeritus*); Philip W. Porter; John G. Rice; Joseph E. Schwartzberg; Earl P. Scott; Eric S. Sheppard; Richard H. Skaggs

Associate Professor: Helga Leitner; Judith A. Martin; Robert B. McMaster; Roger P. Miller; Abdi I. Samatar; Roderick H. Squires; Graham A. Tobin¹; Connie H. Weil

Assistant Professor: William J. Craig; Katherine Klink

Cartographer: Gregory H. Chu

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Geography at Minnesota covers six broad clusters: cultural and historical geography and the history and philosophy of the discipline itself; physical geography and environmental systems; urban and economic geography; cartography and geographic information systems; regional geography; and social and political economy of development. Students work with their advisers to design individual programs suited to their educational and professional goals.

Prerequisites for Admission—Prospective students should have completed the equivalent of introductory courses in physical and human geography and at least seven upper division courses in systematic and regional geography. Students who were not undergraduate geography majors are encouraged to apply but may be required to make up deficiencies.

¹ University of Minnesota, Duluth

Special Application Requirements—Three letters of recommendation must be sent directly to the department. Tardy letters delay processing of the application. Scores from the General (Aptitude) Test of the Graduate Record Examination (GRE) that are less than five years old are required of students with baccalaureate degrees from U.S. institutions. Graduate study in the program begins in the fall quarter. The application deadline is January 1; all applications are evaluated once each year in early February.

Master Degree Requirements—The final examination for both plans is oral. In unusual circumstances the graduate faculty may substitute a written examination for the Plan B oral examination. For further information about master's degree requirements, contact the director of graduate studies.

Doctoral Degree Requirements—Information on selecting an adviser and constructing a doctoral program can be obtained by requesting a copy of "The Graduate Program in Geography at the University of Minnesota" from the director of graduate studies.

Language Requirements—M.A. and Ph.D. students are expected to acquire competence in the research tools appropriate to their endeavors as graduate students and to their future professional work. Often these are foreign languages and/or quantitative or experimental skills. The language and technique requirement is set by the advising committee, which is also responsible for certifying that the requirement has been met before the M.A. final examination is scheduled.

Minor Requirements for Students Majoring in Other Fields—A minor program must be developed in consultation with an appropriate faculty adviser. Consult the director of graduate studies about selecting an adviser.

For Further Information and Applications—Contact the Department of Geography, University of Minnesota, 414

Social Sciences Building, 267 19th Avenue South, Minneapolis, MN 55455 (612/625-6080; fax 612/624-1044).

Geog 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Geog 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Geog 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Regional Studies

5101. HISTORICAL GEOGRAPHY OF NORTH AMERICA. (4 cr) Lukermann
Sequential analysis of settlement and economy in changing environment and resource pattern of North America in the period of frontier interaction, 1500-1900.

5102. HISTORICAL GEOGRAPHY OF NORTH AMERICA. (4 cr; offered alt yrs) Lukermann
Sequential analysis of settlement and economy in changing environment and resource pattern of North America in the period of sectional industrialization, rural to urban change and national metropolitan dominance.

5111. SELECTED REGIONS OF THE EASTERN UNITED STATES. (4 cr; offered alt yrs) Hart
Intensive geographical analysis of selected regions east of the Great Plains. Regions selected vary yearly.

5131. COLONIAL MEXICO AND THE CARIBBEAN. (4 cr) Barrett
Exploration, discovery, livelihood, and circulation to about 1800.

5132. SOUTH AMERICA. (4 cr; offered alt yrs) Weil
Regional survey of physical resources, population, agriculture, manufacturing, and transportation in South America.

5142. GEOGRAPHY OF EAST AFRICA. (4 cr, §Afro 5142; offered alt yrs) Porter
Physical and human geography of Kenya, Tanzania, and Uganda with emphasis on environment as resource, historical geography of colonial and postcolonial eras, geographical organization of human activity, and regional contrasts.

5143. GEOGRAPHY OF WEST AFRICA. (4 cr, §Afro 5143) Scott
Regional study of West Africa from Senegal to Cameroon: social geography of resource use, population, settlement, economic development, and international relations.

5145. DEVELOPMENT IN AFRICA. (4 cr, §Afro 5145, §IntR 5145) Samatar, Scott
Economic, political and social development in Africa, from independence to present. Recording colonial landscapes, bases for North-South relations, big power interventions, and participation in the world economy.

5171. WESTERN EUROPE. (4 cr; offered when feasible) Leitner, Rice

Graduate Programs

5172. EASTERN EUROPE. (4 cr) Leitner
Physical and human geography of socialist realms of Eastern Europe with comparative analyses of individual countries; emphasis on historical, economic, and political diversity, with topical case studies.

5173. NORDEN. (4 cr; offered alt yrs) Rice
Physical and human geography of Sweden, Finland, Denmark, Norway, and Iceland; emphasis on population change and settlement patterns.

5176. SCANDINAVIA IN THE 19TH AND 20TH CENTURIES. (4 cr, §Hist 3273; offered alt yrs) Metcalf, Rice
Team-taught, interdisciplinary examination of social and economic transformation of Scandinavia, 1800 to present; from agrarian periphery to European integration; impact of demographic, economic, and social change; social democracy and politics of consensus.

5177. SCANDINAVIA IN THE EARLY MODERN PERIOD. (4 cr, §Hist 3272; offered alt yrs) Metcalf, Rice
Team-taught, interdisciplinary examination of social and economic transformation of Scandinavia, 1500-1800; centralization of state power and the Reformation; struggle for commercial and political control of Baltic; absolutism in the North; political and agrarian reforms.

5178. SCANDINAVIA IN THE MIDDLE AGES. (4 cr, §Scan 5118; offered alt yrs) Rice, Metcalf
Team-taught interdisciplinary examination of economic, political, and social history of Scandinavia, from late Viking period until circa 1500. Agrarian and urban societies; peasant and elite perspectives; growth of economic, political, religious and social institutions.

5181. RUSSIA AND ENVIRONS. (4 cr) Adams
Physical and human geography of republics of former USSR. Imprint of central planning and state socialism on regional economies, city systems, and internal structures of cities. Economic and cultural linkages among regions and republics. Conflicts rooted in religion, ethnicity, and tradition. Contacts with neighboring states and regions. Physical environmental problems.

5191. AGRICULTURAL MARKETING IN AFRICA. (4 cr; offered alt yrs) Samatar, Scott
Cultural, ecological, and spatial analysis of structural change in rural Africa with emphasis on the impact of commercialism on traditional socioeconomic institutions and the spatial behavior pattern of small land-holders.

5211. EAST ASIA: REGIONAL ANALYSIS. (4 cr, §3211) Hsu
Regional aspects of East Asian life. The effects, within a traditional context, of population growth and modern technology on the transformation of society and reorganization of space.

5212. SOUTH ASIA. (4 cr, §3212) Schwartzberg
Physical and human geography of India, Pakistan, Bangladesh, Sri Lanka, Afghanistan, and the Himalayan kingdoms; geographic aspects of social structure, population pressure, economic development, and international relations.

5215. CHINA. (4 cr, §3215; prereq one social science course) Hsu
Socioeconomic geography of China. Environment as resource, population dynamics, economic development, and social change. Geographic organization of human activities, regional contracts, foreign trade, and international relations.

Topical Studies

5311, 5312. TIME GEOGRAPHY I, II. (4 cr per qtr; offered when feasible) Miller

5361. THE GEOGRAPHY OF LAND OWNERSHIP. (4 cr; prereq #) Squires
Evolution and spread of land ownership in United States. Public records associated with land ownership.

5371. NORTH AMERICAN CITIES. (4 cr; prereq 1301 or 1501 or 1970 or 3371 or 3973 or 5001 or #) Adams
Emergence of towns and cities in North America; urban economy and its locational requirements, past and present; central place theory; comparisons of city systems in capitalist, socialist, and developing areas; structure and change of land used inside urban areas.

5372. METRO ANALYSIS I: POPULATION AND HOUSING. (4 cr) Adams
Metro housing stocks, supply of housing services; demand for housing; population and households; housing price structure, changes, intraurban migration; spatial submarkets and housing in metro areas. Emphasis on linking theory, method, and case studies.

5373. METRO ANALYSIS II: URBAN ECONOMIC GEOGRAPHY. (4 cr) Adams
Urban economic base analysis, shift-share analysis, and inter-metro competition; input-output analysis with ecological multipliers; central place theory and urban structure, functional regions within the city center; services economy and metro land development; locational conflict within city. Emphasis on linking theory, method, and case studies.

5385. POLITICAL ECONOMY OF DEVELOPMENT. (4 cr; prereq sr or grad student or #) Samatar
Nature and scope of the modern world system (capitalism) and its impact on regional development processes; roles of the state and international financial institutions.

5393. LOOK OF THE LAND. (4 cr; offered alt yrs) Hart
Major components of landscape; emphasis on interaction between structures created by people and distinctive rural landscapes in North America, northwestern Europe.

5411. MEDICAL GEOGRAPHY. (4 cr; offered alt yrs) Weil
Concepts and methods, including distribution and diffusion of disease; impact of environmental, population, and social change on health; distribution, accessibility, and use of health practitioners and facilities.

5423. CLIMATE MODELS AND MODELING. (4 cr; prereq 3421 or #) Klink, Skaggs
Survey of development of and research with one-, two-, and three-dimensional climate models. Overview of environmental processes and their numerical representation in models; evaluation of model sensitivity and accuracy; coupling between atmosphere, biosphere, hydrosphere, and cryosphere; assessment of model predictions for climate change.

5424. APPLIED CLIMATOLOGY. (3 cr, §Soil 5424; prereq 3421 or Soil 5240 or #; offered alt yrs) Baker, Klink, Skaggs
Application of climatic principles and data to selected problems in environmental management and agriculture.

5441. QUATERNARY LANDSCAPE EVOLUTION. (4 cr; prereq 1401 or #) Brown
Roles of geomorphic history, climate change, soil development, and vegetation change in evolution of landscape patterns during Quaternary, with emphasis on North America.

5444. GEOGRAPHY OF WATER RESOURCES. (4 cr; prereq two courses physical geog or #) Brown
Distributional aspects of the magnitude, quality, and dynamics of water resources. Aesthetic, recreational, and material production uses of water; consequences of various human actions in hydrosphere with emphasis on fresh water.

5601. INTRODUCTION TO LAND USE PLANNING. (4 cr) Lukermann
Context of planning within changing geographic patterns of land use. Nature of land use plans; purpose and process of land use planning.

5605, 5606. GEOGRAPHICAL PERSPECTIVES ON URBAN PLANNING I, II. (4 cr; offered alt yrs) Leitner, Miller
Comparative examination of planning concepts and practices in reshaping geography of 19th- and 20th-century cities in Europe, North America, and selected Third World countries. History and ideologies of planning. Planning as response to economic, political, and social change and problems. Interest groups and power relations in planning process. Planning and geography of livable city. *5605*: systematic critical overview of historical evolution of planning; *5606*: case studies.

Technical Studies

5511. CARTOGRAPHIC ANALYSIS. (4 cr; prereq 3511 or basic statistics course; offered alt yrs) Brown, Hsu, McMaster, Porter
Methods of data compilation; quantitative analysis of maps, map types, graphic correlation, composite mapping; area sampling, classification, and other generalization problems.

5512. CARTOGRAPHY: TOPICS. (4 cr; prereq 3511 or #; offered alt yrs) Brown, Hsu, McMaster, Porter
Selected topics: the system of cartographic communication, map design, map reading, map analysis, history of cartography.

5522. COMPUTER CARTOGRAPHY: PRINCIPLES AND DESIGN CONCEPTS. (4 cr; prereq 3511 or #) Hsu
Elements and principles of cartographic design; applications to different map themes; using microcomputer with package software to explore message-focused map design.

5523. ELEMENTS OF DIGITAL CARTOGRAPHY. (4 cr; prereq 3511, 3531 or 5522, 1 programming language or #) McMaster
Fundamental issues. UNIX operating system and programming on workstations. FORTRAN programming and SUNPHIGS. Vector encoding and error. Generalization models and techniques. Geographical data structures. Computational geometry. Cartometric analysis. Computer-generated cartographic symbolization.

5530. CARTOGRAPHY INTERNSHIP. (2-5 cr per qtr [max 10 cr, incl combined cr at 3xxx and 5xxx levels]; prereq #) Hsu, McMaster
Internship with institution, government agency, or private company arranged through and supervised by department.

5531. ADVANCED QUANTITATIVE METHODS IN GEOGRAPHY. (4 cr; prereq basic statistics course; offered alt yrs) Klink, McMaster, Sheppard, Skaggs
Topics may include multivariate methods, regionalization, spatial autocorrelation, spatial pattern analysis.

5562. INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS. (4 cr, §LA 5562; prereq jr or sr in geog or LA or grad student or #) Brown, McMaster
Geographic information systems structure; theory and applications for geographic research, location and resource analysis, and regional planning; location principles, data structure, and variable attributes.

5563. ADVANCED GEOGRAPHIC INFORMATION SYSTEMS. (4 cr; prereq 5562 or LA 5562 or #) McMaster
Concepts and theories. Sources of geographical data including image processing. Geographic data structures, including hierarchical, relational, quadtree, and vaster methods. Techniques of spatial analysis. Error modeling in geographic databases. Spatial interpolation and classification. Visualization of GIS processes and spatial modeling.

5701. FIELD RESEARCH. (4 cr; prereq 12 cr geog, #) Staff
Field investigation in physical, cultural, and economic geography; techniques of analysis and presentation; reconstruction of environments.

5710. FIELD INTERNSHIP. (Cr ar, §IntR 5701; prereq IntR 5930) Staff
Requirements and credits vary with nature of internship. Those for MSID normally carry eight credits per quarter for up to two quarters. All internships are conducted off campus and require contract with department supervisor specifying work to be accomplished and means of reporting achievement.

Graduate Programs

History and Philosophy of Geography

5001. MODES OF GEOGRAPHIC INQUIRY. (4 cr) Sheppard

Different ways of knowing the world and their application to explaining and interpreting geography since 1960. Empirical approaches and geographical hypothesis; structural approaches and socio-spatial systems; interpretive approaches and meaning of geographical phenomena. Application to city systems; integration and diffusion.

5801. DEVELOPMENT OF GEOGRAPHIC THOUGHT. (4 cr, §3801; prereq sr or grad student, three geog courses) Lukermann
Concepts and methods of geography; differing schools of geographic thought as expressed in contemporary geographical literature.

5808. REGIONAL ANALYSIS OF NORTH AMERICA. (4 cr; prereq #) Gersmehl
Regions: what they are, where they come from, how we delimit them, how people perceive them, how they interact with other places, and how they change through time. Attendance at selected lectures and slide presentations in Geog 3101 required.

5856. THE MEANINGS OF PLACE. (4 cr, §4856; prereq #) Martin
Analysis of messages and meanings of our surroundings. Twin Cities central districts and neighborhoods, and selected settings elsewhere. Direct experience.

Directed Studies

5900. TOPICS IN GEOGRAPHY. (4 cr; prereq sr or grad student, Δ)
Course on special topics and regions offered by visiting professors in their research fields.

8001. PROSEMINAR: GEOGRAPHY AND CULTURAL ECOLOGY. (3 cr; prereq #) Staff

8002. PROSEMINAR: THE ECONOMY, THE STATE, AND SPATIAL DEVELOPMENT. (3 cr; prereq #) Staff

8003. PROSEMINAR: HISTORICAL GEOGRAPHY. (3 cr; prereq #) Staff

8004. PROSEMINAR: PHYSICAL GEOGRAPHY. (3 cr, §8401; prereq #) Brown, Gersmehl, Klink, Skaggs
Historical development of research in physical geography, current research trends, and transfer of current research to undergraduate education.

8005. PROSEMINAR: POPULATION GEOGRAPHY. (3 cr; prereq #) Staff

8006. PROSEMINAR: RESEARCH METHODS IN GEOGRAPHY. (3 cr; prereq #) Staff

8007. PROSEMINAR: THEORIES OF DEVELOPMENT AND CHANGE. (3 cr; prereq #) Staff

8010. SEMINAR: THEORETICAL GEOGRAPHY. (3 cr; prereq #; offered when feasible) Staff

8020. SEMINAR: ECONOMIC GEOGRAPHY. (3 cr; prereq #; offered alt yrs) Staff

8120. SEMINAR: HISTORICAL GEOGRAPHY. (1-3 cr; prereq #) Staff

8125. SEMINAR: PUBLIC LAND RECORDS. (1 cr; prereq #; offered alt yrs) Squires

8140. SEMINAR: AFRICA. (3 cr; prereq #) Porter, Samatar, Scott

8210. SEMINAR: SOUTH ASIA. (1-3 cr; prereq #) Schwartzberg

8300. GEOGRAPHICAL WRITING. (3 cr; prereq #) Hart
Analysis of the organization and presentation of geographic research. Critiques of selected examples of geographical writing.

8301. GEOGRAPHICAL EDUCATION. (3 cr; prereq #) Gersmehl
Guided study of the process of teaching geography at the college level.

8302. RESEARCH DEVELOPMENT. (1-3 cr; prereq #) Staff
Guided study of research proposal process: topic choice, statement of problems, research design, identification of funding sources, and proposal writing.

8320. CONSIDERING SPACE, PLACE, AND HUMAN ACTIVITY. (3 cr; prereq #) Martin
Aspects of place analysis/place description from variety of analytical and perceptual perspectives.

8330. SEMINAR: RURAL GEOGRAPHY. (3 cr; prereq #) Hart

8335. AGRARIAN CHANGE IN THE THIRD WORLD. (4 cr) Samatar
Nature of agricultural development in Third World capitalist economies. Assessment of transformation of peasant agriculture into predominantly commodity-producing system.

8344-8345†. SEMINAR: PUBLIC LAND POLICY. (3 cr per qtr; prereq #) Squires
Policies of federal and state governments in acquiring and using land.

8350. SEMINAR: WORLD POPULATION PROBLEMS. (3 cr; prereq #; offered alt yrs) Hsu, Rice

8400. SEMINAR: PHYSICAL GEOGRAPHY. (3 cr; prereq #) Brown, Gersmehl, Klink, Skaggs

8420. SEMINAR: CLIMATOLOGY. (3 cr; prereq #; offered alt yrs) Klink, Skaggs
Detailed study of selected topics. Topics vary yearly; examples include modeling, climatic variability, predictability, severe local storms, drought, and energy balance.

8510. SEMINAR: CARTOGRAPHY. (1-3 cr; prereq #; offered when feasible) Hsu, McMaster, Porter

8800. SEMINAR: DEVELOPMENT OF GEOGRAPHIC THOUGHT. (3 cr; prereq #) Lukermann

8970. DIRECTED READINGS. (1-5 cr) Staff

8980. TOPICS IN GEOGRAPHY. (1-3 cr; prereq #)

8990. RESEARCH PROBLEMS IN GEOGRAPHY. (Cr ar) Staff

Geological Engineering (GeoE)

Professor: Steven L. Crouch, *head*; Andrew Drescher; Charles Fairhurst; Theodore V. Galambos; Gary Parker; Otto D. L. Strack

Adjunct Professor: Peter A. Cundall

Associate Professor: Randal J. Barnes; Emmanuel M. Detournay; Efi Foufoula-Georgiou; Catherine E. French; Joseph F. Labuz; David E. Newcomb; Karl A. Smith; Raymond L. Sterling; Henryk K. Stolarski; Vaughan R. Voller

Assistant Professor: Gary A. Davis; Jerome F. Hajjar; Carol Kittredge Shield; Mark B. Snyder

Research Associate: Louis F. Goldberg

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B), M.Geo.E., and Ph.D.

Curriculum—The graduate program in geological engineering is administered in the Department of Civil Engineering. As such, the graduate program is closely allied with civil engineering. The master of geological engineering program is designed for engineering graduates who are particularly interested in planning, design, operation, and management in geotechnical areas, or for graduate students with experience in engineering geology and other geotechnical areas who wish to increase their background and study current developments and design procedures.

Prerequisites for Admission—In general, adequate preparation in undergraduate subjects and in the sciences fundamental to geological engineering is required. A bachelor's degree from an engineering program accredited by the Accreditation Board for Engineering and Technology (ABET) is required for admission to the M.Geo.E. program. Applicants to these professional programs who have B.S. degrees in other fields (geology, physics, chemistry) are required to make up

deficiencies in the basic engineering curriculum after admission.

Special Application Requirements—None.

Degree Requirements—M.Geo.E. students should consult the General Information section under Professional Master's Degree in Engineering. All students should consult the department *General Information Bulletin for Graduate Students* for further information.

The final examination for the master's degrees is oral.

Language Requirements—None.

For Further Information and Applications—Contact the Geological Engineering Program, University of Minnesota, Civil Engineering Building, 500 Pillsbury Drive S.E., Minneapolis, MN 55455 (612/625-5522).

GeoE 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

GeoE 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

GeoE 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5218. DESIGN OF UNDERGROUND EXCAVATIONS. (4 cr; prereq 5302 or #, IT student or grad IT major)

In-situ stresses in rock mass; rock mass behavior. Elastic and inelastic deformation around underground excavations. Design of linings, support, and rock reinforcement; problems of hard and soft ground excavations, new Austrian tunneling method, materials handling, ventilation, special problems, case histories.

5260. DRILLING, BLASTING, AND COMMINATION. (4 cr; prereq CE 3300 or #, IT student)

Rock excavation and size reduction by drilling, blasting, and comminution; basic mechanics of fracture; bit penetration into rock; breakage and selection functions in comminution. Properties of explosive; strain wave transmission, reflection, and refraction in drilling and blasting; design of blasting rounds; controlled blasting; ground and air vibrations. Tunnel boring machines; types of crushing and grinding equipment and their selection.

5262. GEO-ENGINEERING ANALYSIS. (4 cr; prereq sr or #, IT student or grad IT major)

Comprehensive analysis of a geological engineering or rock mechanics problem. Involves integration of concepts of rock and soil mechanics, geology and geophysics, mineral engineering, and economics in a specific problem chosen by the student and staff. Preparation of a professional report.

Graduate Programs

5302. APPLIED ROCK MECHANICS. (4 cr; prereq 5300, IT student or grad IT major)
Principles and techniques of site investigations in rock. Design of surface and underground excavation and mine stability and methods of ground control. Application of numerical models in design.

5437. COMPUTER APPLICATIONS IN GEOLOGICAL ENGINEERING. (4 cr; prereq CE 3020, Math 3221 or equiv or #)
Methods (finite differences, finite elements, boundary elements) for solution of problems in hydrology, structural engineering, geomechanics, and environmental engineering that reduce to partial differential equations. Each method illustrated in context of one or more practical problems.

5555. ENGINEERING GEOSTATISTICS. (4 cr; prereq Stat 3091 or #, IT upper div or grad student)
Problem solving and decision making in geological engineering using tools of applied statistics. Emphasis on spatially correlated data, e.g., geologic site characterization, rock mass parameter estimation, ore body modeling, optimal sample design for groundwater contamination assessment.

5660-5661-5662. SPECIAL GEOLOGICAL-ENGINEERING PROBLEMS. (Cr and hrs ar; prereq IT sr or #)
Literature survey, research work, or design study in geological-engineering problems.

5700. SYSTEMS ANALYSIS FOR GEOLOGICAL ENGINEERING. (4 cr; prereq IT upper div or grad student)
Introduction to systems analysis and decision making; expert systems; operations research techniques, modeling and simulation. Applications in geological engineering and related fields.

8302. SOIL/ROCK PLASTICITY AND LIMIT ANALYSIS. (4 cr, §CE 8302; prereq 3300)
Plasticity of soils and rocks. Hardening and perfectly plastic models. Yield conditions, flow rules. Theorems of limit analysis. Static solutions, method of characteristics. Kinematic solutions, hodograph, energy balance. Applications to soil/rock engineering problems.

8336. BOUNDARY ELEMENT METHODS I. (4 cr; prereq AEM 3016 or #)
Boundary element methods for elastostatics: stress discontinuity, displacement discontinuity, and direct boundary integral methods. Derivation of basic mathematical solutions from theory of elasticity. Applications of boundary element methods in geomechanics.

8350. ADVANCED ROCK MECHANICS I. (4 cr; prereq 5302)
Implementation of rock mechanics techniques in civil and mining engineering practice, involving lab and field techniques for specification of rock material and rock mass properties, stress determination in rock, rock support, reinforcement and improvement, and methods of measuring response of rock to excavation-induced loads.

8360. ENGINEERING MODEL FITTING. (4 cr; prereq civil or mineral or geo-eng grad student or #; offered alt yrs)
Parameter estimation and inverse modeling in civil, geological, and mineral engineering. Formulation of engineering model fitting problems, comparison and selection of various fit criteria, selection and implementation of solution algorithms on computer, analysis and interpretation of results, and design of future measurement plans.

8601. SEMINAR: GEOLOGICAL-ENGINEERING. (Cr ar; prereq #)

8612, 8613, 8614. GEOLOGICAL-ENGINEERING RESEARCH PROBLEMS. (Cr ar; prereq #)

Geology and Geophysics (Geo)

Regents' Professor: Herbert E. Wright (*emeritus*)

Professor: William Seyfried, Jr., *head*; E. Calvin Alexander, Jr.; Subir K. Banerjee; Roger LeB. Hooke; Peter J. Hudleston; Shun-ichiro Karato; Kerry R. Kelts; David L. Kohlstedt; Ronald L. Morton¹; V. Rama Murthy; Robert O. Pepin; Hans-Olaf Pfannkuch; Joseph Shapiro; Robert E. Sloan; James H. Stout; Paul W. Weiblen; David Yuen

Associate Professor: Christian P. Teyssier, *director of graduate studies*; R. Lawrence Edwards; Emi Ito; Karen L. Kleinspehn; Christopher Paola

Assistant Professor: Bruce Moskowicz; Mark A. Person

Other: Michael E. Berndt; Val W. Chandler; Daniel R. Engstrom; Paul H. Glaser; Robert G. Johnson; Glenn B. Morey; Linda C. K. Shane; David L. Southwick

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—Geology: M.S. (Plan A and Plan B) and Ph.D.; Geophysics: M.S. (Plan A and Plan B) and Ph.D.

Curriculum—The geology major includes the areas of Quaternary studies, structural geology, stratigraphy, paleontology, crystallography, mineralogy, economic geology, experimental and theoretical petrology, isotopic and aqueous geochemistry, experimental geochemistry, geomorphology, glaciology, groundwater geology, limnology, and sedimentology. The geophysics major includes the areas of applied and theoretical geophysics, paleomagnetism and rock magnetism, and mineral and rock physics. Courses in the minor and supporting fields are normally

¹ University of Minnesota, Duluth

taken from outside the department, although they may be taken from within in special cases. Students may accommodate other areas of interest such as earth resources, engineering geology, environmental geology, materials science, soil science, and paleoecology by choosing a minor or supporting field from outside the department.

Prerequisites for Admission—A bachelor's degree in geology or geophysics; at least one year of study in calculus, chemistry, and physics; and a full-time geological field course of at least five weeks' duration are required. Applicants with degrees in other fields or with limited background deficiencies are also considered. In general, an outstanding academic record is expected.

Special Application Requirements—Graduate Record Examination scores are required for admission and financial aid consideration; three letters of recommendation are required for financial aid and are optional but recommended for admission consideration. Applications for admission are considered at any time, although applications for financial aid should be submitted by January 15 to ensure consideration. Studies may begin in any quarter or summer session, although fall quarter is preferable.

Degree Requirements—For both the master's and doctoral degrees, certain advanced courses must be completed either before entrance or during the first year of graduate work. These courses include two quarters of mathematics or one quarter each of mathematics and statistics (in addition to the prerequisites for admission) and two quarters of 5xxx or 8xxx analytical science, with courses selected from a list available from the director of graduate studies. These courses may form part of a supporting field or minor if taken after admission.

Doctoral Degree Requirements—See general Graduate School requirements.

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—Established on an individual basis with approval by the Graduate Studies Committee.

For Further Information and Applications—Contact the Department of Geology and Geophysics, University of Minnesota, 106 Pillsbury Hall, 310 Pillsbury Drive S.E., Minneapolis, MN 55455 (612/624-1333; fax 612/625-3819; e-mail umn_geo@darcy.geo.umn.edu).

Geo 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Geo 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Geo 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

General Geology

5004. MINERALOGY. (4 cr, §3401; prereq Chem 1051, Math 1252 or #; not open to geol or geophys or geo or min engr majors) Introduction to crystallography, crystal chemistry, and crystal physics. Physical and chemical properties, crystal structures and chemical equilibria of major mineral groups. Lab includes crystallographic and polarizing microscopes. X-ray diffraction exercises, hand specimen mineral identification.

5010. FIELD WORKSHOP. (2 cr; prereq geol or geophys or geo engr major or #) Staff Geologic or geophysical field study.

5020. LABORATORY WORKSHOP. (2 cr; prereq geol or geophys or geo engr major or #) Staff Geologic or geophysical lab study.

5030. MODELING WORKSHOP. (2 cr; prereq geol or geophys or geo engr major or #) Staff Modeling of geologic or geophysical systems.

5051. PHYSICAL GEOLOGY FOR TEACHERS. (4 cr, §1001; prereq education degree, 1 term college chem or physics; no grad credit for geol or geophys majors) Introduction to scientific methods and the nature of Earth. Survey of main features of the physical world and of processes that have evoked them.

5052. HISTORICAL GEOLOGY FOR TEACHERS. (4 cr, §1002; prereq education degree, 1001 or 5051 or #; no grad credit for geol or geophys majors) Sloan Introduction to origin of Earth, physical evolution of its crust through geological time, and biological changes that occurred during its history. Lab, fieldwork, and seminar.

Graduate Programs

5101f. GEOCHRONOLOGY AND STRATIGRAPHY.

(4 cr; prereq 3301) Staff
Methods for measuring geologic time and dating rocks; correlation and other stratigraphic techniques.

5108. ADVANCED ENVIRONMENTAL GEOLOGY.

(4 cr; prereq geol core curriculum through 5201 for majors or #) Pfannkuch

Human impact on the geological environment and effect of geology/geologic processes on human life from point of view of ecosystems and biogeochemical cycles.

Geologic limits to resources and carrying capacity of Earth. Land use planning, environmental impact assessment, ecogeologic world models. Field project.

5111. FIELD GEOLOGY.

(5-9 cr; restricted to majors in geol or geophys or geo engr; prereq 5201, #; no grad credit for geol or geophys majors) Staff

Geologic mapping on topographic maps and aerial photos; field identification of igneous, sedimentary, and metamorphic rocks; measurement of stratigraphic sections; study of structural and geomorphic features. Major report required after completion of fieldwork.

5121f. HISTORY OF THE EARTH.

(3 cr; prereq geol major or #) Sloan
Analysis of interrelationships between plate tectonics, atmospheric composition, sea level, stratigraphic record, and organism evolution. Causes of mass extinctions and adaptive radiations.

5151. INTRODUCTION TO PALEONTOLOGY.

(5 cr; prereq 1002 or #) Sloan
Morphology, classification, and ecology of major fossil groups.

5154. VERTEBRATE PALEONTOLOGY I.

(5 cr; prereq 5151 or EEB 5114) Sloan
Morphology, evolution, and stratigraphic distribution of fossil fish, amphibians, reptiles, and birds.

5155. VERTEBRATE PALEONTOLOGY II.

(5 cr; prereq 5154 or EEB 5114) Sloan
Morphology, evolution, and stratigraphic distribution of fossil mammals.

5201. STRUCTURAL GEOLOGY.

(5 cr; prereq 3102, 3401 or #, IT upper div major in geol, geophys, geo engr, mineral engr or CLA jr or sr geol major; no grad credit for geo or geophys majors) Teyssier
Primary and secondary structures of rocks; mechanics and modes of deformation; field methods in geology. Field trips.

5202. TECTONIC STYLES.

(3 cr; prereq 5201 or #; offered alt yrs) Hudleston
Origin and nature of major types of disturbances affecting the continental crust, including analysis of the form and development of individual structural components.

5203. GEOTECTONICS.

(3 cr; prereq 5201 or #; offered alt yrs) Teyssier
Problems associated with global tectonics; structure and evolution of Earth's crust and lithosphere; active compressional, extensional, and wrench tectonic regimes, with numerous examples from various parts of world; interpretation of older tectonic systems.

5251. GEOMORPHOLOGY. (4 cr [5 cr with term project]; prereq 1001, Math 1031 or #; 3 lect and 2 lab hrs per wk, lab often used for field trips) Hooke
Origin, development, and continuing evolution of landforms in various environments. Environmental implications emphasized. Weathering, slope and shore processes, fluvial erosion and deposition, wind action, tectonics, and impact phenomena.

5252. REGIONAL GEOMORPHOLOGY.

(3 cr [may be repeated for cr if different regions studied]; prereq 5201 or #; 1-wk field trip; offered alt yrs) Hooke
Geology of particular region of country, emphasizing geomorphology. One-week field trip late in quarter.

5255. GLACIOLOGY.

(4 cr [5 cr with term project]; prereq Math 3261 or #; offered alt yrs) Hooke
Theory of glacier flow. Internal structures and temperature distribution in glaciers and ice sheets. Reading assignments and problems.

5261. GLACIAL GEOLOGY.

(4 cr [5 cr with term paper or map lab]; prereq 1002 or #)
Formation and characteristics of modern glaciers; erosional and depositional features of Pleistocene glaciers; history of Quaternary environmental changes in glaciated and non-glaciated areas. Field trips.

5311. GEOCHEMICAL PROCESSES.

(4 cr; prereq 3301, Chem 5520 or #) Ito, Seyfried
Processes pertinent to the distribution and control (structural, thermodynamic and kinetic) of chemical species in Earth and hydrosphere.

5313. AQUEOUS GEOCHEMISTRY.

(4 cr; prereq 5311, Chem 5520 or #) Seyfried
General principles of solution chemistry with application to geology including solution-mineral equilibria, redox processes in natural waters, and geochemistry of hydrothermal fluids.

5321. ISOTOPE GEOLOGY.

(4 cr; prereq 3301 or #) Edwards, Ito
Introduction to theory and uses of radioactive, radiogenic, and stable isotopes in geology. Radioactive dating, geothermometry, and tracer techniques in geologic processes.

5351. ECONOMIC GEOLOGY; METAL SULFIDE DEPOSITS.

(4 cr [5 cr with lab]; prereq 3401, 5201 or #)
Nature and distribution of sulfide deposits and analysis of processes by which metals are concentrated in magmatic, hydrothermal, and sedimentary environments.

5405. OPTICAL MINERALOGY.

(2 cr; prereq 3401) Weiblen
Optical properties of minerals; symmetry and crystal optics; identification of minerals using polarizing microscope.

5452. IGNEOUS AND METAMORPHIC PETROLOGY.

(5 cr; prereq 3402, Chem 5520, Math 3261 or #) Stout
Theoretical course that develops basic thermodynamic tools and chemographic analysis for the interpretation of chemical processes in igneous and metamorphic rocks. Lab, field trip, problem sets, and term paper.

5601. LIMNOLOGY. (4 cr §EEB 5601; prereq Chem 1052) Shapiro

Events occurring in lakes, reservoirs, and ponds; their origins, physics, chemistry, and biology. Interrelationships of these parameters and effects of civilization on lakes.

5602. ALL ABOUT LAKES FOR TEACHERS: THEIR ORIGINS, BEHAVIOR, AND MANAGEMENT. (4 cr, §3602; prereq education degree) Shapiro

Origin of lakes, their response to solar radiation and wind, their unique flora and fauna and effects of these organisms on chemistry of lake waters and vice versa. Human impact on lakes; methods of lake restoration and management.

5603. GEOLOGICAL LIMNOLOGY. (4 cr; prereq 5601 or EEB 5601)

Tectonic and climatic setting of lakes; physical, chemical, and biological processes of sedimentation in lakes.

5613. KARST HYDROGEOLOGY AND TRACER APPLICATIONS. (4 cr; prereq 5641, #; offered alt yrs) Alexander, Pfannkuch

Physical and chemical principles and processes operating in karst hydrogeology and use of natural and synthetic chemical and isotopic labels or tracers to determine source, age, and mixing parameters of water in various natural reservoirs.

5621. LIMNOLOGY LABORATORY. (2 cr, §EEB 5621; prereq 5601 or EEB 5601 or #) Megard

Lab to accompany Geo 5601 (EEB 5601). Techniques for obtaining information about conditions in lakes and streams. Procedures for measuring abundance and population dynamics of aquatic organisms, with emphasis on plankton. Field instruments, sampling devices, chemical analyses, microscopy, and analysis of data. One Saturday field trip.

5631. EARTH SYSTEM: GEOSPHERE/BIOSPHERE INTERACTIONS. (4 cr, §EEB 5004; prereq 3202, 3301 or #)

Interdisciplinary study of mechanisms that force global change, feedbacks, and dynamics on various time scales, using paleorecord to illustrate processes.

5641. GENERAL AND PHYSICAL HYDROGEOLOGY. (4 cr; prereq 1001, Chem 1052, Math 1252, Phys 1105, core curriculum through 3402 for geol majors or #) Pfannkuch

Introduction to theory of groundwater geology, hydrologic cycle, watershed hydrology, Darcy's law, governing equations of groundwater motion, flow net analysis, analog models, and groundwater resource evaluation and development.

5642. QUANTITATIVE HYDROGEOLOGY. (4 cr; prereq 1001, Chem 1052, Math 1252, Phys 1105, core curriculum through 3402 for geol majors or #) Person

Applied analysis of steady and transient equations of groundwater motion and chemical transport using analytical and numerical methods. Numerical flow net analysis, well hydraulics, salt-water intrusion problems, and unsaturated flow.

5643. CHEMICAL HYDROGEOLOGY. (4 cr; prereq 1001, Chem 1052, Math 1252, Phys 1105, core curriculum through 3402 for geol majors or #) Alexander

Introduction to chemistry of natural waters, acid-base and redox reactions, carbonate equilibria, contaminant hydrology, isotope hydrology, and chemical modeling.

5651. SEDIMENTOLOGY. (5 cr; prereq 3402, IT upper div major in geol, geophys, geo engr, mineral engr or CLA jr or sr geol major or #; no grad credit for geol or geophys majors) Paola

Interpretation of origin of sedimentary rocks through application of basic physical and chemical principles, understanding of modern depositional environments, and petrographic microscopy.

5652. SEDIMENTARY PETROLOGY AND PROCESSES. (5 cr; prereq 3402, 5651 or #; offered alt yrs) Kleinspehn, Paola

Analysis of hand-specimen scale and microscopic features of carbonate and clastic sedimentary rocks and their associated chemical, biological, and physical processes. Primary physical structures, petrographic microscopy, diagenesis, and new analytical techniques in sandstone petrology.

5653. STRATIGRAPHY AND BASIN ANALYSIS. (4-6 cr [6 cr with lab]; prereq 5651 or #; offered alt yrs) Kleinspehn

Modern techniques and principles of stratigraphic analysis of sedimentary basins in various tectonic settings. Seismic stratigraphy, correlation techniques, paleocurrent analysis, computer basin modeling, and geochronology of sedimentary basins.

5654. MARINE AND LACUSTRINE SEDIMENTARY ENVIRONMENTS. (4 cr; prereq 5651 or #; offered alt yrs) Kleinspehn

Principles of facies analysis of modern and ancient marine depositional systems, including deltas, fan deltas, barrier islands, beaches, storms, and turbidity currents in lakes and marine settings. Interpretations of marine tidal systems, carbonate platforms, reefs, continental shelves, and abyssal-plain processes.

5655. CONTINENTAL SEDIMENTARY ENVIRONMENTS. (4 cr; prereq 5651 or #; offered alt yrs) Kleinspehn

Principles of facies analysis of modern and ancient non-marine depositional systems.

5656. DEPOSITIONAL MECHANICS. (3-4 cr; prereq 5651, Math 3261 or #; offered alt yrs) Paola

Elementary mechanics of sediment transport applied to quantitative interpretation of sedimentary rocks.

5980. SEMINAR: CURRENT TOPICS IN GEOLOGY AND GEOPHYSICS. (1-6 cr; prereq #)

8098. SEMINAR: CURRENT TOPICS IN GEOLOGY AND GEOPHYSICS. (1-6 cr; prereq #)

8099. RESEARCH IN GEOLOGY AND GEOPHYSICS. (1-6 cr; prereq #)

Graduate Programs

8202. ADVANCED STRUCTURAL GEOLOGY.

(3 cr; prereq 5201; offered alt yrs) Hudleston
Detailed study of structural geometry of folded rocks; origin of foliation and lineation; multiple deformation; advanced structural methods. Extensive reading in journal literature. Lab research on selected topics. Field trips.

8203. GEOTECTONICS. (3 cr, §5203; prereq 5201 or #; offered alt yrs) Teyssier

Problems associated with global tectonics; structure and evolution of Earth's crust and lithosphere; active compressional, extensional, and wrench tectonic regimes, with numerous examples from various parts of world; interpretation of older tectonic systems.

8262. QUATERNARY PALEOECOLOGY AND CLIMATE.

(4 cr; prereq 5261 or #) Kelts, Wright
Principles of stratigraphic pollen analysis. Pleistocene and Holocene vegetation and climatic history as interpreted from pollen diagrams from different parts of the world. Paleoclimatic interpretation of ocean-sediment cores.

8315. STABLE ISOTOPE GEOCHEMISTRY. (3 cr;

prereq 5321 or #; offered alt yrs) Ito
Stable isotope fractionations in geological, environmental, and biological systems. Theory and application pertinent to research interests of students.

8453. PHASE EQUILIBRIUM IN MINERAL SYSTEMS.

(3 cr; prereq 5452, Chem 5520, Math 3261; offered yrly when demand warrants) Stout
Principles of homogeneous and heterogeneous equilibria and their application to problems in petrology. Emphasis on derivations from first principles and formulation of algebraic and graphical methods essential to multicomponent systems.

8454. IGNEOUS PETROLOGY. (3 cr; prereq 5452;

offered yrly when demand warrants) Weiblen
Igneous rocks and processes including igneous textures and associations, and appropriate phase equilibria to relate current theory and observation to the broad problems of petrogenesis. Term paper required.

8455. METAMORPHIC PETROLOGY. (3 cr; prereq

8453; offered yrly when demand warrants) Stout
Metamorphic processes; theory and observation are related to current problems. Fundamental concepts and techniques are related to progressive development of mineral assemblages. Term paper required.

8602. ADVANCED LIMNOLOGY. (3 cr, §EEB 8602;

prereq 5601 or EEB 5601, #) Shapiro
Detailed study of selected problems in limnology using current and classical literature. Term paper required.

8612. ANALYTICAL GEOHYDROLOGY. (3 cr [4 cr with term paper]; prereq Math 3261, CE 3400 or #; offered alt yrs) Pfannkuch

Microphysics of flow through porous media; geological factors in aquifer performance; equations for groundwater flow; analysis of pumping tests; potential theory in groundwater flow; computer and analog models of aquifers; groundwater basin analysis.

8617. TRANSPORT PHENOMENA IN NATURAL POROUS MEDIA. (2-3 cr; prereq CE 3400 or Chem 5520 or equiv or #; 2 lect hrs per wk and term paper) Pfannkuch

Microscopic flow parameters, momentum, mass and energy transport through porous media, rate processes, coupled processes and nonequilibrium thermodynamics, geologic controls of natural flow systems in porous media and aquifers.

8618. FINITE ELEMENT METHODS IN SUBSURFACE FLOW AND TRANSPORT PROBLEMS. (4 cr; prereq #) Person

Derivation of shape functions, formulation of strong and weak variation form of transport equations, assembly of local and global stiffness matrices and load vectors, solution procedures, stability analysis, and post-processing. Students develop 1- and 2-dimensional models of diffusion and advection-dispersion equations applied in sensitivity studies.

8620. GEOFLUIDS SEMINAR: FLUID FLOW AND GEOLOGIC PROCESSES WITHIN THE EARTH'S CRUST. (2 cr; prereq #) Person

Chemical-rock interactions in mid-ocean ridge systems, metal ore genesis, remagnetization of sediments by hydrothermal fluids, fate of pollutants, ice flow in glaciers, magma melt migration, mantle convection. Lab, field, and computational methods used to study fluid transport processes and rock-water interactions within Earth's crust.

Geophysics

5501w. GEOPHYSICAL METHODS IN GEOLOGY.

(4 cr; prereq 3402, Phys 1253, IT upper div student or CLA jr or sr or #; no grad credit for geol or geophys majors)

Geophysical properties of Earth and its materials, internal structure and constitution, geophysical exploration methods and geologic interpretation, radioactivity and thermal structure of Earth, physical basis for plate tectonics.

5505. SOLID-EARTH GEOPHYSICS I. (4 cr; prereq 3201, Phys 1253)

Basic elasticity, basic seismology, and physical structure of Earth's crust and deep interior.

5506. SOLID-EARTH GEOPHYSICS II. (4 cr; prereq 3201, Phys 1253)

Earth's gravity fields, mantle viscosity, paleomagnetism, seismic tomography, and basic mantle convection and thermal history.

5507. SOLID-EARTH GEOPHYSICS III. (4 cr; prereq 3201, Phys 1253)

Mechanical properties and transport processes in Earth materials and their importance to range of geophysical phenomena.

5508. MINERAL AND ROCK RHEOLOGY. (4 cr; prereq 3201, Phys 1253) Karato

Elastic, anelastic, and viscous deformation of minerals and rocks. Materials science fundamentals and geological/geophysical applications.

5515. PRINCIPLES OF GEOPHYSICAL EXPLORATION. (4 cr; prereq Phys 1291)

Seismic exploration (reflection and refraction), potential techniques (gravity and magnetics), and electrical techniques of geophysical exploration.

5522. TIME-SERIES ANALYSIS OF GEOLOGICAL AND GEOPHYSICAL PHENOMENA. (4 cr; prereq Math 3221 or #) Yuen

Analysis of both linear and nonlinear phenomena. Examples from ice age cycles, earthquakes, climatic fluctuations, volcanic eruptions, atmospheric phenomena, thermal convection, and other time-dependent natural phenomena. Modern concepts of nonlinear dynamics and complexity theory applied to geological phenomena.

5535. GEOLOGICAL THERMOMECHANICAL MODELING. (4 cr; prereq Math 3261 or #; offered alt yrs) Yuen

Heat and mass transfer processes in Earth's crust and mantle. Quantitative study of thermomechanical phenomena. Emphasis on analytical and modern numerical techniques.

5536. APPLICATIONS OF FLUID MECHANICS TO GEOLOGICAL PROBLEMS. (4 cr; prereq 1 yr calculus, CE 3400 or AEM 3200 or #; offered alt yrs) Yuen

Scaling of equations for geological approximations, applications to geological situations, rheology.

5541. GEOMAGNETISM. (3 cr; prereq 3201, Math 1251, Phys 1251 or #; offered alt yrs) Banerjee
Present geomagnetic field at Earth's surface and core-mantle boundary, secular variation, paleointensity variation, geomagnetic field reversal, models for field transition.

5543. PALEOMAGNETISM. (4 cr; prereq 3201, Math 1251, Phys 1251 or #; offered alt yrs) Moskowitz
Physical and chemical basis of paleomagnetism. Origin of natural remanent magnetization and its stability, mineralogy of magnetic minerals, paleomagnetic measurement techniques, statistics of paleomagnetic data, magnetic polarity stratigraphy, apparent polar wander, environmental magnetism.

8522. TIME-SERIES ANALYSIS OF GEOLOGICAL AND GEOPHYSICAL PHENOMENA. (3 cr; prereq Math 3221 or #) Yuen

Time-series analysis of linear and nonlinear phenomena. Examples from ice age cycles, earthquakes, climatic fluctuations, volcanic eruptions, atmospheric phenomena, thermal convection, and other time-dependent natural phenomena. Modern concepts of nonlinear dynamics and complexity theory applied to geological phenomena.

8543. PRINCIPLES OF ROCK MAGNETISM. (3 cr; prereq 5541 or #) Banerjee

Remanent magnetizations, their classification and origins. Primary versus secondary magnetizations. Separation of multicomponent magnetizations. Paleointensities from rocks and meteorites.

8571. ADVANCED GEODYNAMICS. (3 cr; prereq Math 3261 or #; offered alt yrs) Yuen

Theory of mantle convection, thermal history of Earth, viscoelastic processes in Earth, postglacial rebound, and mantle rheology.

Geophysics

See Geology and Geophysics.

German

Professor: Gerhard H. Weiss, *chair*; James A. Parente, Jr., *director of graduate studies*; Evelyn S. Firchow; Ruth-Ellen B. Joeres; Anatoly Liberman; Jochen Schulte-Sasse; Wolfgang F. Taraba; Jack D. Zipes

Associate Professor: Leonard L. Duroche; G. Lee Fullerton; Richard W. McCormick; Hanna Schissler; Arlene A. Teraoka; Ray M. Wakefield

Assistant Professor: Gary C. Thomas; Stephanie C. Van D'Elden

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Coursework and theses may emphasize German literature, philologically oriented aspects of the language, or a combination of the two.

Prerequisites for Admission—For major work, a minimum of 36 upper division quarter credits or equivalent in German, of which a minimum of 20 credits must be in German literature courses, is required. Candidates whose preparatory work evidences gaps that can be remedied may be asked to complete supplemental work before admission.

Special Application Requirements—The following must be forwarded directly to the department: three letters of recommendation, a complete set of transcripts (in addition to transcripts sent to the Graduate School), a copy of one or more papers representative of current level of scholarly development, and a statement of professional goals describing the applicant's intellectual development and plans for the future. For master's program applicants, and for all students wishing to be considered for fellowships, the General

Graduate Programs

(Aptitude) Test of the Graduate Record Examination (GRE) is required; the GRE is optional for those applicants whose native language is not English and who are required to take the Test of English as a Foreign Language (TOEFL). For the doctoral program, applicants must have a master's degree from an accredited institution or present other evidence of adequate background and competence.

Prospective students should contact the department for further information. Students generally are admitted in the fall quarter only. All financial aid application materials for the Graduate School Fellowship, departmental fellowships, and teaching assistantships must be received by January 15.

Master's Degree Requirements—Students must complete Ger 8001-8002-8003; four literature courses selected from four of the following periods: 1) Middle Ages, 2) Renaissance to Baroque, 3) 18th century, 4) 19th century, 5) 20th century; two courses in philology; and two or more courses outside the German program. Consult the current *Graduate Study in German* brochure for more details. All candidates must demonstrate proficiency in German at the ACTFL Advanced Plus level. Plan B students must submit one research paper of high quality. The final examination is oral, involving not only the areas included in coursework but also the Plan A or B papers and the minor or related field.

Doctoral Degree Requirements—A minimum of nine courses beyond the M.A. level is required, including two philology courses and 8801. In addition, five courses (totaling at least 20 credits) outside the department are required for a minor or supporting program. For the written preliminary examination, the candidate submits a bibliography of her/his research area from which three department examiners develop a set of questions. The candidate selects one question and has one week to write a 20-25 page paper. The oral preliminary examination includes general questions on German literature, philology,

and the minor or supporting program. Consult the current *Graduate Study in German* brochure for more details.

Language Requirements—For the M.A. degree, proficiency in German is the only requirement, but students are strongly urged to learn a third language. For the Ph.D. degree, students must demonstrate a high degree of competence in one language, or reading proficiency in two languages, other than German and English.

Minor Requirements for Students

Majoring in Other Fields—The approval of the director of graduate studies is a prerequisite for minor work in the field. Three graduate German literature courses are required for an M.A. minor in German, and six graduate German courses (three beyond the M.A.), one of which must be in philology, are required for a Ph.D. minor.

For Further Information and

Applications—Contact the Department of German, Scandinavian, and Dutch, University of Minnesota, 205 Folwell Hall, 9 Pleasant Street S.E., Minneapolis, MN 55455 (612/625-2080; fax 612/624-8297).

Note—Because not all courses listed below are offered every year, see current *Graduate Study in German* brochure for course selection in a given year.

Ger 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Ger 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Ger 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

German (Ger)

German Language, Literature, and Culture Studies

5011. ADVANCED COMPOSITION AND CONVERSATION. (4 cr; prereq 3013 or equiv)

5016. ADVANCED TRANSLATION: THEORY AND PRACTICE. (4 cr; prereq 3016 or #)
Readings and discussion of translation theory, related issues in stylistics, philosophy of language; examination of sample translations; student production of translations, with methodological commentary.

5101, 5102. THE ANALYSIS OF GERMAN. (4 cr per qtr; prereq 1105, Ling 3001/5001 or #)

5101: Phonology and morphology of modern German.
5102: Syntax of modern German.

5103. THE ANALYSIS AND TEACHING OF GERMAN. (1 cr; prereq #)

Teaching theory and practice.

5331. CULTURAL ANALYSIS. (4 cr; prereq 1 qtr German civilization and culture or equiv)

Techniques of cultural analysis (contrastive, anthropological, traditional) through the examination of literary texts, newspapers, language usage, etc.; "cultural myths" and forms of humor.

5490. TOPICS IN GERMAN LITERATURE. (4 cr per qtr [max 8 cr]; prereq 3104, 3105, jr or sr or grad student)
Topic, specified in *Class Schedule*, focuses on specific author, group of authors, genre, period, or subject matter.

5510. TOPICS IN CONTEMPORARY GERMAN CULTURE. (4 cr [may be repeated for max 8 cr]; prereq 3513 or equiv)

5621. GERMAN CINEMA FROM CALIGARI TO HITLER. (4 cr; prereq 3xxx film studies course or #; may be applied toward German major or minor if part of reading done in German)

German cinema from its beginnings, through its golden age in 1920s, to end of Weimar Republic in 1933; includes Expressionism and New Objectivity; leading directors: Rye, Wiene, Lubitsch, Murnau, Lang, Pabst.

5622. NAZI AND POSTWAR GERMAN CINEMA. (4 cr; prereq 3xxx film studies course or #; may be applied toward German major or minor if part of reading done in German)

German cinema, 1933-1962: Nazi cinema, including Riefenstahl, Harlan, Sirk; continuities (e.g., Harlan) and discontinuities (e.g., Staudte's work in East and West Germany) in postwar cinema.

5623. NEW GERMAN CINEMA. (4 cr; 3xxx film studies course or #; may be applied toward German major or minor if part of reading done in German)
West German cinema, 1962 to present: from early acclaim in mid-1960s (Schlöndorff, Kluge) to attainment of international stature by mid-1970s (Herzog, Fassbinder, Wenders, von Trotta); feminist and avant-garde films; crisis of 1980s.

5624. GDR CINEMA. (4 cr; prereq 3xxx film studies course or #; may be applied toward German major or minor if part of reading done in German)
History of East German cinema, from Staudte's work in 1940s, through "socialist realism" in 1950s, to development of more critical and sophisticated cinema of 1970s and 1980s (Wolf, Beyer, others).

5630. TOPICS IN GERMAN CINEMA. (4 cr [max 8 cr]; prereq 3xxx film studies course or #; may be applied toward German major or minor if part of reading done in German)

Topic may focus on specific directors, formal or political characteristics, film production or reception, or other film-theoretical issues (e.g., "Politics of Melodrama in Sirk and Fassbinder").

5711, 5712. HISTORY OF GERMAN LANGUAGE. (4 cr)

Internal and external history. Changes in sounds, grammar, and vocabulary of German and its dialects as manifested in texts from 750 A.D. to present.

5721-5722. MIDDLE HIGH GERMAN LANGUAGE. (4 cr)

Fluent reading of normalized texts. Reading and analysis of non-normalized texts. Formal description of phonology, morphology, syntax.

5731-5732. OLD HIGH GERMAN. (4 cr)

Reading and analysis of texts. Formal description of phonology, morphology, and syntax.

5734. OLD SAXON. (4 cr)

Reading and analysis of texts. Formal description of phonology, morphology, syntax.

5740. READINGS IN PHILOLOGY. (4 cr per qtr [max 12 cr])

Reading of new and/or old research on some single topic in structure of historical and/or contemporary German languages.

5771. EARLY NEW HIGH GERMAN. (4 cr)

Reading and analysis of texts. Formal description of phonology, morphology, syntax.

5781, 5782. VARIETIES OF MODERN GERMAN.

(4 cr per qtr; prereq 5101, 5102 or #)

5781: Regional varieties. *5782:* Social varieties. Lexical, syntactic, and phonological variation examined using contemporary methods of dialectology and sociolinguistics.

5970. DIRECTED STUDIES. (1-5 cr; prereq #, Δ, CLA approval)

8001-8002-8003. BASIC SEMINAR IN GERMAN LITERATURE. (4 cr per qtr; prereq grad major in German or #)

Guided research in selected areas; methods and theory applicable in study of German literature. Introduction to bibliography and research skills. Oral reports and seminar papers.

8203. MIDDLE HIGH GERMAN COURTLY LYRIC. (4 cr; prereq 8202, 8723 or #)

8206. TOPICS IN MIDDLE HIGH GERMAN LITERATURE. (4 cr; prereq 8202, 8723 or #)

8210. TOPICS IN 16TH- AND 17TH-CENTURY GERMAN LITERATURE. (4 cr per qtr [max 12 cr])

8212. GERMAN LITERATURE OF THE 17TH CENTURY. (4 cr)

8219. LITERATURE OF THE 19TH CENTURY. (4 cr)

Literature, literary movements and influences represented in drama, lyric, and shorter prose forms.

8220. TOPICS IN 18TH-CENTURY GERMAN LITERATURE. (4 cr per qtr [max 12 cr])

8221, 8222. ROMANTICISM. (4 cr per qtr)

Graduate Programs

8230. LYRIC POETRY. (4 cr per qtr [max 12 cr])
Literary periods or movements, thematic and genre issues, historical and cultural contexts.

8235, 8236. EIGHTEENTH CENTURY: FROM AUFKLÄRUNG THROUGH STURM UND DRANG. (4 cr per qtr)

8241. EXPRESSIONISM IN GERMAN LITERATURE. (4 cr)

8261, 8262. GERMAN LITERATURE SINCE WORLD WAR II. (4 cr per qtr)

8301. THE 19TH-CENTURY NOVEL. (4 cr)

8307. THE GERMAN NOVELLE: FROM GOETHE TO KAFKA. (4 cr)

8311. THE 20TH-CENTURY NOVEL. (4 cr)

8324, 8325, 8326. GERMAN DRAMA FROM NATURALISM TO THE PRESENT. (4 cr per qtr)
8324: From 1880 to 1910. 8325: From 1910 to 1930.
8326: From 1930 to present.

8330. TOPICS IN 19TH-CENTURY GERMAN LITERATURE. (4 cr per qtr [max 12 cr])
An issue or movement in 19th-century German literature, using a variety of critical approaches.

8331. THE 18TH-CENTURY NOVEL. (4 cr)
Selected readings, theoretical writings on the novel; several contemporaneous non-German novels by English writers.

8340. TOPICS IN 20TH-CENTURY GERMAN LITERATURE. (4 cr per qtr [max 12 cr])

8351. ROMANTHEORIE. (4 cr)
Analysis of 20th-century criticism of the genre *Roman*.

8407. GOETHE. (4 cr)

8421. HEINRICH VON KLEIST. (4 cr)

8431. HEINE. (4 cr)

8451. FRIEDRICH NIETZSCHE. (4 cr per qtr)

8801. DISSERTATION SEMINAR. (4 cr)
For doctoral students beginning to establish topics and doing research for dissertations in German literature.

8810. THE GERMAN WOMAN AS WRITER. (4 cr per qtr [max 8 cr])
German women writers from 18th to 20th century, using methods of feminist critical analysis.

8820. ADVANCED THEORETICAL SEMINAR. (4 cr per qtr [max 12 cr]; prereq 8112 or 8113 or #)
Issues in contemporary critical thought.

Philology

8701. PHILOLOGICAL PROSEMINAR: BIBLIOGRAPHY. (4 cr)

8713. CONTEMPORARY GERMAN. (4 cr; prereq 8712)
Varieties and analysis in an historical framework.

8740. READINGS IN PHILOLOGY. (4 cr per qtr [max 12 cr])

8741, 8742, 8743. GOTHIC AND METHODS OF COMPARATIVE GERMANIC LINGUISTICS. (4 cr per qtr; prereq #)

8751-8752. MANUSCRIPT READINGS AND TEXT RECONSTRUCTION. (4 cr per qtr; 8751: prereq #; 8752: prereq 8751 or #)
8751: Manuscript readings. 8752: Medieval text editing.

8761, 8762, 8763. PHILOLOGICAL SEMINAR. (4 cr per qtr; prereq #)

Literature and Philology

8990. READING AND RESEARCH. (Cr ar [3-6 cr]; prereq #; may be taken on tutorial basis with #)

Dutch (Dtch)

5490. TOPICS IN DUTCH LITERATURE. (4 cr per qtr [max 8 cr]; prereq reading knowledge of Dutch, jr or sr or grad student)
Topic on specific author, group of authors, genre, period, or subject matter. Topic listed in *Class Schedule*.

5742. MIDDLE DUTCH. (4 cr)
Study of oldest recorded poetry and prose; linguistic and literary aspects; older Dutch dialects; relations between Middle Dutch and Middle High German.

5743. EARLY MODERN DUTCH. (4 cr; prereq 5742 or #)
Study of 16th and 17th century Dutch poetry and prose; linguistic and literary aspects in context of Dutch "Golden Age." Development toward modern standard Dutch.

Germanic Philology

Professor: Anatoly Liberman (German), *director of graduate studies;* Evelyn S. Firchow (German); Nils Hasselmo (Scandinavian); Calvin B. Kendall (English); Robert Sonkowsky (Classics); David J. Wallace (English)

Associate Professor: Rita Copeland (English); Kaaren Grimstad (Scandinavian)

Other: Stephanie C. Van D'Elden (associate director, Independent Study)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Emphases are medieval literature and the history and structure of the Germanic languages.

Prerequisites for Admission—None.

Special Application Requirements—Three letters of recommendation and a satisfactory score on the General (Aptitude) Test of the Graduate Record Examination (GRE) are required. Because Germanic philology is not listed in the GRE department codes, applicants should use the department code for Scandinavian when taking the test. GRE results should be forwarded to the Department of German, Scandinavian, and Dutch.

Master's Degree Requirements—Nine quarter courses are required. See the program publication for details. The final examinations consist of a three-hour written and a one-hour oral examination.

Doctoral Degree Requirements—A total of 25 to 30 quarter courses (including work completed for the M.A. degree) are recommended. A Ph.D. qualifying examination, which is substantially the same as the written M.A. examination in Germanic philology, is administered to students who have earned their M.A. degree at another institution. This examination must be taken within one year of entering the Ph.D. program. See the program publication for details.

Language Requirements—For the M.A. degree, students must demonstrate competence in English and Medieval Latin. For the Ph.D. degree, students must demonstrate competence in English, German, Medieval Latin, and two additional languages chosen in consultation with the adviser.

Minor Requirements for Students

Majoring in Other Fields—For a master's degree minor, three philological courses are required. All courses must be selected with the help of a philology adviser from the committee. For a doctoral degree minor, three additional philological courses are required.

For Further Information and Applications—Contact the Germanic Philology Program, Center for Medieval Studies, University of Minnesota, 304 Walter Library, 117 Pleasant Street S.E., Minneapolis, MN 55455 (612/626-0805).

GPhl 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

GPhl 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

GPhl 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Gerontology

Professor: David O. Born (health ecology; dentistry); Pauline G. Boss (family social science); James C. Cloyd (pharmacy practice); Maurice W. Dysken (psychiatry); Nancy N. Eustis (public affairs); Judith M. Garrard (public health); Robert L. Kane (public health); Rosalie A. Kane (health services research and policy, public health); Frank M. Lassman (*emeritus*: otolaryngology; communication disorders; physical medicine and rehabilitation); Matthew K. McGue (psychology); Donald G. McTavish (sociology); Susan S. Meyers (rural sociology); Earl W. Morris (design, housing, and apparel); Jeylan T. Mortimer (sociology); Jean K. Quam (social work); Muriel B. Ryden (nursing); Mariah Snyder (nursing); Michael Wade (kinesiology); Jonathan D. Wirtschafter (ophthalmology); Shirley L. Zimmerman (family social science)

Associate Professor: Dennis A. Ahlburg (industrial relations); Margaret J. Bull (nursing); Harlan G. Copeland (curriculum and instruction, education); Sara S. DeHart (nursing); Daniel F. Detzner (family social science); Corinne T. Ellingham (physical medicine and rehabilitation); Bernadine M. Feldman (nursing); Evelyn M. Franklin (design, housing, and apparel); Cynthia R. Gross (pharmacy practice); David R. Guay (pharmacy practice); Peter A. Hancock (kinesiology); Lois J. Heller¹ (physiology); Joseph M. Keenan (family practice and community health); Robert E. Kennedy (sociology); Helen Q. Kivnick (social work); Sanders D. Korenman (public affairs); March L. Krotee (physical education and recreation); Tom Alan Larson (pharmacy practice); Steven H. Miles (medicine); James A. Mortimer (neurology); Mary E. O'Connell (pharmacy practice); Richard L. Reed (family practice and community health); Robert C. Serfass (kinesiology); Caroline R. Weiss (kinesiology and leisure studies); Robert E. Yahnke (General College)

Assistant Professor: Charles E. Boulton (family practice and community health); Susan L. Cooper (pharmacy practice); Leslie A. Grant (public health); Patrick W. Irvine (Center for Urban and Regional Affairs); Kathleen Krichbaum (nursing); James T. Pacala (family practice and community health); Stephen K. Shuman (dentistry); Salma K. Somani (pharmacy practice); Marlene S. Stum (family social science); La Dora V. Thompson (physical medicine and rehabilitation); Paul D. Thurax (public health)

Adjunct Assistant Professor: Barton W. Galle, Jr. (continuing medical education)

Senior Fellow: Sharon K. Patten (public affairs)

Research Associate: Kenneth W. Hepburn (family practice and community health)

Lecturer: James R. Reinardy (social work)

Other: Alice J. Stark (public health)

¹ University of Minnesota, Duluth

Graduate Programs

Course of Study—Minor in gerontology, applicable to master's (M.A. and M.S.) and doctoral programs.

Curriculum—The graduate minor program in gerontology provides a multidisciplinary foundation in gerontology and a concentration in at least two of the following four areas of gerontology: biological or medical sciences; psychological, behavioral, or social sciences; humanities or fine arts; and public policy and practice, economics, law, or politics. The program of courses is developed in consultation between the student and the director of graduate studies of the All-University Council on Aging (AUCA). The Multidisciplinary Perspectives on Aging course (4 credits) is required for both the master's and doctoral programs. Additional courses are selected from a designated course list that includes more than 50 courses offered by many disciplines.

Prerequisites for Admission—Admission to the gerontology graduate minor is contingent upon prior admission to a master's or doctoral degree-granting program within the Graduate School. Informal discussion of potential programs can be arranged with the director of graduate studies at any time.

Minor Requirements—At the master's level, the minor program requires a minimum of 9 graduate-level quarter credits that include the Multidisciplinary Perspectives on Aging course (4 credits). The remaining 5 or more credits are taken in courses selected from the designated course list in two of the four areas mentioned above.

The doctoral program requires a minimum of 18 graduate-level quarter credits that include the Multidisciplinary Perspectives on Aging course (4 credits). The remaining 14 or more credits are taken in courses selected from the designated course list in at least two of the four areas mentioned above.

If mastery of the field of gerontology is desired, it is suggested that the student consider additional coursework beyond the required minimums for the master's or

doctoral programs. Students also have the option of the related areas at the master's level or the supporting programs for the doctoral programs that are described further in this bulletin.

Language Requirements—None specific to the minor program. See requirements of the major department.

Application Procedures—Contact the director of graduate studies of the All-University Council on Aging.

For Further Information and Applications—Contact the Graduate Minor Program in Gerontology, All-University Council on Aging, University of Minnesota, 330 Humphrey Center, 301 19th Avenue South, Minneapolis, MN 55455 (612/625-9099; fax 612/626-0273).

AdEd 5440; CPsy 5305; Nurs 5780; PA 5414; PubH 5737; Soc 5960 (sec 1); SW 5024.

MULTIDISCIPLINARY PERSPECTIVES ON AGING. (4 cr)

Multidisciplinary introduction to aging and aging process. Biological, social, and psychological aspects of aging; theories of aging; physiology of aging; death and bereavement; issues and problems of older adults in America; human services and delivery systems such as social services, health, nutrition, long-term care, and education; public policy and legislation; advocates; retirement; lifelong learning; and humanities and aging.

SPh 5007. BIOLOGY OF AGING. (2 cr)

Biological theories of aging; organ systems; cardiovascular and renal systems; reproductive and endocrine systems; immunity, hearing, visual, and dental changes in older individuals; and issues of health and disease.

Students may review additional graduate-level courses in aging by requesting "Courses on Aging at the University of Minnesota" from the All-University Council on Aging. Also available from the council is a brochure on the graduate minor in gerontology.

Greek

See Classical and Near Eastern Studies.

Health Informatics (HInf)

Professor: Laél C. Gatewood, *director, health computer sciences;* Stanley M. Finkelstein, *director of graduate studies;* Donald P. Connelly; Sheila A. Corcoran-Perry; David P. Fan; Ilene B. Harris; Paul E. Johnson; George G. Klee; Donald G. McQuarrie; Robert P. Patterson; Stephen S. Rich; George L. Wilcox

Associate Professor: Lynda B. Ellis

Assistant Professor: Michael A. Altmann; Christopher G. Chute; Steven D. Hillson; Sandra J. Potthoff; Stephen C. Strother; Keith Willard; Zhangqing Zhuo

Research Associate: Bruce H. Sielaff

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S (Plan A and Plan B) and Ph.D.

Curriculum—The graduate programs in health informatics train students to apply the methodologies and use of computers, statistics, and information sciences to information management for the health sciences. These programs offer instruction in health services computing, clinical decision making, health systems analysis, simulation, and consulting. Training is provided for health professionals seeking a master's degree to validate competencies in information management, for information technologists obtaining a master's degree to emphasize health applications, and for graduate students undertaking doctoral studies to develop new methodologies and to evaluate applications of clinical information systems. Further information on current research areas is available from the director of graduate studies.

Prerequisites for Admission—A baccalaureate degree in one of the social, biological, mathematical, or physical sciences is required. Before admission to the program, a student must complete at least two courses in the biological or life sciences, one year of calculus, linear algebra, and experience or coursework in at least one higher-level computer programming language. At least one course in biology or life science, the calculus, and the programming prerequisite are required before applying for admission to the

program. A course in differential equations is required for doctoral studies.

Special Application Requirements—The Graduate Record Examination or similar professional examination (e.g., MCAT) is required. Three letters of recommendation and a statement of purpose must be submitted with the application. Fall quarter entry is recommended.

Master's Degree Requirements—Both plans require seven core courses in health informatics, a sequence in statistics or biostatistics, and registration in the Health Informatics Seminar for the first year of study. For most students, the program takes two academic years and one summer. It is concluded with an oral examination. For the Plan B master's degree, an additional 20 credits is required. Of these, 10 credits come from a technical area and 10 credits from the health sciences. The research-oriented Plan A master's degree is available to advanced applicants, such as those with a doctoral degree in a health sciences discipline. Programs are planned with the aid of a faculty adviser. A student handbook containing sample programs and other information is available upon request from the director of graduate studies.

Doctoral Degree Requirements—For the Ph.D. degree, students should fulfill the master's basic requirements. At least 24 of the credits in a Ph.D. program must be in 8xxx courses in the area of concentration. Preliminary written and oral examinations are required for admission to candidacy. A final oral examination is required upon completion of the dissertation.

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—Programs are arranged on an individual basis upon consultation with the director of graduate studies, who also approves the final program. Programs consist of 9 or more quarter credits in health informatics for the master's program (Plan A or B) and 18 or more quarter credits for the doctoral program.

For Further Information and Applications—Contact the director of graduate studies in Health Informatics, Division of Health Computer Sciences, University of Minnesota, Box 511 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/625-8440; fax 612/625-7166; e-mail doreen@umnhcs.labmed.umn.edu).

HInf 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

HInf 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

HInf 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5430. HEALTH INFORMATICS I: COMPUTER APPLICATIONS IN HEALTH CARE. (4 cr; prereq algebra or #) Finkelstein

Review of health applications of computers for providing care and managing resources. Introduction to microcomputers and package software for health service administration.

5431. HEALTH INFORMATICS II: DATABASE MANAGEMENT SYSTEMS. (4 cr; prereq 5430, PubH 5420, programming or #) Gatewood
Development of database models and management systems for clinical studies. Introduction to clinical and life science databases and access strategies.

5432. HEALTH INFORMATICS III: HEALTH INFORMATION SYSTEMS. (4 cr; prereq 5430, 5431 or #) Ellis

Basic attributes of information systems used in in-patient, out-patient, and research health data; methods useful to manage and evaluate such systems.

5433. COMPUTER METHODOLOGY IN THE DELIVERY OF HEALTH CARE I: PHYSIOLOGICAL MONITORING AND TESTING. (3 cr; prereq 5432 or #) Finkelstein

Role of computer in monitoring and testing patients; hardware and software requirements for processing clinically significant signals; comparison and evaluation of currently available systems.

5434. COMPUTER METHODOLOGY IN THE DELIVERY OF HEALTH CARE II: INTRODUCTION TO MEDICAL DECISION-MAKING TECHNIQUES. (3 cr; prereq 5432 or PubH 5452 or #) Connelly, Rich

Introduction to biometrical concepts and techniques used to support medical decision-making process, including test efficacy measures, decision analysis, Bayes' Theorem, expert systems, decision support systems, and multivariate analysis.

5436. SEMINAR: HEALTH INFORMATICS. (1-3 cr) Ellis
Presentation and discussion of research problems and current literature.

5446. BIOCOMPUTING CONSULTING SEMINAR. (3 cr; prereq HInf major, 5432, PubH 5454 or #) Gatewood

Overview of new computer and communications hardware and software for health science applications. Group work on client projects illustrates roles and responsibilities involved in analyzing requirements of health science clients, specifying and designing computer and database interfaces, and coordinating system life cycle process.

5470. TOPICS IN HEALTH INFORMATICS. (Cr ar; prereq #)
Selected readings and/or projects.

8405, 8406, 8407. ADVANCED TOPICS IN HEALTH INFORMATICS I, II, III. (3 cr per qtr; prereq 5432, 5435, PubH 5452 or #; offered alt yrs) Finkelstein
Computer systems design for health sciences, small computer concepts and use, computers for clinical services, computer-aided medical decision making, biomedical image processing, and pattern recognition. All topics treat techniques and incorporate actual examples or case studies from the health sciences.

8415. MATHEMATICAL MODELING IN THE HEALTH SCIENCES I: DETERMINISTIC MODELS. (3 cr; prereq Math 3221, programming or #; offered alt yrs) Altmann

Mathematical and computer development of deterministic models for processes in epidemiology, demography, health care, and biochemistry. Matrix and differential equation formulations. Analysis and biological interpretation of long-term behavior, stability, and equilibrium. Computer modeling packages.

8416. MATHEMATICAL MODELING IN THE HEALTH SCIENCES II: STOCHASTIC MODELS. (3 cr; prereq 8415, Math 3221, PubH 5450 or #; offered alt yrs) Altmann

Development and analysis of stochastic models for biomedical sciences. Sources of randomness and error. Semi-Markov chains for state transitions. Probability distributions, transition times, equilibria. Spatial models of disease spread and neuronal activity. Deterministic versus stochastic models.

8417. MATHEMATICAL MODELING IN THE HEALTH SCIENCES III: STOCHASTIC SIMULATION. (3 cr; prereq 8416, Math 3221, PubH 5450, PubH 5452, programming or #; offered alt yrs) Altmann

Construction and use of software for simulation of stochastic models in health sciences. Discrete event scheduling. Methods of random variate generation and variance reduction. Design and analysis of simulation experiments. Sensitivity analysis and response surfaces.

8449. ADVANCED READINGS IN HEALTH INFORMATICS. (1-3 cr; prereq 5432, PubH 5434, #) Staff
Discussion of methodology and results.

8450. RESEARCH IN HEALTH INFORMATICS. (Cr ar; prereq #) Staff

Health Services Research and Policy (PubH)

Professor: Jon B. Christianson; Roger D. Feldman; Judith M. Garrard; Robert L. Kane; Rosalie Ann Kane; John E. Kralewski; Theodor J. Litman; Willard G. Manning; Ira S. Moscovice

Associate Professor: Bryan E. Dowd, *director of graduate studies;* Thomas Choi; Nicole Lurie; John A. Nyman

Clinical Assistant Professor: Steven D. Hillson

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.S. (Plan A and Plan B).

Curriculum—The objective of the program is to train health services researchers and health policy analysts to carry out studies using appropriate theoretical and empirical techniques, formulate health policy options, work effectively in the political arena to shape policies, and evaluate policy initiatives once implemented. The degree can serve as a terminal degree or as the first step toward the Ph.D. in health services research, policy, and administration. Two options are available. Plan A is primarily for students with a professional degree in medicine, dentistry, nursing, or pharmacy. Plan B is for students without a health professional background. Students electing Plan B substitute additional coursework and special projects, including a summer internship in a public or private health services agency/organization, for the thesis. Both options are two-year programs.

In the first year of the program, students receive an overview of the health services research field and are introduced to the social and health sciences paradigms employed most frequently in health services research: economics, sociology, and epidemiology. Students also complete coursework in theoretical statistics and regression analysis. The second year focuses on research design and advanced analytic techniques in coursework on research methods, surveys and sampling, measurement, and evaluation research. In the health policy sequence, analytic methods are

applied to current problems. Students may choose electives from other divisions within the School of Public Health or from other departments within the University.

Prerequisites for Admission—Applicants who have not completed coursework in calculus, statistics, and microeconomics, but are otherwise qualified for admission, will be required to take relevant summer session courses either at the University or at another accredited institution before beginning the program.

Special Application Requirements—Above average performance in the Graduate Record Examination (GRE) is required for admission. A statement of purpose and three letters of reference are also required. Students are admitted in fall quarter only. The program is full time.

Language Requirements—None.

For Further Information and Applications—Contact the Student Services Center, School of Public Health, University of Minnesota, Box 819 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (612/626-3500 or 1/800/774-8636; fax 612/626-6931; e-mail sph-uofm@greg2.sph.umn.edu).

Note—Courses in health services research and policy are listed and described under Public Health in this bulletin. See PubH 5330, 5790, 5793, 5794, 5852, 5862, 5863, 5868, 5870, 8801, 8810-8811-8812, and 8813. See also Stat 5121, 5122, and 5302 under Statistics.

Health Services Research, Policy, and Administration (PubH)¹

Professor: Willard G. Manning, *director of graduate studies;* Mario F. Bognanno; Jon B. Christianson; Bright M. Dornblaser; Roger Feldman; Judith M. Garrard; Robert L. Kane; Rosalie A. Kane; John Krlewski; Theodor J. Litman; Ira Moscovice; Vernon E. Weckwerth

Associate Professor: Thomas Choi; Bryan E. Dowd; Michael D. Finch; G. Kenneth Gordon; George O. Johnson; Nicole Lurie; John A. Nyman; Michael D. Resnick

Adjunct Associate Professor: N. Tor Dahl; Richard J. Oszustowicz

Assistant Professor: Robert A. Connor; James B. Goes; Leslie A. Grant; Sandra J. Potthoff

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—Ph.D.

Curriculum—The doctoral studies program offers advanced graduate education for students seeking teaching and research positions related to health services in academic institutions, government, or the private sector. Students acquire an understanding of the influence of economic, social, and political forces on health and health care, including the cost of health care, with emphasis on the factors affecting the public and private financing of health services; the problems of access to health services among different population subgroups and the attendant issues of equity and social justice in the allocation of health care resources; the nature and evolution of government involvement in health care and its consequences; and the legislative process and role of interest groups in the formulation of health policy.

Prerequisites for Admission—Applicants who have not completed coursework in calculus, statistics, and microeconomics, but are otherwise qualified for admission, will be required to take relevant summer session courses either at the University or at another

accredited institution before beginning the program.

Special Application Requirements—Above average performance on the Graduate Record Examination (GRE) is required for admission. A statement indicating reasons for seeking the Ph.D., plus three letters of reference attesting to the applicant's academic ability and potential for a career in teaching and research, are required. Students are admitted in fall quarter only. The program is full time.

Language Requirements—None.

For Further Information and Applications—Contact the Student Services Center, School of Public Health, University of Minnesota, Box 819 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (612/626-3500 or 1/800/774-8636; fax 612/626-6931; e-mail sph-uofm@greg2.sph.umn.edu).

PubH 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

PubH 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Note—Courses in health services research, policy, and administration are listed and described under Public Health in this bulletin. See PubH 5793, 8750 to 8796, and 8801-8821.

Hispanic and Luso-Brazilian Literatures and Linguistics

Professor: Roberto Reis, *director of graduate studies;* Rene Jara; Antonio Ramos; Nicholas Spadaccini; Hernan Vidal; Anthony N. Zahareas

Associate Professor: Amy K. Kaminsky; Carol A. Klee; Joanna O'Connell; Constance A. Sullivan

Assistant Professor: Francisco A. Ocampo

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B): Hispanic Literature, Luso-Brazilian Literature, Hispanic Linguistics; Ph.D.: Hispanic and Luso-Brazilian Literatures and Linguistics.

¹ A professional Master of Health Care Administration (M.H.A.) degree is available through the School of Public Health. Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Curriculum—Emphases available for the Ph.D. are Spanish literature, Spanish-American literature, Lusophone literatures, and Hispanic linguistics.

Prerequisites for Admission—Prospective students generally have completed an undergraduate degree or substantial coursework in the field, although individuals with other backgrounds may be admitted. The Graduate Studies Committee may require completion of background coursework, without graduate degree credit, for admitted students with insufficient preparation.

Special Application Requirements—Three letters of recommendation from previously attended institutions evaluating the applicant's scholarship, a sample of a writing project, and a complete set of transcripts in addition to that required by the Graduate School should be sent to the director of graduate studies. The Graduate Record Examination is strongly recommended, and is required for fellowship candidates. Financial aid applications should be submitted by January 15 for fall quarter entry.

Master's Degree Requirements—For specific information about program requirements, consult the Department's Graduate Handbook.

Both written and oral final examinations are required for all M.A. degrees.

Doctoral Degree Requirements—Students who hold an M.A. degree or who wish to bypass the M.A. program must pass a Ph.D. qualifying examination by the second quarter after beginning work toward the doctorate. For further information consult the department's Graduate Handbook.

Language Requirements—For the master's degree, students must have a reading knowledge of at least one modern foreign language besides that of their major area. For the doctoral degree, students must have proficiency in the minor language (i.e., Portuguese for those emphasizing one of the Hispanic components, Spanish for those

emphasizing the Luso-Brazilian component). Proficiency is usually demonstrated by use of the minor language in written and oral forms (see the department's Graduate Handbook).

For Further Information and Applications—Contact the Department of Spanish and Portuguese, University of Minnesota, 34 Folwell Hall, 9 Pleasant Street S.E., Minneapolis, MN 55455 (612/625-5858). (Students are issued the department's *Graduate Handbook* on admission.)

Port 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Span 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Span 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Span 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Portuguese (Port)

5210. TOPICS IN BRAZILIAN LITERATURE. (4 cr per qtr [max 12 cr]; prereq 3211 or 3212 or 3213 or three 3xxx or 5xxx literature courses in Spanish with Δ) Major issues of Brazilian literature; treats important authors, movements, currents, genres. Problems, socioeconomic questions, literary techniques related to Brazilian subjects. Topics specified in *Class Schedule*, but usually include: Brazilian poetry up to modern times (overview of Portuguese, Indian, and Negro factors; Mineiros, Condoreira, etc.); Machado de Assis and the 19th-century novel of the Americas; Brazilian modernismo (vanguardist movement of cultural, nationalistic, and aesthetic reappraisal; emphasis on poetry); northeast regionalism (focus on prose narrative); contemporary Brazilian literature (historical survey of important authors, literary movements, conventions, genres, and themes); modern Brazilian theatre (Brazil vs. Spanish America).

5521. LITERATURE IN TRADITIONAL/ EXPANSIONIST PORTUGAL. (4 cr; prereq three 3xxx Portuguese courses or Δ)

Literary movements and key literary figures in Portugal to the mid-eighteenth century (ca. 1750). Literature as a dimension of a sociocultural movement involving modulations of traditionalist social formations and accommodation of overseas expansion.

5522. LITERATURE AND LIBERAL PROBLEMATIC IN PORTUGAL. (4 cr; prereq three 3xxx Portuguese courses or Δ)

Literary movements and key figures from mid-eighteenth century to present. Literature as a dimension of sociocultural movement in which, by emulation and various reconstitutions of society, Portugal attempts to "modernize."

Graduate Programs

5523. NATIONALISM IN BRAZILIAN

LITERATURE. (4 cr; prereq three 3xxx Portuguese courses or Δ)

Major literary works—poetry, novel, essay, or drama—and literary trends from Colonial period and/or 19th century as expressions of nativist/nationalistic project in Brazil.

5524. BRAZILIAN LITERATURE AND

MODERNIZATION. (4 cr; prereq three 3xxx Portuguese courses or Δ)

Major literary works—poetry, novel, essay, memoirs, or drama—and literary trends from 20th century as expressions of modernization process of Brazilian society.

5910. TOPICS IN LUSO-BRAZILIAN CULTURES.

(4 cr; prereq Span 3104 or SpPt 3104 or Δ)

Important cultural manifestations in Portuguese-speaking world: e.g., literature, music, film, oral traditions, TV. Topics specified in *Class Schedule*.

5920. FIGURES IN LUSO-BRAZILIAN

LITERATURE. (4 cr; prereq Span 3104 or SpPt 3104 or Δ)

One Portuguese, Brazilian, or other major Lusophone writer or group of writers whose work has had impact on thought, literature, or social problems. Figures specified in *Class Schedule*.

5970. DIRECTED READINGS. (1-5 cr per qtr [max 15 cr]; prereq # and Δ, CLA approval)

Luso-Brazilian studies, especially in areas not previously covered. Students must submit reading plans for particular topics, figures, periods, or issues. For M.A. and Ph.D. candidates.

5990. DIRECTED RESEARCH. (1-5 cr; prereq #, Δ, CLA approval)

8101. LITERARY CRITICISM AND RESEARCH METHODS. (4 cr)

8920. SEMINAR: LUSO-BRAZILIAN

LITERATURE. (4 cr)

Advanced level study of problems in Luso-Brazilian language, literature, and cultural history. Topics specified in *Class Schedule*.

Spanish (Span)

Linguistics, Philology, History of the Language, and Research Methods

5011. SPANISH STYLISTICS. (4 cr; prereq 10 cr from 3001-3005 series or #; offered when feasible)

5015. METHODS OF TRANSLATION. (4 cr; prereq 10 cr from 3001-3005 series or #)

Meaning, use, and theories of translation. Techniques and problems of translation from Spanish and Portuguese to English and vice versa. Translation patterns, use of special vocabularies, and other adjuncts needed to understand both languages. Practical vocabulary and usage for various fields of work.

5701, 5702, 5703. HISTORY OF IBERO-ROMANCE.

(4 cr per qtr; prereq 3701 or 3702 or #)

Comparative study of origins and development of Ibero-Romance languages; evolution of Catalan, Portuguese, and Spanish compared and contrasted. Methods in reading and analysis of non-literary and literary medieval texts.

5709. HISPANIC LINGUISTIC THOUGHT: 1100-PRESENT. (4 cr; offered when feasible)

5711. THE STRUCTURE OF MODERN SPANISH: PHONOLOGY. (4 cr; prereq 3701, Ling 5302 or #)

Formulation and evaluation of phonological descriptions of Spanish. Approaches to problems in Spanish phonology within metrical, autosegmental, and lexical phonological theories. Useful for students who plan to teach Spanish and for those whose primary language is Spanish.

5712. THE STRUCTURE OF MODERN SPANISH: MORPHOLOGY. (4 cr; prereq 3702, Ling 5302 or #; offered when feasible)

5713. THE STRUCTURE OF MODERN SPANISH: SYNTAX. (4 cr; prereq 3702, Ling 5201 or #)

Introduction to linguistic types that appear across languages, such as grammatical relations, word order, transitivity, causative constructions, relative clauses, and how these are present in syntax of Spanish. Useful for students who plan to teach Spanish and for those whose primary language is Spanish.

5714. THE STRUCTURE OF MODERN SPANISH: SEMANTICS. (4 cr; prereq 5713)

Relationship between syntax and semantics. Application of structural semantics to the Spanish language, including concepts of semantic and lexical fields. Examines cultural patterns in Hispanic world as reflected in semantic structures. Theories of meaning; euphemisms; taboos; semantics and social class. Semantic approaches to literary analysis.

5715. THE STRUCTURE OF MODERN SPANISH: PRAGMATICS. (4 cr; prereq 5713 or #)

Introduction to concepts used in current literature in Spanish pragmatics.

5731. SPANISH DIALECTOLOGY: REGIONAL AND SOCIAL DIALECTS OF MODERN SPAIN.

(4 cr; prereq 5729 or #)

Major dialect areas of Spain, with distinguishing phonological, morphological, lexical, and syntactic variations of each. Impact of recent cultural, political, and socioeconomic transformations on the language.

5732. SPANISH DIALECTOLOGY: REGIONAL AND SOCIAL DIALECTS OF MODERN SPANISH AMERICA. (4 cr; prereq 5729 or #)

Major dialect areas in modern Hispanic America. Form, speech, and language as they relate to the old political and religious divisions of Hispanic America and to the new national boundaries.

5985. THE STUDY OF SPANISH IN THE UNITED STATES: THEORY AND FIELD METHODS. (4 cr; prereq 3701)
Sociolinguistic theory and field methods related to study of Spanish in United States; field experience in Hispanic community of St. Paul.

5991. THE ACQUISITION OF SPANISH AS A FIRST AND SECOND LANGUAGE. (4 cr; prereq 3702 or #)
Examination of studies on acquisition of Spanish as a first and second language; second language acquisition in both formal and informal environments.

8101. LITERARY CRITICISM AND RESEARCH METHODS. (4 cr; offered when feasible)

8710. SEMINAR IN SPANISH AND PORTUGUESE PHONOLOGY. (4 cr; prereq 5711 or #)
Current theoretical issues in phonology of Spanish and Portuguese.

8730. SEMINAR IN SPANISH AND PORTUGUESE SYNTAX. (4 cr; prereq 5713 or #)
Research and critical examination of readings in specific topic of Hispanic syntax.

8750. SEMINAR IN SPANISH AND PORTUGUESE PRAGMATICS. (4 cr; prereq 5715 or #)
Research and critical examination of readings in specific topic of Hispanic pragmatics.

8780. SEMINAR IN HISPANIC SOCIOLINGUISTICS. (4 cr; prereq 5985 or #)
Current topics.

8936. DIRECTED FIELDWORK IN THE DESCRIPTIVE STUDY OF SPANISH. (4 cr; prereq 5729, 8934, Ling 5711)
Directed fieldwork in a descriptive aspect of a regional or social dialect in Spain, Hispanic America, or a Spanish-speaking community of the United States.

Peninsular Literature

5106. THE LITERATURE OF THE RECONQUEST AND FEUDAL SPAIN. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese)
Major literary works and genres of medieval Spain—from the primitive lyric to *La Celestina*—examined against background of social and historical transformations of Spanish Middle Ages.

5107. THE LITERATURE OF THE SPANISH EMPIRE AND ITS DECLINE. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese)
Major Renaissance and baroque works of 16th and 17th centuries—poetry, nonfiction prose, novel, drama—examined against background of establishment of Spanish Empire, internal economic crisis, and ideological apparatus developed by the modern state.

5108. THE SPAIN OF CERVANTES' DON QUIXOTE: HISTORY AND FICTION. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ)
Historical function of literary techniques, narrative perspectives, and ironic discourse of Cervantes' major work during the period of imperial decadence. Tradition of Erasmus folly, madness as anachronism and social satire.

5109. THE LITERATURE OF BOURGEOIS ORDER: ENLIGHTENMENT, ROMANTICISM, AND POSITIVISM. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese)
Major literary works—poetry, essay, novel, and drama—and literary movements of 18th and 19th centuries examined as aesthetic expressions of the long process of consolidation of the bourgeois social order in Spain.

5111. THE LITERATURE OF THE SPANISH CRISIS OF THE 20TH CENTURY. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese)
Major literary works and aesthetic trends of contemporary Spain examined within context of the social, political, and intellectual crisis, from the Spanish-American War of 1898 to the post-Franco period.

5221. SPANISH LITERATURE OF THE 17TH CENTURY: THE DRAMA. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ)
Representative playwrights: Lope, Alarcón, Tirso, Calderón. Dramatic forms, especially comedia, tragedy, and auto sacramental. Approaches to golden age comedia. Themes of honor, purity of blood, country vs. city, free will, others, viewed against background of literary, cultural, and social history.

5234. FEMINISM AND LITERATURE IN SPAIN. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ)
Spanish feminism in thought and practice; literature, cultural discourse, and literary theory.

5272. HISPANIC MODERNISM. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ)
Critical review of artistic and literary production in Hispanic cultures from middle of 19th century to avant-garde. Modernity and modernization in Hispanic world. Spanish generation of 1898. Castilian, Catalan, and Latin-American practices along interdisciplinary and comparative lines.

5316. THE PICARESQUE NOVEL. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ)
Major picaresque narratives—*Lazarillo*, *Guzmán*, *Buscón*, Cervantes' *pícaros*, *Estebanillo González*—in relation to Spanish ambience, Western tradition, European novel, realism. Treats literary autobiography, episodic structure, themes of roguery, delinquency, sin, marginality, social criticism, and moral preoccupations. Comparisons to European counterparts.

Graduate Programs

8100. RESEARCH IN SOCIOHISTORICAL APPROACHES TO SPANISH LITERATURE. (4 cr)

Sociohistorical functions of Spanish literary texts and major theories concerning literary production.

8200. SPANISH LITERARY TEXTS: THEORIES OF FORMAL STRUCTURES. (4 cr)

Research in approaches to and methods of literary analysis of the discourse.

8202. ORALITY AND LITERACY IN MEDIEVAL SPAIN. (4 cr; offered when feasible)

8212. SPANISH LITERATURE OF THE 16TH CENTURY: DRAMA UP TO LOPE DE VEGA. (4 cr; offered when feasible)

8223. SPANISH GOLDEN AGE POETRY. (4 cr)
New Spanish poetry, started by Boscán and Garcilaso and developed by Luis de León, San Juan, and Herrera, new trends by Góngora, Lope de Vega, and Quevedo. Greek, Latin, Italian literary traditions: major lyric genres and ideological lines. Eclogues, *lira*, mystical verse, satires, *conceptismo* and *culteranismo*. The sonnet.

8252. SPANISH LITERATURE: 19TH CENTURY. (4 cr; offered when feasible)

8271. SPANISH THEATRE IN THE 20TH CENTURY. (4 cr; offered when feasible)

8300. THE CONSTRUCTION OF SPANISH LITERARY HISTORY. (4 cr)

Critical purview of how canon of Spanish literary history has been established during last 100 years. Socio-cultural and socio-political theories that underlie constitution of literary history as an academic and historiographic discipline. Literature from Spain or literature in Spanish. Hegemonic literature as national literature in Spain.

8312. THE LIBRO DE BUEN AMOR AND LA CELESTINA. (4 cr; offered when feasible)

8354. SPANISH THOUGHT, LETTERS, MOVEMENTS OF THE 19TH CENTURY. (4 cr; offered when feasible)

8371. THE MODERN SPANISH NOVEL (1900-1936). (4 cr)

Survey of three novelistic generations—of 1898, post-1898, and the “dehumanized” 1930s of surrealism. Emphasis on relationship of thematic content—politics, arts, history, human psychology, Spain itself—to fictional constructs and self-expression in Azorín, Unamuno, Baroja, Valle-Inclán, Pérez de Ayala, Miró, Jamés.

8372. SPANISH 20TH-CENTURY ESSAY. (4 cr; offered when feasible)

8392. CONTEMPORARY SPANISH POETRY (1936 TO PRESENT). (4 cr; offered when feasible)

8502. HISTORY OF SPANISH CINEMA. (4 cr; offered when feasible)

8503. CONTEMPORARY HISPANIC POETRY AFTER THE EARLY THIRTIES. (4 cr)

Critical purview of poetic discourses in Spain and Latin America during past four decades, from crisis to dissolution of modernity in era of television. National practices along interdisciplinary and comparative lines.

8504. MODERN FORMS OF NARRATIVITY AFTER THE EARLY THIRTIES. (4 cr)

Critical purview of narrative discourses in Spain (in both Spanish and Catalan) and Latin America during past four decades, from crisis to dissolution of modernity in era of television. National and non-hegemonic practices (novel, short stories, film, television) along interdisciplinary and comparative lines.

8533. THE BAROQUE IN EUROPEAN LITERATURE: SPAIN. (4 cr)

Third quarter of interdepartmental sequence of literature in translation. The baroque movement in Spain. Characteristics in common with the baroque movement in Italy, France, and Germany.

Spanish-American Literature

5525. CARIBBEAN LITERATURE: AN INTEGRAL APPROACH. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ)

Review of the literature of the Caribbean area; common generic traits and preoccupations. Conceptualization of the region as a totality: themes, similar lines of development, generic tendencies, periods of development and crisis.

5526. CREOLE CONSCIOUSNESS AND MERCANTILIST CULTURE. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ)

Texts written between 1492 and 1780, sociohistorical context. Generic variants and the approach to changing reality in which they are inscribed.

5527. NATIONAL LITERARY CONSCIOUSNESS AND FREE TRADE. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ)

Literary movements as part of the process of formation of nation-states: the incorporation of Latin America in the international capitalist system as producer of foodstuffs and raw materials and importer of manufactured goods (1780-1900).

5528. POPULAR LITERARY CONSCIOUSNESS, 1900-1950. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ)

Spanish-American literature between the eve and aftermath of the two world wars. Impact of modernization, industrialization, and nationalistic and populist thought on emergence of distinctive writing, thematic trends, and literary genre conventions.

5529. NATIONAL AFFIRMATION AND TRANSNATIONALIZATION. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ)

Literary trends of the period (1950 to present) as a reaction to internal social demands for development of independent national cultures and conflicting influence of international economic system.

5531. HISPANIC LITERATURES OF THE UNITED STATES. (4 cr; prereq three 3xxx or 5xxx Spanish or Portuguese lit courses or Δ; offered when feasible)

5532. LITERATURE AND NATIONAL DISINTEGRATION. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ)
Literary reaction to contemporary structural changes in world economic system (1970 to present). Effects on literature as institution. Texts related to revolutionary trends and social movements (feminism, Theology of Liberation, defense of human rights).

5533. LATIN-AMERICAN CULTURAL DISCOURSE. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ)
Contemporary discourses that attempt global explanations of development of Latin-American culture and civilization: liberal diffusionism, Dependency Theory, geopolitics, Doctrine of National Security, Theology of Liberation, human rights movement.

5534. NATIONAL LITERATURES OF SPANISH AMERICA. (4 cr; prereq three 3xxx or 5xxx courses in Spanish or Portuguese or Δ)
Review of national literature of a Spanish-American country. Literary movements and figures, important genres; conceptualization of national identity; literary history as socio-historical project; canon formation and challenge.

5535. HISPANIC-AMERICAN LITERARY HISTORY: AN OVERVIEW. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ; offered when feasible)

5536. FEMINISM AND LITERATURE IN LATIN AMERICA. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or Δ; offered when feasible)

8940. ADVANCED RESEARCH IN SPANISH-AMERICAN LITERARY HISTORIOGRAPHY. (4 cr)
Sources and procedures that have given rise to institutionalizations of Spanish-American literary history. Evaluation and review of epistemological principles and assumptions in theory of literary criticism and histories of literature.

8960. ADVANCED RESEARCH IN SOCIAL APPROACHES TO SPANISH-AMERICAN LITERARY TEXTS. (4 cr)
Function of Spanish-American literature in society according to various theories of social structures: Marxist, Weberian, Frankfurt School, Dependency Theory, Simmelian sociology.

8980. ADVANCED RESEARCH IN SEMIOTIC/STRUCTURAL ANALYSIS OF SPANISH-AMERICAN LITERARY TEXTS. (4 cr)
Challenging Spanish-American literary texts as semiotic processes, both to illuminate their structural machinery of meaning and to open their semiotic projection to the symbolic activity pervading Spanish-American cultural and social environment.

8990. ADVANCED COMPARATIVE RESEARCH OF CARIBBEAN GENRES. (4 cr)

Major literary works and genres of Caribbean literature studied against the background of the sociohistorical vicissitudes of the process leading to the formation and consolidation of the national states.

Topics, Seminars, and Directed Study

5800. SPANISH CULTURE AND SOCIETY IN 20TH-CENTURY SPAIN. (4.5 cr; prereq teachers certificate or #)
Major changes, especially after 1975.

5801. CONTEMPORARY HISPANIC ISSUES FOR SECONDARY TEACHERS. (3 cr [not for CLA cr])
Factors, causes, and consequences underlying contemporary dramatic social, political, and cultural changes in Spanish-speaking countries and in U.S. Hispanic population. Offered in conjunction with Secondary Education workshop, Teaching of Second Languages and Cultures.

5910. TOPICS IN SPANISH PENINSULAR LITERATURE. (4 cr; prereq Span 3104 or Δ)
Major issues or approaches of Spanish literature examined through important groups, movements, trends, methods, genres. Topics may include: conversos; "mysticism"; poesia tradicional; "essay" and Enlightenment; novela realista; avant-garde. Topics specified in *Class Schedule*.

5920. TOPICS IN SPANISH-AMERICAN LITERATURE. (4 cr; prereq Span 3104 or SpPt 3104 or Δ)
Spanish-American literature examined through important groups, movements, trends, methods, genres. Topics specified in *Class Schedule*.

5930. TOPICS IN IBERO-ROMANCE LINGUISTICS. (4 cr per qtr [max 12 cr]; prereq 10 cr from Span 3001-3005 series or #)
Topics specified in *Class Schedule*. For list of sample topics, consult the department. Problems in Hispanic linguistics, including aspects of Luso-Brazilian language. A variety of linguistic approaches and methods.

5940. FIGURES IN SPANISH PENINSULAR LITERATURE. (4 cr; prereq Span 3104 or SpPt 3104 or Δ)
One Spanish writer or group of writers whose work has made an impact on thought, literature, or social problems. Figures may include Alfonso X; Cervantes; Quevedo; Larra; Unamuno; Lorca.

5950. FIGURES IN SPANISH-AMERICAN LITERATURE. (4 cr; prereq Span 3104 or Δ)
One Spanish-American writer or group of writers whose work has had impact on thought, literature, or social problems.

5970. DIRECTED READINGS. (1-5 cr per qtr [max 15 cr]; prereq #, Δ, CLA approval)
To fill gaps in students' preparation, especially when certain courses have not been offered. Students must submit reading plans for particular topics, figures, periods, or issues. Readings in Spanish and/or Spanish-American areas. For master's and Ph.D. candidates.

Graduate Programs

5990. DIRECTED RESEARCH. (1-5 cr ar; prereq #, Δ, CLA approval)

8900.* SPANISH SEMINAR. (4 cr)

Special projects relying heavily on advanced research in Spanish problems. Limited to small group of students. Investigation of assigned fields, analysis of problems, appraisal of principles. For list of sample seminars, consult the department.

8920. SEMINAR: MIGRATION, TRANSNATIONALIZATION, AND HISPANIC LITERATURE. (4 cr)

Development of growing corpus of literature that, while Hispanic in character, has no specific Hispanic national or regional origins but instead issues out of cultural context created by displaced Spanish American populations, particularly in the United States.

8930.* SPANISH DIALECTOLOGY. (4 cr; offered when feasible)

8950.* SEMINAR: SPANISH-AMERICAN LITERATURE. (4 cr)

Special projects of advanced research in Latin-American problems. Investigation of assigned areas, analysis of problems, appraisal of principles. Limited to small group of students. For list of sample topics, consult the department.

8970. DIRECTED READINGS IN ROMANCE LANGUAGES. (Cr ar; prereq Δ)

Studies in authors and topics not offered in other courses. Weekly meetings based on student's research and analysis. Students and instructor agree on plan of reading or particular topics, figures, issues, etc. Readings in Spanish or Spanish-American areas. Primarily for Ph.D. candidates.

Spanish-Portuguese (SpPt)

5930. SELECTED TOPICS IN THE HISPANIC CULTURAL DISCOURSES. (4 cr; prereq reading knowledge of Spanish and Portuguese)

Cultural discourses of Portuguese-speaking and Spanish-speaking worlds. Common background and differences among Iberian and/or Latin American intellectual production. Taught in Portuguese.

5999. THE TEACHING OF COLLEGE-LEVEL SPANISH AND PORTUGUESE: THEORY AND PRACTICE. (4 cr)

For new teaching assistants in Department of Spanish and Portuguese.

8911. SEMINAR: FEMINIST PERSPECTIVES ON HISPANIC AND LUSO-BRAZILIAN CULTURAL DISCOURSES. (4 cr)

Feminist theoretical issues and critical practice, application to Hispanic and Luso-Brazilian literary and cultural discourse; relationship of feminist criticism to other theoretical models and methodologies.

8920. CROSS-CULTURAL ISSUES IN HISPANIC AND LUSO-BRAZILIAN LITERATURES. (4 cr; prereq #)

Comparative study of literary production in historical periods when economic, social, political, and ideological bonds among Hispanic and Lusophone countries are intensified.

History (Hist)

Professor: Kinley J. Brauer, *chair*; Josef L. Altholz; Bernard S. Bachrach; Paul W. Bamford (*emeritus*); Hyman Berman; Clarke A. Chambers (*emeritus*); John K. Evans; Sara M. Evans; Caesar E. Farah; Edward L. Farmer; David F. Good; Barbara A. Hanawalt; John R. Howe; Allen F. Isaacman; Thomas Kelly; Sally G. Kohlstedt (history of science and technology); David Kopf; Edwin T. Layton (history of science and technology); Stanford E. Lehmborg; Byron K. Marshall; Elaine Tyler May (American studies); Mary Jo Maynes; Robert E. McCaa; Russell R. Menard; Michael F. Metcalf; John K. Munholland; Paul L. Murphy; David W. Noble; Thomas S. Noonan; Carla R. Phillips; William D. Phillips, Jr.; R. John Rath (*emeritus*); Kathryn L. Reyerson; Richard L. Rudolph; Joel B. Samaha; Stuart B. Schwartz; Theofanis G. Stavrou; Romeyn Taylor (*emeritus*); John A. Thayer; James D. Tracy; Joe W. Trotter, Jr.; Carol L. Urness (James Ford Bell Library); Rudolph J. Vecoli; William E. Wright (*emeritus*)

Associate Professor: George D. Green, *director of graduate studies*; John M. Eyer (history of medicine); Susan N. G. Geiger (women's studies); Andrea Hinding (Humanities/Social Sciences Libraries); David O. Kieft; Lary L. May (American studies); Gianna Pomata; Steven Ruggles; Hanna Schissler (German and history); Allan H. Spear; Dennis Valdes; Ann B. Waltner

Assistant Professor: Victoria Coifman (Afro-American studies); Lisa A. Norling; Jean M. O'Brien-Keheo

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Areas of concentration include Africa; Asia; England; Ancient, Medieval, Early Modern, and Modern Europe; Early Modern World; Latin America; and the United States and its colonial background. Scholarly resources include the Center for Austrian Studies, the Center for Advanced Feminist Studies, the Center for Medieval Studies, the Immigration History Research Center, Modern Greek Studies, the Center for Early Modern History, and the Social Welfare History Archives.

Prerequisites for Admission—Applicants for the master's degree normally should have completed general undergraduate survey courses in two or three broad areas of history, two years of advanced undergraduate work in two areas of history, and training in a foreign language. Some prerequisites may be made up after admission. In some circumstances, students without undergraduate history majors may be admitted to the M.A. program. Applicants for the Ph.D. program normally should have completed a master's degree, but highly qualified applicants may apply directly for admission to the Ph.D. program without having completed an M.A. degree.

Special Application Requirements—The following are required by the department: a statement of background and purpose, three letters of recommendation, a statement of specific areas and subfields of interest, and scores from the General (Aptitude) Test of the Graduate Record Examination or the Miller Analogies Test. Deadline for financial aid applications is the last week in December. Forms and instructions should be requested from the department.

Master's Degree Requirements—Plan A requires a thesis, plus a minimum of nine courses in history (including thesis credits for the equivalent of four of these) and two courses in other fields. Plan B requires a minimum of seven courses in history, two in outside fields, and two more in either history or outside fields. For detailed requirements see the department publication *Graduate Study in History*. A final oral examination is required for all master's programs.

Doctoral Degree Requirements—Students must complete advanced research seminars and prepare for preliminary examinations in areas of concentration. Students are expected to complete twelve courses in history and five in outside fields. Detailed requirements are outlined in the department publication *Graduate Study in History*.

Language Requirements—A reading knowledge of one foreign language is required before admission to the master's

examination, and of two foreign languages before admission to the preliminary examinations for the Ph.D. degree. Some areas of concentration may require additional foreign languages. In some cases, competence in quantitative methods may replace one of the foreign languages. See *Graduate Study in History* for details.

Minor Requirements for Students

Majoring in Other Fields—For the master's degree, Plan A (a Plan B minor is not available), a minimum of three related courses in history are required. For the Ph.D. degree, at least six courses in history, including proseminar or seminar work, and a written and oral examination, are required.

For Further Information and

Applications—Contact the Department of History, University of Minnesota, 633 Social Sciences Building, 267 19th Avenue South, Minneapolis, MN 55455 (612/624-2800).

Hist 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Hist 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Hist 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Methodology and Comparative History

5011, 5012. QUANTITATIVE METHODS IN HISTORICAL RESEARCH. (4 cr per qtr; prereq #) McCaa, Menard, Ruggles

Introduction to quantitative approaches to analysis of historical problems. Data collection, questions of measurement, analytical techniques, and rudimentary statistics as they apply to historical research. Relationship of quantitative inferences to nonquantitative procedures.

5429. SLAVERY IN THE AMERICAS. (4 cr; offered alt yrs) Isaacman, Menard, Schwartz, Spear
Comparative history of slavery, concentrating on slave regimes in the United States, Latin America, and Caribbean. Emphasis on slavery as both an economic and social system.

5630. COMPARATIVE EARLY MODERN HISTORY. (4 cr; prereq #)

Critical examination of literature comparing history of different regions of world in Early Modern era, ca. 1450-1750.

Graduate Programs

5797. METHODS OF POPULATION HISTORY.

(4 cr; prereq #; offered alt yrs) McCaa, Ruggles
Study and analysis of past population and its relation to other historical developments. Birth, marriage and the family, household structure, diseases, death, impact of industrialization and urbanization in various areas and times.

5920. TOPICS IN COMPARATIVE WOMEN'S HISTORY.

(4 cr; prereq #) Evans, Maynes, Norling, Waltner
Cross-cultural and thematic explorations in the history of women, including women, markets, and agriculture; women in colonialism; women and class formation; women and religion; prostitution; the medical construction of gender; women's narratives as historical sources.

5930. TOPICS IN COMPARATIVE THIRD WORLD HISTORY. (4 cr; prereq #) Isaacman, Kopf, Schwartz
Recurring themes in third world history. Topics vary quarterly.

5942. POPULAR CULTURE AND MODERN HISTORY.

(4 cr)
Introduction to history of mass media and popular culture in 18th, 19th, and early 20th centuries. Readings on history of media and popular culture and on theoretical approaches to study of mass media.

5960. RESEARCH IN QUANTITATIVE HISTORY.
(4 cr; prereq 5011 or 5012 or 5797, #; offered when feasible) Ruggles

5970. DIRECTED STUDY. (1-15 cr; prereq #, Δ, CLA approval) Staff
Qualified senior and graduate students may register for work on a tutorial basis.

5990. DIRECTED RESEARCH. (1-15 cr; prereq #, Δ, CLA approval) Staff
Qualified senior and graduate students may register for work on a tutorial basis.

8011. SOCIAL HISTORY AS SOCIAL SCIENCE.
(4 cr; prereq #; offered when feasible) Pomata

8015F. SCOPE AND METHODS OF HISTORICAL STUDIES. (4 cr; prereq #) Staff
Development of historical studies over time (especially in 19th and 20th centuries); methodologies currently shaping historical research; theoretical developments within the discipline during 19th and 20th centuries.

8630. SEMINAR IN EARLY MODERN HISTORY.
(4 cr; prereq grad in history, #; 5630 recommended) Staff

8942. MASS MEDIA AND POPULAR CULTURE IN THE 18TH AND 19TH CENTURIES. (4 cr; prereq #)
Follows 5942. Students write research paper on an historical aspect of popular culture or on a topic in which popular culture is an inherent component.

8970. DIRECTED STUDY. (1-15 cr; prereq #) Staff
Work on a tutorial basis.

8990. DIRECTED RESEARCH. (1-15 cr; prereq #) Staff
Work on a tutorial basis.

Africa and African Peoples

5436. SOCIAL HISTORY OF AFRICAN WOMEN: 1850 TO PRESENT. (4 cr; prereq # for undergrads) Geiger

Recent scholarship in African women's social history, undertaken from various perspectives and employing, as well as testing, differing frameworks of historical analysis for African continent.

5447. PROBLEMS IN EAST AFRICA. (4 cr) Isaacman
Advanced course in African history focusing on specific themes and methodological problems.

5931. HISTORY OF AFRICA: SOCIAL GROUPINGS, CONFLICTS. (4 cr; prereq #; offered alt yrs) Isaacman
Rise of social differentiations in precolonial and contemporary African societies and how this process affects state formation and development.

5932. AFRICAN HISTORIOGRAPHY. (4 cr; prereq #) Isaacman
Written sources of African history from antiquity to the present. Emphasis on critique of content and writing.

5939. METHODOLOGY FOR THE STUDY OF AFRICAN HISTORY. (4 cr; prereq #; offered alt yrs) Isaacman
The process of historical reconstruction in nonliterate societies; collection and interpretation of oral traditions.

8430. TOPICS IN THE HISTORY OF AFRICAN PEOPLES. (3 cr; prereq #) Isaacman

8944, 8945. AFRICAN HISTORY. (3 cr per qtr; prereq #; offered when feasible) Isaacman

Ancient

5061. HISTORY OF GREECE: TO 600 B.C. (4 cr) Kelly
Political, economic, and social developments from first appearance of Greeks to ca. 600 B.C.

5062. HISTORY OF GREECE: 600-400 B.C. (4 cr) Kelly
Birth and development of democracy in Athens and militarism in Sparta; birth and development of philosophical and historical thought; development of Athenian Empire; Peloponnesian War between Athens and Sparta.

5063. HISTORY OF GREECE: 400-200 B.C. (4 cr) Kelly
Spartan, Theban, and Macedonian hegemony; Alexander the Great and the Hellenistic monarchies to 200 B.C.

5071, 5072, 5073, 5074. HISTORY OF ROME. (4 cr per qtr) J Evans
5071: To 133 B.C. 5072: 133 B.C. to 31 B.C. 5073: 31 B.C. to A.D. 180. 5074: A.D. 180 to A.D. 395.

5561-5562†. ANCIENT GREEK HISTORY. (4 cr per qtr; prereq #; offered when feasible) Kelly

5571-5572-5573. ROMAN HISTORY. (4 cr per qtr; prereq #; offered when feasible) J Evans

8051-8052-8053†. ANCIENT HISTORY. (3 cr per qtr; prereq #; offered when feasible) Kelly, J Evans

East Asia**5461. ANCIENT CHINA.** (4 cr)

Origins of Chinese civilization, classical philosophies, and Han empire (to 220 A.D.).

5462. BUDDHIST CHINA. (4 cr; offered alt yrs)

Disintegration of Han empire; aristocratic society; barbarian invasions; spread of Buddhism and reintegration of empire in T'ang period (220-906 A.D.).

5464. EARLY MODERN CHINA: 1350-1750. (4 cr, §3464) Farmer, Waltner

Ming and early Ch'ing empires; expulsion of Mongols and centralization of imperial power; high point of Confucian bureaucratic rule, commercial development, philosophical innovation, popular fiction, Manchu conquest, and early Western contacts.

5465. CHINA'S RESPONSE TO THE WEST: 1750-1911. (4 cr, §3465) Farmer, Waltner

Eighteenth-century demographic crisis; growth of Western trade, Opium Wars, and peasant rebellion; early reform efforts, cultural conflicts with West, imperialism in China, and first phase of Chinese revolution.

5467. THE NATIONALIST REVOLUTION IN CHINA: 1900 TO PRESENT. (4-5 cr; prereq # for 5-cr regis) Farmer

Failure of early republic, warlordism, new culture movement, and development of Chinese nationalism. Rise of Nationalist Party and intervention of Soviet Union, Japan, and United States. Taiwan and Republic of China.

5468. PEOPLE'S REPUBLIC OF CHINA: THE COMMUNIST REVOLUTION, 1900 TO PRESENT. (4 cr, §3468; prereq 3468) Farmer

Introduction of Marxism to China, rise of Communist Party and development of rural guerrilla movement. Career of Mao Tse-tung and developments in the People's Republic: The Great Leap, Cultural Revolution, Gang of Four.

5473. FAMILY, SCHOOL, AND WORK IN MODERN JAPANESE HISTORY. (4 cr) Marshall

Impact of industrialization on family life, economic role of women, educational opportunities and curriculum, the work ethic and Japanese employment system in 19th and 20th centuries.

5510. TOPICS IN EAST ASIAN HISTORY. (4 cr per qtr [may be repeated for cr]; prereq #: offered when feasible) Farmer, Marshall, Taylor**5511. SOCIAL AND INTELLECTUAL CHANGE IN LATE CHOU AND HAN CHINA.** (4 cr; prereq #: offered alt yrs)

Axial Age transcendence of primordial myths in cultural crisis of late Chou and early Han: major schools of philosophy and statecraft; establishment of literati as social elite.

5514. TOPICS IN MING AND CH'ING HISTORY: 1350-1800. (4 cr; prereq #: offered alt yrs) Farmer, Waltner

Major issues in early modern Chinese history, especially imperial institutions, neo-Confucian thought, and Ming-Ch'ing transition.

5515. LOCAL INSTITUTIONS IN MODERN CHINA. (4 cr; prereq #: offered alt yrs) Farmer

Marketing system, village, and clan and family structure in rural China; local control devices, religious practices, and status of women.

5517. CHINESE INTELLECTUAL HISTORY: 20TH CENTURY. (4 cr; prereq #: offered alt yrs) Farmer

Cultural change and intellectual currents leading up to May 4th Movement of 1919. Major disputes and problems growing out of that period.

5518. CHINESE INTELLECTUAL HISTORY: MAO TSE-TUNG AND MARXISM. (4 cr; prereq #: offered alt yrs) Farmer

Introduction of Marxism into China; thought and writings of Mao Tse-tung, questions of cultural identity and values in People's Republic of China.

5519. TOPICS IN CHINESE HISTORY. (4 cr; prereq #: offered alt yrs) Farmer

Readings and discussions of topics in recent Chinese history.

5521. INTRODUCTORY PROSEMINAR ON THE MEIJI REVOLUTION IN JAPAN. (4 cr; prereq #: offered alt yrs) Marshall

Readings in English on the reforms from 1868 to 1912 and their economic, social, political, and cultural consequences.

5522. CURRENT ISSUES IN JAPANESE HISTORY. (4 cr; prereq #: offered alt yrs) Marshall

Readings in English on current interpretations and topics in Japanese history.

8464, 8465, 8466. RESEARCH IN LATE IMPERIAL CHINA: YUAN, MING, AND QING. (3 cr per qtr; prereq reading knowledge of Chinese, #: offered when feasible) Farmer, Waltner

Farmer, Waltner

8960. TOPICS IN CHINESE HISTORY. (4 cr; prereq good reading knowledge of modern Chinese) Farmer, Waltner

Seminar examines particular aspect of Chinese history, using materials primarily in Chinese. Topics vary.

Near East**5730. PROSEMINAR IN MIDDLE EAST HISTORY, 16TH TO 19TH CENTURY.** (4 cr per qtr [max 12 cr]) Farah

Topics, which vary quarterly, on Mamluk, Safavid-Qajar, and Ottoman era concerning relations with each other and outside world, to include political, diplomatic, and ideological orientations and conflicts; cultural and social trends; commerce; transformations due to Western impact, to secularization, and to modernization and colonial encroachments, which shaped new ideological trends and gave rise to nationalisms and Islamic activism.

Graduate Programs

Medieval Europe

5100. SELECTED TOPICS IN MEDIEVAL

EUROPE. (4 cr per qtr; prereq #; offered when feasible) Bachrach, Hanawalt, W Phillips, Reyerson

5115. MEDIEVAL LATIN HISTORIANS. (4 cr;

prereq good reading knowledge of Latin) Bachrach
Writing of history in Western Europe during Middle Ages. Focus on idea of history, philosophy of various historians, techniques of research by medieval historians and chroniclers, history as literature, and value of medieval histories to modern research scholars. Original Latin texts only.

5118. SCANDINAVIA IN THE MIDDLE AGES. (4 cr,

§Scan 5118, §Geog 5178) Metcalf, Rice
Team-taught interdisciplinary examination of economic, political, and social history of Scandinavia from late Viking period until circa 1500. Agrarian and urban societies; peasant and elite perspectives; growth of economic, political, religious, and social institutions.

5134. RUSSIA BEFORE THE MONGOL

CONQUEST. (4 cr; offered alt yrs) Noonan
Origins and development of the Kievan state, 850-1240.

5137. NOMADS OF SOUTHERN RUSSIA FROM

SCYTHIANS TO MONGOLS, 600 B.C.-1300 A.D. (4 cr; offered alt yrs) Noonan
The nomads who occupied the Russian steppe (Scythians, Sarmatians, Huns, Avars, Bulgars, Khazars, Pechengs, Cumans, Mongols) and their society.

5248. THE HISTORY OF POLAND, FROM ITS

ORIGINS TO THE EARLY NINETEENTH

CENTURY. (4 cr)

Survey of Polish history to early 19th century.

5611, 5612, 5613. MEDIEVAL HISTORY. (4 cr per

qtr; prereq 1 yr of medieval history or equiv, reading

knowledge of French or German, #) Bachrach, Hanawalt,

W Phillips, Reyerson

5616. PROSEMINAR: MEDIEVAL SPAIN. (4 cr;

prereq #)
Review of secondary literature of history of medieval Spain from Visigothic period to Renaissance. Emphasis on later Middle Ages.

5620. SELECTED TOPICS IN MEDIEVAL

HISTORY. (4 cr; prereq 1 yr medieval hist or equiv, reading knowledge of appropriate foreign language[s], #)
Topics in European and/or Mediterranean history from fall of Roman Empire through end of Middle Ages.

5634, 5635. MEDIEVAL RUSSIAN HISTORY. (4 cr

per qtr; prereq 5134, 5135, 5136, #, reading knowledge of Russian or French or German; offered when feasible)
Noonan

8111-8112-8113+. MEDIEVAL HISTORY. (3 cr per

qtr; prereq #; offered when feasible) Bachrach,
Hanawalt, W Phillips, Reyerson

8141-8142-8143+. MEDIEVAL FRENCH HISTORY.

(3 cr per qtr; prereq #; offered when feasible) Bachrach,
Reyerson

Early Modern Europe

5135. FROM KHAN TO TSAR: RUSSIA, 1240-1530.

(4 cr; offered alt yrs) Noonan
Mongol rule of Russia, rise of Lithuania, emergence of Muscovy.

5136. FROM IVAN THE TERRIBLE TO PETER

THE GREAT: RUSSIA, 1530-1700. (4 cr; offered alt yrs) Noonan
Reign of Ivan the Terrible, time of troubles, great Cossack revolt in Ukraine, 17th-century Muscovy, enserfment of peasantry.

5200. TOPICS IN EUROPEAN HISTORY. (4 cr)

Detailed treatment of selected historical themes. Topics vary quarterly.

5211. FRANCE IN THE OLD REGIME. (4 cr; offered

when feasible)

5617. SPAIN, THE EARLY MODERN PERIOD,

1450-1750. (4 cr; prereq #; offered when feasible) C

Phillips

5621. ITALIAN RENAISSANCE. (4 cr; prereq #)

Pomata, Tracy
Humanism; political development of city-states.

5625. THE GERMAN REFORMATION. (4 cr; prereq

#) Tracy
Luther; urban religious movements; Catholic Reformation.

5626. RENAISSANCE FRANCE TO RICHELIEU.

(4 cr; prereq #; offered alt yrs) Tracy
French monarchy, reformation and counter-reformation, religious wars, and intellectual history.

5631, 5632. EARLY MODERN HISTORY. (4 cr per

qtr; prereq #, reading knowledge of at least 1 foreign language)
Review of secondary literature on processes of global integration ca. 1450-1700 and on comparative study of different regions.

5640. TOPICS IN EARLY MODERN EUROPE. (4 cr)

5651-5652-5653. ENGLISH HISTORY: TUDOR AND

STUART PERIODS. (4 cr per qtr; prereq #) Lehmborg
Critical study of principal writings about English history. 5651: 1485 to 1558. 5652: 1558 to 1625. 5653: 1625 to 1689.

5715. READINGS ON EUROPEAN WOMEN'S

HISTORY: 1450-1750. (4 cr per qtr; prereq #) Pomata
Survey of recent literature on social history of European women and introduction to bibliographical and archival resources.

5957. SOCIAL HISTORY OF ANGLO-AMERICAN

LAW. (4 cr; prereq #; offered alt yrs) Samaha
Law as a cultural and social institution rather than as a means for social control. Law in action as opposed to law in books; law and legal institutions related to social, cultural, and economic developments.

5961-5962. EXPANSION OF EUROPE. (4 cr per qtr;

prereq #)

8150. SEMINAR IN ENGLISH HISTORY. (3 cr [may be repeated for cr]; prereq #: offered when feasible) Altholz, Hanawalt, Lehmsberg

8715. RESEARCH ON EUROPEAN WOMEN'S HISTORY: 1450-1750. (4 cr; prereq 5715, one European language, #) Pomata
Follows 5715. Research project based on primary sources identified in 5715.

Modern Europe

5171, 5172, 5173. MODERN ENGLAND: 1783 TO PRESENT. (4 cr per qtr; offered alt yrs) Altholz
5171: 1783 to 1846, triumph of the middle class. *5172:* 1846 to 1901, Victorian era. *5173:* 1901 to 1972, war and social change.

5200. TOPICS IN EUROPEAN HISTORY. (4 cr)
Detailed treatment of selected historical themes. Topics vary quarterly.

5212. FRENCH REVOLUTION AND NAPOLEON. (4 cr; offered when feasible)

5231. MODERN FRANCE FROM 1848 TO DEGAULLE. (4-5 cr) Munholland
Survey of French society and political life from revolution of 1848 to contemporary France. Foreign language component (French) available for an extra credit.

5249. THE HISTORY OF POLAND IN THE 19TH AND 20TH CENTURIES. (4 cr)

5265. MODERN RUSSIA: THE 19TH CENTURY. (4 cr; offered alt yrs) Stavrou
Political, cultural, and social developments from Alexander I to the 1905 revolution. The revolutionary movement and consequences of the emancipation of the serfs; Russian industrialization.

5266. MODERN RUSSIA: THE 20TH CENTURY. (4 cr; offered alt yrs) Stavrou
Fall of the Russian monarchy, revolutions, and Soviet regime.

5276. INTELLECTUAL AND CULTURAL HISTORY OF MODERN GREECE. (4 cr; offered alt yrs) Stavrou
Literary and cultural contributions of modern Greece in national and European contexts.

5284. DIPLOMATIC HISTORY OF EUROPE: 1848-1900. (4 cr; offered when feasible) Kieft

5285. DIPLOMATIC HISTORY OF EUROPE: 1900-1945. (4 cr; offered when feasible) Kieft

5286. DIPLOMATIC HISTORY OF EUROPE: 1945 TO PRESENT. (4 cr; offered when feasible) Kieft

5294, 5295. SOCIAL HISTORY OF RUSSIA AND EASTERN EUROPE. (4 cr per qtr) Rudolph
Lives of peasants and workers, nobles, and merchants. Family, marriage, sexuality; culture and tradition; work; social movements (revolutionary, women's, nationalist); socialist societies and economies; post-community society. *5294:* Through 19th century. *5295:* 20th century.

5671-5672-5673†. MODERN ENGLAND: 1783 TO PRESENT. (4 cr per qtr; prereq #: offered alt yrs) Altholz

5710. INTRODUCTORY PROSEMINAR IN 18TH- AND 19TH-CENTURY EUROPE. (4 cr per qtr; prereq #)
Topics in the historical literature of modern Europe, 18th and 19th centuries. Topics vary within one of following areas: politics and diplomacy; intellectual and cultural history; economy; society.

5720. INTRODUCTORY PROSEMINAR IN CONTEMPORARY EUROPE. (4 cr per qtr; prereq #)
Selected topics to introduce problems of interpretation and analysis in contemporary European history from late 19th century to Cold War period.

5721-5722†. EUROPE IN THE 20TH CENTURY. (4 cr per qtr; prereq #: offered alt yrs) Munholland
5721: Background and impact of World War I. *5722:* Interwar years and World War II.

5735. READINGS ON EUROPEAN WOMEN'S HISTORY: 1750-PRESENT. (4 cr per qtr; prereq #) Maynes
Reading and discussion.

5744-5745. TOPICS IN MODERN GERMAN HISTORY. (4 cr per qtr; prereq #: offered alt yrs) Kieft, Maynes
Selected readings and discussions on topics such as the reform era, social crisis of Vormärz, 1848 revolution, unification, imperial economic development, World War I, growth of German socialism, intellectual history of Weimar, Nazi state.

5756-5757†. MODERN GREEK STUDIES. (4 cr per qtr; prereq #: offered alt yrs) Stavrou
Evolution of modern Greece from middle of 18th century to present. *5756:* Political, cultural, and socioeconomic factors that contributed to Greek nationalism and establishment of independent Greece. *5757:* Political and cultural developments in 20th century.

5761f-5762w-5763s†. RUSSIAN HISTORY. (4 cr per qtr; prereq reading knowledge of Russian or German or French or #: offered alt yrs) Stavrou

5777, 5778. AUSTRIAN AND HABSBURG HISTORY. (4 cr per qtr; prereq #: offered alt yrs) Wright
5777: Habsburg Central Europe to 1918. *5778:* Modern Austria in context of Central and Eastern Europe after 1918.

5784-5785. DIPLOMATIC HISTORY OF 19TH- AND 20TH-CENTURY EUROPE. (4 cr per qtr; prereq #: offered when feasible) Kieft

5791f, 5792w. SOCIAL HISTORY OF MODERN EUROPE SINCE 1750. (4 cr per qtr; prereq #: offered when feasible) Rudolph

Graduate Programs

5793, 5794. READINGS IN EUROPEAN ECONOMIC HISTORY: 1750 TO PRESENT. (4 cr per qtr; prereq #)

5793: Europe's rise in world economy, England's industrial revolution; uneven spread of development within Europe. 5794: Late-nineteenth-century capitalism and imperialism, interwar economic instability, post-World War II economic miracle in western Europe, continuity and change in eastern Europe.

8150. SEMINAR IN ENGLISH HISTORY. (3 cr [may be repeated for cr]; prereq #; offered when feasible) Altholz, Hanawalt, Lehmborg

8223. RECENT EUROPEAN HISTORY. (3 cr; prereq #) Munholland

8244f-8245wf. HISTORY OF THE HABSBURG MONARCHY. (3 cr per qtr; prereq #; offered alt yrs) Good

8260. RESEARCH IN MODERN EUROPEAN HISTORY. (4 cr; prereq #)

8735. RESEARCH ON EUROPEAN WOMEN'S HISTORY: 1750 TO PRESENT. (4 cr; prereq 5735, one European language, #) Maynes
Follows 5735. Research project based on primary sources identified in 5735.

Latin America

5420. TOPICS IN LATIN AMERICAN HISTORY. (4 cr per qtr; prereq #) McCaa, C Phillips, Schwartz, Valdes

Detailed treatment of historical themes common to entire Latin American area. Topics vary quarterly.

5901, 5902. LATIN AMERICAN HISTORY. (4 cr per qtr; prereq reading knowledge of Spanish, #) McCaa, Schwartz, Valdes

Designed for beginning graduate students as an introduction to major historical writings on various Latin American themes.

8401-8402-8403. LATIN AMERICAN HISTORY. (3 cr per qtr; prereq #; offered when feasible) McCaa, Schwartz

United States

5331, 5332. AMERICAN CONSTITUTIONAL HISTORY. (4 cr per qtr; offered alt yrs) Murphy
Origins and development of constitutional government in America with emphasis on role of constitutional politics in evolution of public policy. 5331: English and colonial background through reconstruction. 5332: Constitution and the rule of law in modern America.

5334. AMERICAN LEGAL HISTORY. (4 cr) Murphy
History of American law from English antecedents, American reception, Americanization, and development of American legal institutions and legal culture through the rise and decline of legal realism.

5349. SOCIAL WELFARE IN AMERICA. (4 cr) Chambers

Advanced survey of social services, public policies, and profession of social work—colonial era to present. Issues include dependency, deviancy, crime, social security, public health, social reform, functions of public and voluntary institutions (charities, settlements).

5379. PROBLEMS IN COLONIAL AMERICAN HISTORY. (4 cr; prereq 3801 or #) Howe, Menard, Norling, O'Brien-Kehoe

Specific problems in colonial history with emphasis on intellectual and cultural history.

5381su. MINNESOTA HISTORY WORKSHOP. (5 cr) Berman

Survey of Minnesota history with emphasis on local resources for constructing such accounts, and appropriate methodologies. Themes vary yearly.

5801-5802†. SEVENTEENTH- AND EIGHTEENTH-CENTURY AMERICAN HISTORY. (4 cr per qtr; prereq #; offered alt yrs) Menard, O'Brien-Kehoe

5807. RESEARCH IN U.S. POLITICAL HISTORY. (4 cr; prereq 5805 or 5806 or #; offered when feasible) Howe

5816. THE BEGINNINGS OF AMERICAN POLITICS. (4 cr; prereq #; offered alt yrs) Howe
Development of American political institutions, behavior, and culture from colonial beginnings through American Revolution and ratification of federal constitution. Emphasis on connections between politics, society, and American culture.

5817. PROSEMINAR: 19TH-CENTURY U.S. POLITICAL HISTORY. (4 cr; prereq #; offered alt yrs) Howe

Intensive readings course surveying history and historiography of 19th-century American politics. Emphasis on social analysis of politics. 5817: 1789-1850's.

5821-5822. AMERICAN HISTORY IN THE 20TH CENTURY. (4 cr per qtr; prereq #) Berman, Chambers, Spear

5831-5832†. AMERICAN POLITICAL AND CONSTITUTIONAL HISTORY. (4 cr per qtr; prereq #; offered alt yrs) Murphy

Reading and research proseminar exploring various dimensions of constitutional politics in American experience. 5831: Late 18th and 19th century. 5832: 20th century.

5841, 5842. AMERICAN ECONOMIC HISTORY. (4 cr per qtr; prereq #) Green

5844, 5845. AMERICAN LABOR HISTORY. (4 cr per qtr; prereq #) Berman
Readings in classics of American labor history. Research methods and materials in labor history.

5857-5858. SOCIAL HISTORY OF AMERICAN WOMEN. (4 cr per qtr; prereq #) S Evans, Norling
Survey of historical literature, conceptual frameworks, and methodological problems in history of American women from 1600 to present.

5861-5862. HISTORY OF AMERICAN IMMIGRATION. (4 cr per qtr; prereq #; offered alt yrs) Vecoli

Readings in the historiography of immigration and ethnic groups.

5871-5872. INTELLECTUAL HISTORY OF THE UNITED STATES IN THE 19TH AND 20TH CENTURIES. (4 cr per qtr; prereq #; offered alt yrs) Noble

Writings of current scholars of American culture that express paradigmatic conflicts in study of ideas and values.

5881, 5882. AMERICAN FOREIGN RELATIONS. (4 cr per qtr; prereq #; offered alt yrs) Brauer

Intensive readings in the historiography of American foreign relations with emphasis on American imperialism, domestic sources of foreign policy, and international political, economic, and cultural relations. 5881: To 1900. 5882: Since 1900.

5890. TOPICS IN AMERICAN INDIAN SOCIAL HISTORY. (4 cr per qtr [max 12 cr]; prereq #) O'Brien-Kehoe

Social history of American Indian groups, focusing on historical demography, gender roles, interracial relationships, urbanization, and internal differences within Indian communities.

5957. LAW, SOCIETY, AND AMERICAN CRIMINAL JUSTICE. (4 cr; prereq #) Samaha

Readings in societal, legal, and ideological development of modern American criminal justice, focusing on influences of ideology, politics, culture, social science on law and criminal justice.

8239-8240. GENDER, RACE, CLASS, AND/OR ETHNICITY IN AMERICA. (4 cr per qtr [max 12 cr for 8240], §AmSt 8239, 8240; prereq # or Δ for 8239, 8239 or # or Δ for 8240) E May

Social, psychological, historical, and artistic modes of self-expression and intellectual analysis of people in the United States identified as female and male or as members of racial, ethnic, or national-origin groups. 8239: Research strategies. 8240: Topical development.

8347. SOCIAL HISTORY OF AMERICAN WOMEN. (4 cr; prereq 5857-5858, #; offered when feasible) S Evans, Norling

8361. HISTORY OF AMERICAN IMMIGRATION. (3 cr; prereq #; offered when feasible) Vecoli

8381. HISTORY OF AMERICAN FOREIGN RELATIONS. (3 cr; prereq 5881, 5882, #; offered when feasible) Brauer

History of Medicine and Biological Sciences (HMed)

Professor: Leonard G. Wilson, *head and director of graduate studies*

Associate Professor: John H. Beatty; John M. Eycler

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.A. (Plan A only) and Ph.D.

Curriculum—Candidates for the master's degree take 21 credits in the history of medicine and 8 credits in history. Doctoral students complete approximately 54 credits in the history of medicine, history of science, history, and science.

Prerequisites for Admission—Applicants for the master's degree should already possess either the M.D. degree, or a Ph.D. or master's degree in a medical or biological science. Applicants for the Ph.D. degree should either possess the M.S. degree, or have extensive training in the biological sciences basic to medicine or in public health.

Special Application Requirements—Three letters of recommendation from former teachers and scores from the General (Aptitude) and Subject (Advanced) Tests of the Graduate Record Examination are required of all applicants. New students are admitted quarterly.

Master's Degree Requirements—The program is intended to be completed within four to six academic quarters of full-time study, or an equivalent period of part-time study. Each candidate will be required to submit a 40- to 50-page thesis on a subject in the history of medicine based on historical research in primary sources with proper citation of the sources used.

Doctoral Degree Requirements—Survey courses in the history of medicine and history of science are required. Other courses are chosen on the advice of the director of graduate studies. Students are required to take their minor or supporting field in history, unless they already possess extensive training in history.

Graduate Programs

Language Requirements—Master's students must demonstrate competence in one foreign language, preferably French or German. Doctoral students must demonstrate competence in two foreign languages, preferably French and German. Doctoral students must pass the examination in one foreign language before the end of their first academic year and in the second language before the end of their second academic year. For students interested in a historical period before 1800, Latin is a third required foreign language.

Minor Requirements for Students Majoring in Other Fields—Master's degree students with a minor in history of medicine and history of the biological sciences must complete the sequence of survey courses in the history of medicine (5400, 5401, 5402) and the seminar (5410-5411-5412). Ph.D. students with a minor in history of medicine and history of the biological sciences must complete the same course requirements as for the M.A. minor and take written and oral examinations.

For Further Information and Applications—Write to the Department of History of Medicine, University of Minnesota, Box 506 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/624-4416).

HMed 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

HMed 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

HMed 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5002. PUBLIC HEALTH ISSUES IN HISTORICAL PERSPECTIVE. (4 cr, §PubH 5002) Eyler
Introduction to the evolution of major recurring problems and issues in public health including environment and health, food customs and nutrition, control of alcohol and drugs, venereal diseases and public policy, human resources regulation, and relationship of science to promotion of health.

5035. THE GERM THEORY AND THE MEDICAL PROFESSION. (4 cr, §Hist 5035) Eyler
Formulation of the germ theory of disease and consequences for medical procedures (therapeutics, surgery, management of hospitals), public health programs, and structure and prestige of the medical profession.

5045. MEDICAL PROFESSION IN AMERICA. (4 cr, §Hist 5045) Eyler

Historical analysis of the American medical profession in the 19th and 20th centuries; role of institutions, influence of social and moral values, and consequences of specialization and scientific innovation.

5102. MEDICINE AND SOCIETY IN THE ENLIGHTENMENT. (4 cr, §Hist 5702; prereq #) Eyler
Seminar dealing with the interrelations of medicine and society from the late 17th to the early 19th centuries. Emphasis on methods and materials used by medical historians. Readings and research.

5120-5130. HISTORICAL TOPICS: MEDICINE AND THE MODERN STATE. (4 cr per qtr [sequence may be repeated for max 16 cr], §Hist 5940-5950; prereq #) Eyler

Topics vary yearly. Emphasis on mid-18th century to the present.

5400. EARLY HISTORY OF MEDICINE TO 1650.

(4 cr; offered alt yrs) Wilson

Paleopathology, primitive medicine, medicine in ancient Egypt and Mesopotamia, Greek medicine in classical times and under Roman Empire, transmission of Greek medicine through the Arabs to the Latin West, medieval medicine, Andreas Vesalius and the revival of anatomy, William Harvey and the discovery of circulation of the blood.

5401. MEDICINE DURING THE SCIENTIFIC REVOLUTION: 1650-1850. (4 cr; offered alt yrs)

Wilson

Thomas Sydenham and the concept of distinct diseases, new chemical and mechanical theories of medicine, rise of medical teaching, pathological anatomy and definition of new diseases, impact of chemistry and physics on medicine in early 19th century, cell theory, discovery of anesthesia.

5402. MEDICINE SINCE 1850. (4 cr; offered alt yrs)

Wilson

Controversy over spontaneous generation and germ theory of disease, development of antiseptic surgery, the public health movement, revolution in basic medical sciences, reform of medical education and growth of medical specialties, changing relationship of medicine to society.

5410f-5411w-5412sf. SEMINAR: EMERGENCE OF MODERN MEDICINE, 1750-1900. (3 cr per qtr; prereq 3001, 3002, 3003, Hist 3031, Hist 3032, Hist 3033 or 5400, 5401, 5402) Wilson

8230, 8231, 8232. READINGS: HISTORY OF SCIENCE. (3 cr per qtr) Wilson

Introduction to serious scholarly literature in history of science, focusing on a limited number of key historical problems; e.g., Ptolemaic astronomy, Aristotle's physics and biology, Galenic physiology, the Copernican revolution. Kepler, Galileo, Newton, Harvey, Lavoisier, Lyell, Darwin.

8630, 8631, 8632f,w,s. DIRECTED STUDY. (3 cr per qtr [max 15 cr]; prereq #)

Work on a tutorial basis.

History of Science and Technology (HSci)

Professor: Alan E. Shapiro, *director*; Ronald N. Giere; Sally Gregory Kohlstedt; Edwin T. Layton; Roger H. Stuewer

Associate Professor: John Beatty, *director of graduate studies*; John M. Eyer; Arthur L. Norberg

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—The program emphasizes conceptual developments within science and technology, as well as interactions between science, technology, and society.

Prerequisites for Admission—The prerequisite is a bachelor's degree with a minimum grade average of B. Students should be capable of interdisciplinary study. Depending on background and career objectives, additional preparatory studies may be necessary in either the science-technology area or in the humanities and social sciences.

Special Application Requirements—Three letters of recommendation are required.

Master's Degree Requirements—Programs vary with the student's needs and background, but typically include at least six foundation courses from at least three of the following "areas": history of physics, history of biology, history of technology, and social and institutional history of science and technology. An oral final examination is required.

Doctoral Degree Requirements—The Ph.D. program is intended for those planning professional careers in teaching, research, or other activities requiring a high degree of scholarly competence. Individual curricula vary, but a typical program includes at least six "area" courses (see Master's Degree Requirements). Ph.D. candidates must also take at least three courses in ancient to early modern history of science or technology, and at least three courses in modern to contemporary history of science or technology.

Language Requirements—Candidates for the M.A. degree must demonstrate reading proficiency in one foreign language, normally French or German. Candidates for the Ph.D. degree must demonstrate reading proficiency in two foreign languages, normally French and German.

Minor Requirements for Students

Majoring in Other Fields—Requirements are arranged on an individual basis. See also the description of the freestanding minor program in studies of science and technology.

For Further Information and

Applications—Including the publication *A Guide to Graduate Study in the History of Science and Technology*, which supplies more detailed information about requirements, contact the Program in History of Science and Technology, University of Minnesota, 342e Tate Laboratory of Physics, 116 Church Street S.E., Minneapolis, MN 55455 (612/624-7069).

HSci 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

HSci 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

HSci 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5011. THEORIES OF COLOR: NEWTON TO HELMHOLTZ. (4 cr; offered when feasible) Shapiro

5111. PHYSICAL SCIENCES IN ANTIQUITY. (4 cr; offered when feasible) Shapiro

5113. NATURAL PHILOSOPHY IN THE SCIENTIFIC REVOLUTION. (4 cr) Shapiro
Emergence of modern science in 17th century. Development of scientific method (nature of scientific explanation, experiment, quantitative approach) and new conceptual basis for physical world (space, matter, force). Bacon, Galileo, Descartes, Boyle, and Newton, among others.

5201, 5202. HISTORY OF BIOLOGY. (4 cr per qtr, §3201, §3202) Beatty
Scientific, philosophical, and social factors in development of biology; changing styles of biological reasoning and changing relationships between biological and physical sciences. 5201: Biology from antiquity through early modern period. 5202: Biology in 19th and 20th centuries.

5242. THE DARWINIAN REVOLUTION. (4 cr; prereq Biol 1009 or 1101 or #) Beatty
Pre-Darwinian conceptions of nature; development and reception of Darwin's theory of evolution by natural selection; broader context of Darwinian Revolution, including religious thought, political theory, and views about proper scientific methodology.

Graduate Programs

5244. HISTORY OF ECOLOGY AND ENVIRONMENTALISM. (4 cr)

Historical development and interaction of ecology as profession and political stance; conservation, dust bowl era, population control, DDT controversy, and international environmental issues.

5321. HISTORY OF COMPUTING. (4 cr, §3321)

Norberg

History of computing developments in the last century with equal attention to factors affecting evolution of hardware and software, growth of the industry and its relation to other business areas, and changing relationships resulting from new data gathering and use of machinery.

5331. TECHNOLOGY AND AMERICAN CULTURE. (4 cr, §3331) Norberg

Historical survey of development of American technology in its cultural and intellectual context, from colonial period to present. Transfer of technology to America; establishment of infrastructure promoting economic growth; relationship among government, corporate, and academic influences; social response to technological developments.

5332. SCIENCE AND AMERICAN CULTURE. (4 cr, §3332) Kohlstedt

Historical survey of development of American science. Transfer of science to America; development of indigenous traditions for pursuit of science; establishment of infrastructure for education and research; response of public to scientific development; relationship among government, corporate, and academic scientists.

5401. ENGINEERING ETHICS IN HISTORICAL PERSPECTIVE. (4 cr, §3401)

Historical survey of engineering ethics in America. Successful and unsuccessful strategies for dealing with ethical issues compared primarily by using recent case studies, such as the space shuttle Challenger.

5511. HISTORY OF SCIENTIFIC

METHODOLOGY. (4 cr; offered when feasible) Beatty

5681. ENGINEERING IN HISTORY. (4 cr) Layton

Emphasis on Industrial Revolution. Complementary roles of science and design (including aesthetics) in development of engineering.

5825. PHYSICS AND SOCIETY IN 20TH-CENTURY

AMERICA. (4 cr, §3825, §3835) Stuewer
Nineteenth-century heritage; 20th-century discoveries, physical theories; growth of physics in America after World War I; intellectual migration of the 1930s; nuclear physics, the Manhattan project, and the atomic bomb; McCarthyism and Oppenheimer; current and past contributions of Minnesota physicists.

5924. HISTORY OF 19TH-CENTURY PHYSICS.

(4 cr, §Phys 5924; prereq general physics or #) Stuewer
Conceptual developments in physics (Young, Fresnel, Oersted, Ampère, Faraday, MacCullagh, Maxwell, Hertz, Lorentz, Lavoisier, Rumford, Dalton, Mayer, Joule, Helmholtz, Carnot, Clausius, Kelvin, Boltzmann, Mach, others). Relationships of these developments to social, philosophical, and theological influences.

5925. HISTORY OF 20TH-CENTURY PHYSICS.

(4 cr, §Phys 5925; prereq general physics or #) Stuewer
Conceptual developments in relativity (Michelson, Lorentz, Poincaré, Einstein, others), quantum mechanics (Planck, Einstein, Rutherford, Bohr, Sommerfeld, Ehrenfest, Pauli, Millikan, Compton, Heisenberg, de Broglie, Schrödinger, Born, others), and nuclear physics (Chadwick, Gamow, Fermi, others). Relationships of these developments to social, philosophical, and theological influences.

5935. HISTORY OF NUCLEAR PHYSICS. (4 cr; prereq general physics or #; offered when feasible) Stuewer

5970. DIRECTED STUDIES. (1-15 cr; prereq #)

5990. DIRECTED RESEARCH. (1-15 cr; prereq #)

8111. HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY. (4 cr; prereq HSci grad student or #) Staff

Analysis of scholarship in history of science and technology. Major approaches and controversies.

8121. FOUNDATIONS FOR RESEARCH IN ANCIENT SCIENCE. (4 cr; prereq HSci grad major or minor or #)

Development of natural and mathematical science in ancient Near East and Classical Greece.

8122. FOUNDATIONS FOR RESEARCH IN THE SCIENTIFIC REVOLUTION. (4 cr; prereq HSci grad major or minor or #)

Copernican revolution; mechanical philosophy; development of experimental science; Newtonian synthesis.

8900. SEMINAR: HISTORY OF EARLY PHYSICAL SCIENCES. (4 cr; prereq #) Shapiro

8910. SEMINAR: HISTORY OF MODERN PHYSICAL SCIENCES. (4 cr; prereq #) Stuewer

8920. SEMINAR: HISTORY OF BIOLOGICAL SCIENCES. (4 cr; prereq #) Beatty

8930. SEMINAR: HISTORY OF TECHNOLOGY. (4 cr; prereq #) Layton

8940. SEMINAR: HISTORY OF SCIENCE AND TECHNOLOGY IN AMERICA. (4 cr; prereq #) Kohlstedt

8941. WOMEN IN SCIENCE: HISTORICAL PERSPECTIVES. (4 cr)

Analysis of women's roles in development of science and technology; emphasis on their initiative, their participation in scientific institutions, and attitudes toward women as scientists within scientific inquiry.

8970. DIRECTED STUDIES. (1-5 cr per qtr [max 15 cr]; prereq #)

8990. DIRECTED RESEARCH. (1-5 cr per qtr [max 15 cr]; prereq #)

Horticulture (Hort)

Professor: Gary M. Gardner, *head:* James J. Luby, *director of graduate studies:* Peter D. Ascher; Mark L. Brenner; John V. Carter; David W. Davis; Wesley P. Hackett; Florian I. Lauer; Pen H. Li; Joan Nassauer; Harold M. Pellett; David G. Pitt; Joseph R. Sowokinos; Bert T. Swanson; Donald B. White; David K. Wildung

Associate Professor: Vincent A. Fritz; Emily E. Hoover; Albert H. Markhart III; Peter J. Olin; Carl J. Rosen; Alan G. Smith

Assistant Professor: John E. Erwin; Susan M. Galatowitsch; Anne M. Hanchek; Mary H. Meyer; Mark S. Strefeler; Cindy B. Tong

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Students normally emphasize either a subdiscipline of horticulture (floriculture, fruits, nursery management, potatoes, turf, or vegetables); a biological discipline related to horticulture (genetics, plant breeding, or plant physiology); or landscape horticulture. The Department of Horticultural Science administers this program, which is closely aligned with the interdepartmental programs of plant breeding and plant biological sciences (see the appropriate headings in this bulletin). All three majors are offered in the Department of Horticultural Science.

Prerequisites for Admission—Applicants are expected to have successfully completed college-level courses in horticulture, biology, chemistry, physics, and mathematics.

Special Application Requirements—Three letters of recommendation submitted on the department's form from persons familiar with the applicant's scholarship potential, a statement of background and career goals, a listing of completed prerequisite courses submitted on the department's form, scores from the General Test of the Graduate Record Examination, and a complete set of transcripts in addition to that required by the Graduate School are required. Students may enter the program any quarter. Because

fellowship nominations and departmental research assistant awards are made in early February, students with outstanding academic records should apply by December 15 preceding the year they wish to enter.

Master's Degree Requirements—A complete statement of degree program requirements may be obtained from the director of graduate studies. There are few specific course requirements, because each program is planned to meet the individual interests and needs of the student. Students are required to present a research planning seminar (8066) and a final seminar (8042). The final examination is oral.

Doctoral Degree Requirements—Programs are flexible, tailored to the student's background and professional interests. With approval from the adviser, courses in related fields may be used as part of the major work. One quarter of teaching in conjunction with a supervised teaching course (8000) is required of all students. Students are expected to participate in and present at least one seminar (8042) and one research planning discussion (8066) and to earn 2 credits in such discussion courses as 8060, 8061, 8062, 8063, 8064, and 8065.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Horticultural Science, University of Minnesota, 305 Alderman Hall, 1970 Folwell Avenue, St. Paul, MN 55108 (612/624-4242; fax 612/624-4941; e-mail kuype001@maroon.tc.umn.edu).

Hort 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Hort 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Hort 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5001. HARVEST TO MARKET OF HORTICULTURAL CROPS. (3 cr; prereq PBio 3131)
Li, Tong

Physiological processes of horticultural crops after harvest as related to maturity, time to harvest, quality, ripening, senescence, handling, storage, and marketing. Interdisciplinary approaches to problem solving and decision making in post-harvest management.

Graduate Programs

5015. RESTORATION AND RECLAMATION

ECOLOGY. (4 cr; prereq 1 plant biol or botany course, 1 ecol course) Galatowitsch
Ecological and physiological concepts as basis for revegetation of grasslands, wetlands, forests, and other landscapes. Methods for plant materials selection, stand establishment, evaluating revegetation success. Overview of federally and state-administered restoration and reclamation programs. Weekend and evening trips to examine several restoration and reclamation sites in Minnesota.

5026f. LANDSCAPE MANAGEMENT. (4 cr; prereq completion of business enrichment requirements and 75% of cr requirement in landscape, nursery, turf sequence) Pedersen

Integrates environmental horticulture industry disciplines and commodities; superimposes appropriate business management principles. Scientific methods and technical applications incorporated through problem solving and case studies.

5031f. TEMPERATE FRUIT PRODUCTION. (4 cr; prereq 3001; PBio 3131 recommended; offered odd yrs) Hoover

Principles of fruit production, emphasizing temperate fruit crops. Integrated management of fruit cropping systems, including site selection, cultural and management practices, taxonomic classifications, physiological and environmental control of plant development. Intensive use of writing.

5034. COMMERCIAL VEGETABLE

AGRICULTURE. (5 cr; prereq 3002 or Agro 1010, Soil 3125) Davis

Crop cultural and product handling and use systems in various world regions. History and evolution of species and product development. Seed and stand establishment; propagation; pest management. Applied physiology and genetics of fruit, bulb, tuber initiation; sink development, maturation, and quality. Lectures, labs, and field trips.

5040w. ADVANCED PLANT GROWTH

REGULATION. (4 cr; prereq sr with 15 cr plant sciences incl 3 cr plant physiology; offered even yrs) Brenner, Hackett

Principles of plant growth and development in relation to optimizing cropping efficiency and product quality. Emphasis on physiological and morphogenetic basis of horticultural practices. Exercises in use of principles and scientific literature to solve horticultural problems.

5042f.* TURF GRASS SCIENCE. (5 cr; prereq 3001, 3072, PBio 3131, PIPa 5001) White

For advanced students in turf with career objectives in professional turf management. All phases of the turf industry considered. Emphasis on the ecology, physiology, and theory of turf population dynamics and on specialized management situations such as golf course, commercial sod production, and fine turf athletic settings.

5046f. NURSERY MANAGEMENT I. (4 cr, 5046-5047-5048†; prereq 1021, 1036) Swanson

Introduction, history, organization, and scope of the nursery industry. General nursery business administration, production schedules and cultural management for seedbeds and field grown stock. Lab includes field trips and greenhouse and field training in nursery operations. Field trips.

5047. NURSERY SCHEDULING AND ENTERPRISE DEVELOPMENT. (2 cr, 5046-5047-5048†; prereq 5046) Swanson

Development of specific crop schedules, using current technical and economic data for efficient production. Development of total nursery enterprise designed for workable and profitable business establishment.

5048s. NURSERY MANAGEMENT AND

PRODUCTION II. (4 cr, 5046-5047-5048†; prereq 5047) Swanson

Pest management and governmental regulations concerning the nursery industry. Container growing operations and marketing of all products. Specific topic research and nursery operation development by the student. Lab includes field trips and greenhouse and field training in nursery operations. Field trips required.

5054s. COMMERCIAL FLORICULTURAL PRODUCTION PRACTICES. (4 cr; prereq 1036, 3002, PBio 3131) Strefeler

Principles of commercial bedding plant production systems. Emphasis on major bedding plant crops and their cultural practices. Lectures, labs, field trips.

5055. COMMERCIAL FLORICULTURE

PRODUCTION SYSTEMS. (5 cr; prereq 1036, 3002, PBio 3131 or #) Strefeler

Problem-solving and management practices in floricultural crop production. Cultural practices, diagnosis of problems, interpretation of soil/leaf analyses, scheduling crop production and mechanization, and computerization of greenhouse operations. Lectures, labs, field trips.

5091.* DIRECTED STUDIES. (2-6 cr; prereq 8 cr

upper div hort course, Δ) Staff
Written or oral report based on library, lab, or field research.

8000. SUPERVISED TEACHING EXPERIENCE IN HORTICULTURE. (2 cr, §Soil 8000, §Agro 8000; prereq #) Hoover

Students are provided classroom or extension teaching experience in Department of Agronomy and Plant Genetics or Horticultural Science or Soil Science and participate in teaching topic discussions to strengthen skills and develop personal teaching philosophy.

8007f,w,s. EXTENSION HORTICULTURE

PRACTICUM. (1-5 cr; prereq 12 grad cr) Staff
Selected activities that may include development of an extension fact sheet, assistance in Horticulture Clinic, or preparation of a workshop or short course.

8022w. BREEDING ASEXUALLY PROPAGATED CROPS. (3 cr; prereq Agro 5020; offered alt yrs) Lauer
Methods applied to improving asexually propagated plants. Apomixis, polyploidy, chimeras, mutations, and interspecific hybridization.

8023f.* EVOLUTION OF CROP PLANTS. (4 cr; prereq 13 grad-level credits) Ascher
Origin, distribution, and evolution of cultivated plants; implication of evolutionary processes on crop breeding for needs of people today.

8041w. DISCUSSIONS IN ADMINISTRATIVE ORGANIZATION. (1 cr) Gardner
Organization and administration in agricultural experiment stations; project development and research outlines.

8042f,w,s.* HORTICULTURAL SEMINAR. (1 cr) Staff
Reports and discussions of problems and investigational work.

8045w.* PLANT RESPONSE TO ENVIRONMENTAL STRESS. (3 cr; prereq 3 cr 5xxx biochem, 3 cr 5xxx plant physiology; offered alt yrs) Carter
Examined from molecular to organismal levels.

8051f,w,s,su.* ADVANCED PROBLEMS IN HORTICULTURAL CROP BREEDING. (3-9 cr; prereq #) Staff
Written report based on library, lab, or field research.

8052f,w,s.* ADVANCED PROBLEMS IN PHYSIOLOGY OF HORTICULTURAL CROPS. (3-9 cr; prereq #) Staff
Written report based on library, lab, or field research.

8060f,w,s. DISCUSSIONS IN POTATO RESEARCH. (1 cr) Lauer
Covers all aspects of potato genetics, breeding, and physiology. Emphasis on current research and literature.

8061f,w,s.* DISCUSSIONS IN PLANT REPRODUCTIVE BIOLOGY. (1 cr; prereq #) Smith
Covers all aspects of intraspecific and interspecific reproductive incompatibility. Topics include genetics, physiology, and biochemistry. Emphasis on current research findings.

8062f,w,s.* SEMINAR: DISCUSSIONS IN STRESS PHYSIOLOGY. (1 cr; prereq #) Li, Carter
Broad subject area of plant hardiness. Temperature and drought stress.

8063f,w,s.* SEMINAR: DISCUSSIONS IN HORTICULTURAL PLANT BREEDING. (1 cr; prereq #) Davis, Lauer, Luby
The application of plant breeding theory and techniques to selected horticultural crops. Structured to encourage student leadership and direction.

8064w,s.* DISCUSSIONS IN FLORICULTURAL SCIENCE. (1 cr; prereq #) Strefeler, Erwin
Emphasis on physiological aspects.

8065w,s.* SEMINAR: DISCUSSIONS IN POSTHARVEST PHYSIOLOGY. (1 cr; prereq #) Li, Tong

Physical requirements and physiological basis of storage techniques used in maintaining quality in horticultural products. Topics include historical evolution of postharvest physiology, biochemical and physical changes occurring during storage and senescence of horticultural products.

8066. DISCUSSIONS IN HORTICULTURE RESEARCH. (1 cr) Smith
Emphasis on research being conducted by graduate students in the department.

8090. GRADUATE HORTICULTURAL RESEARCH. (1-18 cr; prereq Δ) Staff
Directed studies.

Other Courses of Interest

Agro 5020. INTRODUCTION TO PLANT BREEDING

Agro 8200. PLANT BREEDING PRINCIPLES AND METHODS I

Agro 8210. PLANT BREEDING PRINCIPLES AND METHODS II

PBio 5183. WATER, MINERALS, AND TRANSLOCATION

Hospital Pharmacy

Professor: Daniel Canafax; James C. Cloyd; Charles E. Halstenon; John C. Rotschafer; Darwin E. Zaske

Associate Professor: Courtney V. Fletcher, *director of graduate studies;* Paul W. Abramowitz; Robert J. Cipolle; Nina M. Graves; David R. Guay; Ronald S. Hadsall; Henry Mann; Mary E. O'Connell; Linda M. Strand

Assistant Professor: Ronald L. Broekemeier; Charles E. Daniels; Ricci M. Giese; Byron C. Opstad; Thomas S. Rector; Shabir M. Somani; Thomas W. Woller

Clinical Assistant Professor: Christine M. Jolowsky; Bruce E. Scott

Adjunct Instructor: Delores M. Ryan

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.S. (Plan A and Plan B).

Curriculum—The program is designed for qualified pharmacists who wish to prepare for careers in pharmacy management, practice, and drug therapy research in organized health care settings. Research focuses on the delivery of pharmacy services and the use of therapeutic agents in humans.

Graduate Programs

Prerequisites for Admission—A degree from a college of pharmacy and an exceptional scholastic record are required. Evidence of personal capability and fitness for work in the health care field is essential.

Special Application Requirements—Submission of a résumé and special supplemental application form plus completion of a personal interview are required.

Degree Requirements—For Plan A, a minimum of 20 quarter credits in the major field, a minimum of 8 quarter credits in one or more related fields outside the major, and 16 thesis credits. Students are encouraged to select a minor. The final examination is oral.

For Plan B, a minimum of 44 credits of coursework in computer science, health care delivery, hospital administration, hospital pharmacy administration, management seminar, research, statistics, and other subjects. One Plan B project and two Plan B papers are required. Minor fields vary. The final examination is oral.

Language Requirements—None.

For Further Information and Applications—Contact Graduate Studies in Hospital Pharmacy, University of Minnesota, 7-115 Health Sciences Unit F, 308 Harvard Street S.E., Minneapolis, MN 55455 (612/624-2973).

SAPh 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Social and Administrative Pharmacy (SAPh)

8100. SEMINAR. (1 cr per qtr) Staff

8200. RESEARCH PROBLEMS. (Cr ar) Staff

8210, 8220. EXPERIMENTAL PHARMACOTHERAPEUTICS I, II. (3 cr per qtr; offered alt yrs) Canafax, O'Connell
Theory of advanced methodologies, applications, and evaluation techniques used to determine safety, efficacy, and toxicity of drug therapies. *8210:* Advanced theory; approaches, problems, and applications in pharmacotherapeutic problem solving. *8220:* Advanced techniques: therapeutic end points and newly developing methodologies.

8301. CLINICAL THERAPEUTICS. (3 cr per qtr; offered alt yrs)
Clinical lectures on diagnosis and treatment of common diseases.

8400. SPECIAL CLINICAL PROBLEMS. (Cr ar) Staff

Medication errors, drug distribution systems, patterns of drug use, cost-benefit analysis of prescribed medication according to diagnosis, age, dosage form, effectiveness, side effects, incidence of adverse effects, or drug use and misuse.

8700. HOSPITAL ADMINISTRATION. (2 cr; offered alt yrs) Abramowitz
History, classification, organization, and functions of hospital departments in relation to the pharmacy service.

8701. HOSPITAL PHARMACY ADMINISTRATION I. (3 cr; offered alt yrs)

8702. HOSPITAL PHARMACY SURVEY. (1 cr; prereq 8701; offered alt yrs) Broekemeier

8703. HOSPITAL PHARMACY ADMINISTRATION II. (3 cr; offered alt yrs)
Continuation of 8701.

Industrial Education

See Vocational and Technical Education.

Industrial Engineering

See Mechanical Engineering.

Industrial Relations (IR)

Professor: Dennis A. Ahlburg; Richard D. Arvey; Avner Ben-Ner; Hyman Berman; Mario F. Bognanno; John P. Campbell; Rene V. Dawis; Marvin D. Dunnette; John A. Fossum; Morris M. Kleiner; Jeylan T. Mortimer; Paul R. Sackett; James G. Scoville; George Seltzer (*emeritus*); Mahmood A. Zaidi

Associate Professor: Ross E. Azevedo; Michael P. Keane; Raymond A. Noe; Cheri L. Ostroff

Assistant Professor: John W. Budd; Brian P. McCall; Judi M. Parks; Yijiang Wang

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Subfields are collective bargaining; compensation and reward theory and administration; economics of human resources; organization theory and administration; and staffing, training, and development.

Prerequisites for Admission—Entering students are expected to have completed, or to complete during their first quarter,

introductory courses in micro- and macroeconomics, and psychology.

Special Application Requirements—Three letters of recommendation evaluating the applicant's scholarship, a complete set of transcripts (in addition to that required by the Graduate School), and Graduate Record Examination scores are required. Applicants whose native language is not English are required to score at least 550 on the Test of English as a Foreign Language (TOEFL).

Entry in both the day and evening M.A. programs is in fall or spring quarter only. *Priority* application deadline is December 15 for fall quarter. Applications received after this deadline are considered on a space-available basis. Entry in the Ph.D. program may be in any term; application deadlines are those established by the Graduate School. The financial aid application deadline is December 15.

Master's Degree Requirements—The M.A. degree is offered in day and evening programs. For Plan A, a minimum of twelve courses, 16 thesis credits, and a thesis are required (64 credits). Major coursework includes 8002, 8001, 8011, one course from at least three areas in industrial relations, and three additional industrial relations courses. The related field must consist of a minimum of two courses in an approved field or fields of study related to industrial relations. Commonly selected fields are business administration, economics, psychology, sociology, or statistics. The twelfth course may be in industrial relations or a related field.

For Plan B a minimum of sixteen courses (64 credits) and three Plan B papers are required. Major coursework includes 8001, 8002, 8003, 8004, 8005, 8006, 8007, 8011, 8012, and four additional industrial relations courses. A minimum of 12 graduate credits must be earned in related fields, at least 8 credits of which must be in a single field. Commonly selected fields are business administration, economics, psychology, sociology, or statistics. A Plan B paper must be written in conjunction with 8011 and

8012. The third paper can be written in conjunction with any other course appearing on the approved program.

Students with limited or no business administration background may take a core of specified M.B.A. courses consisting of a minimum of 12 credits.

A final oral examination is required under both plans after all coursework and Plan B papers are accepted or the thesis draft approved by the adviser.

Doctoral Degree Requirements—In addition to coursework and study in industrial relations, students are expected to have a solid preparation in one or more of the six designated related social or behavioral science disciplines (anthropology, economics, history, political science, psychology, sociology). Students must successfully complete examinations in research methodology and two of the five industrial relations subfields.

Ph.D. programs should be composed of a major and a research program. The research program must include a minimum of 24 credits in research methods and techniques.

The graduate faculty in industrial relations may require higher performance standards than those specified in the General Information section of this bulletin.

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—Industrial relations may be selected as a minor or as part of a supporting program for the Ph.D. by students majoring in education, hospital and health care administration, or the social and behavioral sciences. The minor must consist of at least 28 credits, including five courses in at least four subfields, plus a Ph.D. seminar. Industrial relations can also be offered as a related field in business administration. Students must complete a minimum of 28 credits. For specific minor and related field requirements, consult the director of graduate studies.

For Further Information and Applications—Contact the Industrial Relations Center, University of Minnesota,

Graduate Programs

537 Management and Economics Building,
271 19th Avenue South, Minneapolis, MN
55455 (612/624-5810; fax 612/624-8360;
e-mail e french@csom.umn.edu).

IR 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

IR 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

IR 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5000. TOPICS IN PERSONNEL AND INDUSTRIAL RELATIONS. (1-8 cr) Staff

Selected topics of current relevance to human resource management.

5002. SYSTEMS OF CONFLICT AND DISPUTE RESOLUTION. (4 cr) Azevedo

Introduction to theoretical and practical treatment of conflict settlement in interpersonal, work-related, community, business, and international settings. Lectures, discussions, observations of actual dispute resolution sessions, and lab exercises, with students participating in dispute resolution simulations applied to real world conflicts.

5006. LABOR POLICY. (3 cr, §PA 5430) Budd, Kleiner

Analysis of public policies regarding employment, unions, and labor markets. Public programs affecting wages, unemployment, training, worker mobility, security, and quality of work life. Policy implications of the changing nature of work.

5990. INDEPENDENT STUDY IN PERSONNEL AND INDUSTRIAL RELATIONS. (1-8 cr; prereq Sch Mgmt or Grad Sch Mgmt approval) Staff
Individual readings or research topics in human resource management.

8000. GRADUATE TOPICS IN INDUSTRIAL RELATIONS. (Cr ar; prereq 8002, IR MA student or Sch Mgmt approval) Staff
Selected topics.

8001. INTRODUCTION TO QUANTITATIVE METHODS AND TECHNIQUES FOR INDUSTRIAL RELATIONS. (4 cr; prereq IR grad student or Δ)

Ahlburg, Budd, Keane, McCall, Noe
Industrial relations problems. Application of descriptive and inferential statistics, including probability, hypothesis testing, confidence intervals, analysis of variance, and bivariate linear regression and correlation. Introduction to computer software and hardware for problem solutions and exercises.

8002. AN INTRODUCTION TO INDUSTRIAL RELATIONS. (4 cr, §3002; prereq Econ 1101, Econ 1102, Psy 1001, IR MA student or Δ) Azevedo, Fossum, Scoville, staff

Labor markets, human resource management, federal-state employment policy, resolution of industrial conflict. Valuing, employing, developing, motivating, and maintaining human resources in an industrial society.

8003. STAFFING, TRAINING AND DEVELOPMENT. (4 cr; prereq 8002 or #, IR grad major or Δ; IR grad major must register A-F) Arvey, Noe, Ostroff, Sackett

Introduction to staffing processes (recruitment, selection, promotion, demotion, transfer, dismissal, layoff, retirement), training development theory and techniques as mechanisms for influencing individual and organizational outcomes, such as performance, satisfaction, and climate.

8004. DESIGN AND MANAGEMENT OF ORGANIZATIONS FOR A CHANGING WORLD. (4 cr; prereq 8002 or #, IR grad major or Δ; IR grad major must register A-F) Arvey, Ben-Ner, Ostroff, Parks, Wang

Introduction to micro through macro organizational issues at individual, dyadic, group, organizational, and environmental levels; their implications for organizational design, control, coordination, and development.

8005. COMPENSATION AND REWARD THEORY AND PROGRAMS. (4 cr; prereq 8002 or #, IR grad major or Δ; IR grad major must register A-F) Azevedo, Fossum, Parks

Introduction to compensation and reward programs in employing organizations. Concepts, models, and theories of organizational and employee behavior in design and implementation of pay programs. Job evaluation, salary surveys, pay structures, salary increase programs, variable compensation, benefit programs, executive compensation, skill-based pay, and laws and regulations.

8006. INTRODUCTION TO LABOR MARKET ANALYSIS. (4 cr; prereq 8002 or #, IR grad major or Δ; IR grad major must register A-F) Ahlburg, Azevedo, Bognanno, Budd, Keane, McCall, Zaidi

Labor supply and demand analysis, its international dimensions; determination of wages, employment and unemployment; accumulation of human capital and investment in education and training; government regulation in areas of discrimination and workplace safety; role of unions in wage determination.

8007. COLLECTIVE BARGAINING: PRIVATE AND PUBLIC SECTORS. (4 cr; prereq 8002 or #, IR grad major or Δ; IR grad major must register A-F) Bognanno, Budd

Introduction. Evolution of U.S. trade unions and public policy, bargaining environment and structure, goals and negotiations, contract administration and results. International comparisons, labor-management cooperation, and newly emerging issues.

8011. INTERMEDIATE QUANTITATIVE METHODS AND TECHNIQUES FOR INDUSTRIAL RELATIONS. (4 cr; prereq 8001, IR grad student or Δ)

Ahlburg, Budd, Keane, McCall, Noe
Theory and applications of alternative quantitative methods and techniques in formulation and analysis of various industrial relations problems and practices. Cases, problem sets, and computer exercises.

8012. INDUSTRIAL RELATIONS SYSTEMS. (4 cr; prereq completion of the core course sequence in IR or #, IR grad major or Δ; IR grad major must register A-F) Arvey, Sackett, Scoville, Seltzer
Integration of industrial relations subfields. Application of elements of industrial relations to human resource management issues in public and private sectors. Course project involves evaluation of industrial relations practices in chosen organization.

8013. STAFFING AND SELECTION: STRATEGIC AND OPERATIONAL CONCERNS. (4 cr; prereq 8003 or #, IR grad major or Δ; IR grad major must register A-F) Arvey, Noe, Ostroff, Sackett
Theory and practice related to staffing decisions (recruitment, selection, promotion, demotion, transfer, dismissal, layoff, retirement) in organizations. Legal environment in which staffing decisions are made. Staffing from strategic and operational perspectives.

8014. ORGANIZATIONAL STRUCTURE AND ENVIRONMENTAL SYSTEMS. (4 cr; prereq 8004 or #, IR grad major or Δ; IR grad major must register A-F) Arvey, Ben-Ner, Parks, Wang
Impact of environmental systems on organization design and dynamics of organizational redesign. Employing organizations in terms of general and specific environmental conditions: technological, legal, political, economic, demographic, ecological, and cultural.

8015. COMPENSATION THEORY AND APPLICATIONS. (4 cr; prereq 8005 or #, IR grad major or Δ; IR grad major must register A-F) Azevedo, Fossom, Parks
Effects of economy and demography of employees on employers and pay programs; effects of changes in hiring, development, and use of employees on design of pay program components. Cost-benefit analysis of compensation program components on organizational outcomes. Integration of compensation programs in human resource management.

8016. HUMAN RESOURCE PLANNING. (4 cr, §8036; prereq 8006 or #, IR grad major or Δ; IR grad major must register A-F) Azevedo, Zaidi
Theoretical and empirical models of planning for human resource use. Micro-economic analysis; Delphi processes; Markov, Career-Path, and Transition models; and programming approaches. Focus on quantitative analysis of movement of workers through organization.

8017. LABOR MOVEMENTS IN A CHANGING WORLD. (4 cr; prereq 8007 or #, IR grad major or Δ; IR grad major must register A-F) Bognanno, Budd
Labor movement philosophies. Critical evaluation of labor movement growth and adjustment to environmental change. Domestic and international perspectives of labor movement innovations.

8022. INTERNATIONAL HUMAN RESOURCE MANAGEMENT. (4 cr; prereq 8002 or MBA 8015 or # or Δ; IR grad major must register A-F) Bognanno, Scoville, Zaidi
Introduction. Legal, institutional, and market aspects of work arrangement, and their impact on multinational and transnational corporations operating in foreign countries.

8023. EMPLOYEE TRAINING: CREATING A LEARNING ORGANIZATION. (4 cr; prereq 8003 or #, IR grad major or Δ; IR grad major must register A-F) Arvey, Noe, Sackett
Theory, research, and practice related to design and implementation of employee training programs. Instructional design, training techniques, transfer of training, and program evaluation and costing. Role of employees, unions, and firm policies and practices in training process.

8024. ORGANIZATION DESIGN AND CHANGE. (4 cr; prereq 8004 or #, IR grad major or Δ; IR grad major must register A-F) Arvey, Ben-Ner, Wang
Principles of organizational and task design in relation to internal organizational operations. Resource dependency, power, conflict, and political behavior in organizations. Information structures, centralization, and decentralization.

8025. EMPLOYER-SPONSORED EMPLOYMENT BENEFITS PROGRAMS. (4 cr; prereq 8005 or #, IR grad major or Δ; IR grad major must register A-F) Azevedo
Design and administration of nonmandatory compensation benefit programs: health insurance and wellness programs; pensions, salary reduction, and deferred compensation programs; pay for time not worked; other insurance plans. Analysis of risks related to workforce demography and employee behaviors. Compliance with legal requirements. Cafeteria benefit plans.

8026. HUMAN RESOURCES AND FIRM PERFORMANCE. (4 cr, §8046; prereq 8006 or #, IR grad major or Δ; IR grad major must register A-F) Kleiner
Role that human resource policies and practices play in firm productivity, profitability, and market value.

8027. DISPUTE RESOLUTION PRACTICES: MEDIATION, FACT FINDING, AND ARBITRATION. (4 cr; prereq 8007 or #, IR grad major or Δ; IR grad major must register A-F) Bognanno, Budd
Private and public sector impasse/dispute resolution for contract negotiation and administration. Methods and practices used in grievance resolution, mediation, fact finding, and arbitration. Newly emerging approaches.

8032. COMPARATIVE AND INTERNATIONAL LABOR MOVEMENTS. (4 cr; prereq 8002 or #, IR grad major or Δ; IR grad major must register A-F) Scoville
Emergence, evolution, structures, functions, and challenges ahead of labor movement in developed countries. Industrial relations systems in comparative perspective. International labor organizations. Prospects and problems of labor in developing countries.

8033. EMPLOYEE DEVELOPMENT: CREATING A COMPETITIVE ADVANTAGE. (4 cr; prereq 8003 or #, IR grad major or Δ; IR grad major must register A-F) Noe
Theory, research, and practice. Career development and planning, employee and management development techniques, and organizational and employee concerns related to mobility, job stress, balancing work and family, obsolescence and plateauing, and cross-cultural assignments.

Graduate Programs

8034. MOTIVATION AND WORK BEHAVIOR IN CONTEMPORARY ORGANIZATIONS. (4 cr, §8035; prereq 8004 or #, IR grad major or Δ; IR grad major must register A-F) Parks

Major topics of microlevel organizational behavior with more intensity and depth than typically found in survey course. Accountability, organization citizenship behaviors, forms of organizational attachment, motivation and issues of equity and justice.

8037. LABOR-MANAGEMENT NEGOTIATIONS.

(4 cr; prereq 8007 or #, IR grad major or Δ; IR grad major must register A-F) Bognanno, Budd
Analysis of the nature of negotiations with applications to private and public sector collective bargaining. Nature of conflict and dilemma between competition and cooperation. Determinants of bargaining strategies, tactics, outcomes, and impasses. Newly emerging issues.

8042. HUMAN RESOURCE INFORMATION

SYSTEMS. (4 cr; prereq IR core or #, IR grad major or Δ; IR grad major must register A-F)

Analysis of use of human resource information systems as related to industrial relations. Hardware and database fundamentals, software applications, security issues, vendor evaluation, system and software development and design issues, and strategies for gaining user acceptance.

8045. PUBLIC POLICY AND EMPLOYEE

BENEFITS. (4 cr; prereq 8005 or #, IR grad major or Δ; IR grad major must register A-F)

Survey of federally and state-mandated employee benefits: workers compensation, unemployment insurance, and social security. Tax issues related to benefits. Impacts of legally mandated benefits on employers and employees. International and comparative issues in legally mandated benefits. Coordination of benefits for expatriate employees.

8106. TOPICS IN MICRO LABOR MARKET

ANALYSIS. (4 cr; prereq 8006 or #, IR PhD major or Δ; IR grad major must register A-F) Ahlburg, Bognanno, Keane, McCall, Zaidi

May include micro aspects of unemployment, implicit-contracts and efficiency wages, investment in human capital, occupational choice, job search, job matching and turnover, migration, labor force participation, and government program evaluation.

8116. TOPICS IN MACRO LABOR MARKET

ANALYSIS. (4 cr; prereq 8006 or #, IR PhD major or Δ) Ahlburg, Keane, Zaidi

May include theories of unemployment based on sectoral shocks, theories of wage rigidity, efficiency wage theories, interindustry wage structure, role of labor market in resource allocation, and effects of government intervention in labor market.

8800. ADVANCED QUANTITATIVE RESEARCH METHODS. (4 cr; prereq IR core or #, IR PhD major or Δ; IR grad major must register A-F) Ahlburg, Budd, Keane, McCall

General linear model and its assumptions and violations; simultaneous equations; pooling cross-section and time series; limited and qualitative dependent variable models; sample selection models; hazard models. Emphasis on application to industrial relations and management.

8801. SEMINAR: INDUSTRIAL RELATIONS

RESEARCH METHODOLOGY. (4 cr; prereq IR PhD major or Δ) Ahlburg, Bognanno, Keane, McCall
Research methodology appropriate to study of industrial relations; application in research projects.

8802. SEMINAR: INDUSTRIAL RELATIONS

SYSTEMS. (4 cr; prereq IR core or #, IR PhD major or Δ) Scoville, Zaidi

Industrial relations thought and research. Investigating, integrating, and synthesizing more traditional related disciplines, theories, and research into interdisciplinary body of knowledge concerned with human resource problems and employment relationships.

8803. SEMINAR: STAFFING, TRAINING, AND

DEVELOPMENT. (4 cr; prereq 8003 or #, IR PhD

major or Δ) Arvey, Noe, Ostroff, Sackett
Staffing and training concepts, problems, and research.

8804. SEMINAR: ORGANIZATION THEORY. (4 cr;

prereq 8004 or #, IR PhD major or Δ) Arvey, Ben-Ner, Parks, Wang
Organization theories, application in industrial relations research and practice.

8805. SEMINAR: COMPENSATION AND

REWARD. (4 cr; prereq 8005 or #, IR PhD major or Δ) Azevedo, Fossum

Issues of employee compensation and reward; analysis of relevant theoretical models; formulation of research into compensation and reward issues.

8806. SEMINAR: ANALYSIS OF CURRENT

LABOR MARKET THEORY AND EMPIRICAL

RESEARCH. (4 cr; prereq 8006 or #, IR PhD major or Δ) Ahlburg, Bognanno, Keane, McCall, Zaidi
Functions and operations of labor markets, theory, and research.

8807. SEMINAR: COLLECTIVE BARGAINING

AND LABOR RELATIONS. (4 cr; prereq 8007 or #, IR

PhD major or Δ) Bognanno, Budd
Analysis of contemporary theoretical and empirical research.

8990. INDEPENDENT STUDY IN INDUSTRIAL

RELATIONS. (Cr ar; prereq #; IR grad major must regis

A-F only) Staff
Individual readings and/or research projects especially useful to student's objectives and program.

Interdisciplinary Archaeological Studies (InAr)

Regents' Professor: Rutherford Aris (chemical engineering and materials science); Herbert E. Wright, Jr. (*emeritus*: ecology, evolution, and behavior)

Professor: Frederick M. Asher (art history); Arthur C. Aufderheide¹ (laboratory medicine and pathology); Bernard Bachrach (history); Subir K. Banerjee (geology and geophysics); Frederick A. Cooper (Classical and Near Eastern studies); Edward J. Cushing (ecology, evolution, and behavior); Guy E. Gibbon (anthropology); Stephen Gudeman (anthropology); Jackson P. Hershbell (Classical and Near Eastern studies); Eva C. Keuls (Classical and Near Eastern studies); Ronald T. Marchese¹ (interdisciplinary programs); Sheila J. McNally (Classical and Near Eastern studies); Michael F. Metcalf (history); Thomas S. Noonan (history); Robert J. Poor (art history); George R. Rapp, Jr.¹ (archaeometry laboratory); Timothy G. Roufs¹ (sociology-anthropology); William B. Schwabacher (chemistry); Alan E. Shapiro (history of science); Theofanis G. Stavrou (history); Ellen J. Stekert (English); Peter S. Wells (anthropology)

Adjunct Professor: Orrin C. Shane

Associate Professor: Robert C. Bright (ecology, evolution, and behavior); Gerald W. Johnson (civil engineering); William W. Malandra (Classical and Near Eastern studies); Howard D. Mooers¹ (geology); Jonathan Paradise (Classical and Near Eastern studies); Daniel D. Reisman (Classical and Near Eastern studies); Philip H. Sellow (Classical and Near Eastern studies); Janet D. Spector (anthropology)

Adjunct Associate Professor: Scott F. Anfinson; Gordon R. Peters; Nancy C. Wilkie

Assistant Professor: Joseph D. Alchermes (Classical and Near Eastern studies); Catherine E. B. Asher (art history); Eve B. Cole¹ (philosophy); Joan Fagerlie (University Libraries); Oliver P. Nicholson (Classical and Near Eastern studies)

Adjunct Assistant Professor: Susan C. Mulholland¹ (archaeometry laboratory)

Lecturer: John R. Bower¹ (sociology-anthropology); William K. Miller¹ (archaeometry laboratory)

Other: John M. Weeks (University Libraries)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. and M.S. (Plan A and Plan B) and Ph.D.

Curriculum—The program in interdisciplinary archaeological studies offers opportunities to create individualized degree programs in which a focus in archaeology is

integrated with aspects of one or more other fields. Students define their own interests and, in consultation with their adviser, design a program suited to their individual needs. The potential combination of fields integrated with archaeology is limited only by faculty expertise and interest. Graduate work toward the master's degrees can be pursued on the Twin Cities campus or Duluth campus or both. The focus of coursework for the Ph.D. is on the Twin Cities campus.

Prerequisites for Admission—Applicants must demonstrate a commitment to a course of interdisciplinary studies not available in traditional department settings.

Special Application Requirements—Graduate Record Examination scores are required. The program normally begins in fall quarter, but enrollment beginning in winter or spring quarter is possible in special circumstances. The application deadline for consideration for Graduate School fellowships is December 15.

Degree Requirements—The program does not offer set tracks of study. However, students at the master's level are expected to take a series of three core seminars, which include combinations of method and theory in archaeology, archaeologic science, and an interdisciplinary topics seminar. New doctoral-level students are expected to take an interdisciplinary topics seminar and core seminars they have not taken earlier in one form or another. Except for these basic requirements, each student creates her/his own interdisciplinary program in consultation with program advisers. All programs of study are subject to review by the program steering committee. The final examination for both master's degrees is oral.

Language Requirements—All students are expected to acquire competence in the research tools necessary for their graduate and future professional work. Often these are foreign languages and/or quantitative or experimental skills. The language and/or technique requirement is set by the student's advising committee.

¹ University of Minnesota, Duluth

Graduate Programs

For Further Information and Applications—Contact Interdisciplinary Archaeological Studies, University of Minnesota, 215 Ford Hall, 224 Church Street S.E., Minneapolis, MN 55455 (612/625-1062).

InAr 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

InAr 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

InAr 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5100. TOPICS IN INTERDISCIPLINARY ARCHAEOLOGICAL STUDIES. (4 cr; prereq enrollment in program or #)

8001. METHOD AND THEORY IN ARCHAEOLOGY. (4 cr, §AnSt 8001; prereq grad major or #) Staff

Survey and evaluation of archaeological approaches to the nonliterary, material evidence for past human activities and societies.

8002. ADVANCED THEORY IN ARCHAEOLOGY. (4 cr, §AnSt 8002; prereq grad major or #) Staff
Theoretical foundations in contemporary perspective.

8003. ARCHAEOLOGIC SCIENCE. (4 cr, §AnSt 8003; prereq grad major or #) Staff
Review and evaluation of application of knowledge base and methodology of natural sciences to solution of archaeological problems.

8100. INTERDISCIPLINARY SEMINAR. (4 cr, §AnSt 8100; prereq grad major or #) Staff, visitors
Review and evaluation of approaches to interdisciplinary research; themes vary; leadership and research shared by staff, visitors, and students.

8200. DIRECTED READINGS. (Cr ar, §AnSt 8200; prereq Δ) Staff
Independent reading under supervision of program staff members.

8300. DIRECTED RESEARCH. (Cr ar, §AnSt 8300; prereq Δ) Staff
Independent work under supervision of program staff members. Projects include, but are not restricted to, research involved in master's and Ph.D. programs.

Interfacial Engineering (CIE)

Professor: D. Fennell Evans (chemical engineering and materials science), *director*, Center for Interfacial Engineering, and *director of graduate studies*; Frank S. Bates (chemical engineering and materials science); Howard L. Brockman (Hormel Institute); Robert W. Carr, Jr. (chemical engineering and materials science); C. Barry Carter (chemical engineering and materials science); Steven L. Crouch (civil and mineral engineering); Edward L. Cussler (chemical engineering and materials science); E. Dan Dahlberg (physics and

astronomy); H. Ted Davis (chemical engineering and materials science); John F. Evans (chemistry); William W. Gerberich (chemical engineering and materials science); Wayne L. Gladfelter (chemistry); David L. Kohlstedt (geology and geophysics); Jack L. Lewis (orthopedic surgery); Benjamin Y. H. Liu (mechanical engineering); Timothy P. Lodge (chemistry); Christopher W. Macosko (chemical engineering and materials science); Peter H. McMurry (mechanical engineering); L. Edward Scriven (chemical engineering and materials science); Matthew V. Tirrell (chemical engineering and materials science); Frederick M. Waltz (electrical engineering); Michael D. Ward (chemical engineering and materials science)

Adjunct Professor: Donald J. David; Donald F. Gibbons; Randal M. Hill; Patrick J. Parks

Associate Professor: Alfonso Franciosi (chemical engineering and materials science); Alon V. McCormick (chemical engineering and materials science); Dennis L. Polla (electrical engineering); Henryk K. Stolarski (civil and mineral engineering); Robert T. Tranquillo (chemical engineering and materials science)

Adjunct Associate Professor: William A. Hendrickson; Fred B. McCormick; John R. Minter; Koichi Takamura; Yeshayahu Talmon

Assistant Professor: Lorraine F. Francis (chemical engineering and materials science); Eric Ganz (physics and astronomy); Jeffrey T. Roberts (chemistry)

Course of Study—Minor in interfacial engineering, applicable to master's (M.S. only) and doctoral programs.

Curriculum—In conjunction with the Center for Interfacial Engineering (CIE), an interdisciplinary graduate curriculum is offered for students who wish to master the fundamental science and engineering technology required for effective design and manufacture of products whose performance depends on interactions that take place at the interfaces between materials. The minor's objective is to optimize the ability to control interfacial processes by providing an understanding of the following: different forms, scales, and dimensions of interfacial products and the processes used to manufacture these products; factors involved in stability, metastability, or instability of interfacial systems and processes; the limitations of rates of production due to critical stages involving gas, solid, and liquid phase processing; characterization and measurement of interfacial products; and how to model the desired product and solve reliability problems.

Prerequisites for Admission—Admission to the CIE graduate minor is contingent upon prior admission to a master's or doctoral degree-granting program within the Graduate School and must be accepted by the director of graduate studies of the interfacial engineering minor.

Special Application Requirements—It is anticipated that no more than fifteen doctoral candidates will be admitted into the minor program each year. Students may be admitted to the program in any quarter. CIE does not require an undergraduate major or minor in interfacial engineering as a prerequisite for admission to the minor program. Applicants, however, are expected to show general knowledge of interfacial engineering scholarship as evidenced, for example, in some combination of previous coursework, writing, or current or previous research work.

Minor Requirements—Master's and doctoral students minoring in this program must complete two required courses: *Fundamentals of Interfacial Engineering* (5101) and *Strategies for Interfacial Engineering* (8001). In addition, master's students must complete at least six credits and doctoral candidates a minimum of 12 credits of coursework emphasizing interfacial science or engineering. Appropriate courses may be selected in consultation with the major adviser and with the approval of CIE's director of graduate studies from offerings in chemistry, chemical engineering and materials science, electrical engineering, civil and mineral engineering, mechanical engineering, physics, and geophysics. Coursework in the student's major field, however, may not be applied toward fulfillment of course requirements for the minor. Doctoral candidates may earn up to six credits for approved research projects completed in the laboratory of one of CIE's member companies.

Language Requirements—None specific to the minor program.

For Further Information and Applications—Contact the Center for Interfacial Engineering, University of Minnesota, 179 Shepherd Laboratories, 100 Union Street S.E., Minneapolis, MN 55455 (612/626-2230).

5101. FUNDAMENTALS OF INTERFACIAL ENGINEERING. (3 cr; prereq IT sr or grad student) Nature of interfaces between gases/liquids/solids, effects of composition (adsorption) and curvature (capillarity). Multiphase interfacial systems: contact angle, wetting, and adhesion. Interfacial processing: thin films, coatings, and colloids. Interfacial products and properties: defects, failure analysis, and reliability.

8001. STRATEGIES FOR INTERFACIAL ENGINEERING. (1-3 cr; prereq IT grad student, 5101) Strategies for successful processing of interfacial products. Projects illustrate application of interfacial engineering concepts and knowledge from other disciplines to industrial processing problems. Students work with company representatives as well as with faculty.

Interpersonal Relationships Research (IRel)

Professor: W. Andrew Collins (child development), *director of graduate studies;* Ellen Berscheid (psychology); Larry L. Cummings (management); Harold D. Grotevant (family social science); Willard W. Hartup (child development); Dean Hewes (speech-communication); Robert Leik (sociology); Geoffrey Maruyama (educational psychology); David Olson (family social science); Marshall Scott Poole (speech-communication); A. Marilyn Sime (nursing); Mark L. Snyder (psychology); Alan Sroufe (child development)

Associate Professor: James Maddock (family social science); Patricia Tomlinson (nursing)

Assistant Professor: Patricia Frazier (psychology)

Course of Study—Minor in interpersonal relationships research, applicable to doctoral programs.

Curriculum—Interpersonal relationships research is an interdisciplinary field concerned with behavioral interaction patterns between two persons and the impact of these interactions. Its roots lie in psychology, sociology, family studies, communication, and nursing. The curriculum provides students with broad theoretical and methodological foundations for research on interpersonal relationships.

Prerequisites for Admission—Admission to the interpersonal relationships research

Graduate Programs

graduate minor is contingent upon prior admission to the Graduate School and to a doctoral program in a degree-granting department. Admission to the minor program is limited and only by permission of the director of graduate studies in interpersonal relationships research.

Minor Requirements—Students seeking to complete the interpersonal relationships research minor at the Ph.D. level are required to take the following core courses: Psy 5204, IRel 8001 (a three-quarter proseminar), and IRel 8010. The minor requires a minimum of 21 credits. Additional credits beyond the required courses must be selected from a designated course list that includes approximately 40 courses offered by many disciplines. Credits from courses in the student's major department, however, do not count toward the minor.

Language Requirements—None specific to the minor program.

For Further Information and Applications—Contact the Doctoral Minor Program in Interpersonal Relationships Research, Institute of Child Development, University of Minnesota, 104 Child Development, 51 East River Road, Minneapolis, MN 55455 (612/624-2396).

8001. PROSEMINAR IN INTERPERSONAL RELATIONSHIPS RESEARCH. (1 cr per qtr [max 3 cr]; prereq admission to IRel minor)
Survey of major topics, including theoretical assumptions, methods, and samples of current research.

8010. SEMINAR: STATISTICAL AND METHODOLOGICAL ISSUES IN RESEARCH ON DYADIC RELATIONSHIPS. (3 cr; prereq admission to IRel minor, #)
Survey of topics in design and analysis of research on behavior in two-person interactions.

Italian

See French and Italian.

Japanese

See East Asian Languages, Literatures, and Linguistics.

Journalism

See Mass Communication.

Kinesiology and Leisure Studies

Kinesiology

Professor: Michael Wade, *director:* William R. Charlesworth (child development); Arthur G. Erdman (mechanical engineering); David W. Johnson (educational psychology); Roger T. Johnson (curriculum and instruction); Arthur S. Leon; Herbert L. Pick (child development); Jacqueline Shick; Lela J. Stoner; Albert Yonas (child development)

Associate Professor: Fred S. Apple (laboratory medicine and pathology); Allen W. Burton; Richard S. Crow (epidemiology); Peter A. Hancock; Mary Jo Kane; March L. Krotee; Robert C. Serfass; Diane M. Wiese-Bjornstal

Adjunct Associate Professor: Virgil G. Mathiowetz

Research Associate: Ava J. Walker

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Emphases in the master's and doctoral programs are biodynamics (exercise physiology and biomechanics), motor behavior/human factors, and sociocultural psychology of sport and physical activity.

Prerequisites for Admission—Although prospective students generally have an undergraduate degree in the field, others with a baccalaureate degree may be admitted who have related preparation and a significant background and interest in the scientific study of physical activity. Admitted students may be required to complete background preparation.

Special Application Requirements—A completed interest/experience form, scores from the Graduate Record Examination General Test (verbal and quantitative) or Miller Analogies Test, three letters of recommendation evaluating the applicant's scholarship, and submission of a scholarly paper are required.

Master's Degree Requirements—Requirements include Kin 5980, 8980, 8981

(Plan B only), EPsy 5260, and evidence of effective professional communication. The final examination is oral for both Plan A and Plan B students.

Doctoral Degree Requirements—Programs are individually designed with one area of emphasis in association with a minor or supporting field of study. Preliminary written and oral examinations are based on Kin 5170, Kin 5980, and program coursework. Other coursework requirements for all Ph.D. students include a minimum of nine credits in statistics and six credits of graduate seminar.

Language Requirements—None.

For Further Information and

Applications—Contact the School of Kinesiology and Leisure Studies, University of Minnesota, 224 Cooke Hall, 1900 University Avenue S.E., Minneapolis, MN 55455 (612/624-5017).

Kin 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Kin 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Kin 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Note—Kinesiology course listings immediately follow the recreation, park, and leisure studies program description below.

Recreation, Park, and Leisure Studies

Professor: Leo H. McAvoy¹; John E. Rynders (educational psychology); Stuart J. Schleien¹; Michael Wade; Howard Y. Williams (vocational and technical education)

Associate Professor: Bruce D. Anderson¹; Mary Jo Kane¹; John H. Schultz¹; Diane M. Wiese-Bjornstal; Caroline R. Weiss¹

Assistant Professor: Dorothy H. Anderson (forest resources); Stephan P. Carlson (4-H youth development); Carla E. S. Tabourne

Research Associate: David W. Lime (forest resources)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B); and Ph.D. in education (emphasis in recreation, park, and leisure studies).

Curriculum—Emphases in the master's program are parks and recreation administration, therapeutic recreation, outdoor education/recreation, and sport management. The doctoral degree with the major in education offers preparation for an academic career in the emphases above. For a general description of the major in education, see the Education section of this bulletin.

Prerequisites for Admission—Although prospective students generally have an undergraduate degree in the field, others with related backgrounds may be admitted. Admitted students may be required to complete appropriate undergraduate and graduate courses.

Special Application Requirements—A completed interest/experience form and scores from either the Miller Analogies Test or the Graduate Record Examination are required. Students are admitted each quarter.

Master's Degree Requirements—Requirements include 5980, 8980, and 8981 (Plan B only). A final oral examination is required for both plans.

Doctoral Degree Requirements—The program consists of the following: a common core of at least 18 credits in the historical, scientific, and philosophical foundations of recreation, park, and leisure studies and of higher education; an emphasis area of at least 32 credits; thesis development of at least 52 credits (including 36 thesis credits); and a supporting program or minor of at least 24 credits. Three Ph.D. seminar courses must be included in these degree requirements. Foundation requirements are examined in association with the written preliminary examination.

Language Requirement—None.

For Further Information and

Applications—Contact the School of Kinesiology and Leisure Studies, University of Minnesota, 224 Cooke Hall, 1900 University Avenue S.E., Minneapolis, MN 55455 (612/624-5017).

¹ Also holds graduate faculty appointment in education.

Graduate Programs

Rec 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Educ 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Educ 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Section 4. Recreation, Park, and Leisure Studies

Note—Recreation, park, and leisure studies course listings immediately follow the kinesiology course listings below.

Kinesiology (Kin)

5100. DEVELOPMENTAL/ADAPTED PHYSICAL EDUCATION. (3 cr; prereq #; PEL)

Introduction to physical education for students with disabilities, emphasizing administration, curriculum assessment, history, legal mandates, and resources.

5101. PHYSICAL ACTIVITIES FOR PERSONS WITH DISABILITIES. (3 cr; prereq 5100 or EPsy 5601, educ or grad student; PEL)

Adaptation of physical activities for persons with disabilities, emphasizing application of current movement science research.

5102. PRACTICUM: DEVELOPMENTAL/ADAPTED PHYSICAL EDUCATION. (1-6 cr [max 6 cr]; prereq 5100, 5101 or #; S-N only; PEL)

Observation of and participation in physical education instruction for students with disabilities; includes seminar component for discussion of current issues in development/adapted physical education and exchange of ideas and problems.

5111. SPORT FACILITIES. (3 cr, §Rec 5111)
Planning of areas and facilities for athletics, physical education, and sport; emphasis on current trends and problems in the field.

5120. ADVANCED BIOMECHANICS. (4 cr; prereq biomechanics, 3111 or #; PEL)
Principles of mechanics applied to human movement, analysis of motor skills, application to individual projects.

5121. CONTRIBUTIONS OF BASIC SCIENCE TO KINESIOLOGY. (3 cr)
Recent research in related physical sciences; applications in selected areas.

5122. APPLIED PHYSIOLOGY. (3 cr; prereq 3386 or equiv or #; PEL)
Application of concepts in human physiology to exercise physiology, sports training, and physical activities, with particular reference to respiratory and cardiovascular systems.

5124. HUMAN FACTORS PHYSIOLOGY. (3 cr)
Concepts, problems, and issues associated with ergonomic applications to design and operation of human work space. Ergonomic tools and methodologies, hands-on experience in criticism and redesign of existing systems, and principles for design of more efficient future systems.

5126. ADVANCED PSYCHOLOGICAL AND SOCIOLOGICAL DIMENSIONS OF PHYSICAL ACTIVITY. (3 cr)

Advanced insight into substance, nature, and significance of these dimensions of physical activity; focus on current research, issues, and trends as well as potential practical contributions.

5127. OBSERVATION AND ANALYSIS OF TEACHING PHYSICAL ACTIVITY. (3 cr; prereq PEL or coaching licensure student or sr Kin major or MA student or #)

Development of initial competence in use of observation and supervision tools to analyze teaching of physical activity.

5132. MOTOR DEVELOPMENT. (3 cr, §CPsy 5322; prereq 3132 or #; A-F only; PEL)

Development aspects of motor skill acquisition from birth to physical maturity.

5135. MOTOR LEARNING AND HUMAN PERFORMANCE. (3 cr, §5130; prereq 3135 or #; A-F only; PEL)

Mechanisms of human motor skill learning; emphasis on theories of motor learning and control of movement, motor memory, and individual differences.

5136. PSYCHOLOGY OF COACHING. (3 cr; PEL)

Psychological aspects of coaching at all age and skill levels, including leadership and communication skills, motivation, and mental skills training for performance enhancement.

5140. BIOMECHANICS OF SPORT SAFETY. (3 cr; prereq undergrad kinesiology or physical educ)
Forces and torques developed in sports activities; tolerances of the human body; techniques for preventing injury; design of protective equipment.

5141. NUTRITION FOR EXERCISE AND PHYSICAL PERFORMANCE. (3 cr, §HEEd 5412; prereq 3115 or FSCh 1612 or equiv)

Application of basic nutritional principles to active populations; current issues related to dietary modifications for possible improvement of physical performance; strategies for educating clientele about nutrition and physical performance.

5151. CURRICULUM. (3 cr; prereq educ sr or grad student, 3322, 3323 or #; PEL)
For students without previous experience in curriculum; objectives, content, organization, evaluation, and trends.

5152. CURRICULUM DEVELOPMENT. (3 cr; prereq 5151 or #, educ or grad student; PEL)
Trends, issues, and problems at selected levels of interest: elementary, secondary, junior college; for experienced teachers.

5163. DEVELOPMENTAL MOTOR ASSESSMENT. (3 cr)

In-depth view of concepts, problems, and issues in assessment of motor functioning of children who may be handicapped or nonhandicapped, including critical survey of existing assessment tools and experience in developing specific assessment tool.

5170. FOUNDATIONS OF KINESIOLOGY. (3 cr; prereq grad student or MEd student)

Establishment of guidelines for individual and group professional action; examination of pertinent social forces, educational philosophies, and general ethics.

5371. SOCIOLOGY OF SPORT. (4 cr, §Soc 5371)

Sport within and among societies and nations; social organization: socio-economic development, contemporary structure, personnel, fans; relationship to other institutions: economy, education, family, government, religion; social differentiation: status, ethnicity, sex, age; careers; ethical and social problems: honesty and violence.

5375. COMPETITIVE SPORT FOR CHILDREN AND YOUTH. (3 cr)

Cognitive, behavioral, and biological factors having important implications for competitive sport participants from early childhood through high school. Emphasis on translating sport science research into practical implications for youth sport coaches, teachers, and administrators.

5380. COMPUTER APPLICATIONS IN KINESIOLOGY. (3 cr; prereq Kin or PE major or #)

Potential uses of computers in testing and research; introduction to hardware selection, interfacing of computers and data acquisition devices, and management of data for analysis and presentation.

5385. EXERCISE FOR SPECIAL POPULATIONS.

(3-6 cr; prereq undergrad physiology or biol; may be taken twice in consecutive yrs only)

Problems associated with exercise for persons with conditions or diseases such as arthritis, cancer, diabetes, mental disorders, obesity, old age, or paralysis. Recommended exercise prescriptions and potential benefits for special populations.

5387. DETECTION AND PREVENTION OF CORONARY HEART DISEASE. (4 cr; prereq 3386 or equiv or #)

Introduction to causes, detection, and prevention of major cardiovascular disease emphasizing risk factor identification and modification, role of exercise in prevention, and measurement and interpretation of exercise electrocardiograms.

5388. EXERCISE TESTING, CONDITIONING, AND CARDIAC REHABILITATION. (4 cr; prereq 3386 or equiv, 5387 or #; A-F only for day-school students)

Administration and interpretation of exercise tests, cardiopulmonary resuscitation, and exercise prescription; survey of exercise programs for apparently healthy adults and CHD patients; familiarization with principles for establishment of intervention and rehabilitative programs.

5389. PRACTICAL EXPERIENCE IN GRADED EXERCISE TESTING, PRESCRIPTION, AND DIRECTION. (3-6 cr [max 6 cr]; prereq 5388 or #)

Supervised on-site training in testing, prescription, and direction of programs for adults.

5455. RECREATIONAL SPORTS. (3 cr, §Rec 5455)

5460. FOUNDATIONS OF SPORT MANAGEMENT. (3 cr, §Rec 5460; prereq Kin or Rec major or #)

Principles of sport management and fitness areas, including theories and techniques related to marketing, administration, and management of sport enterprises. Organizational theory and policy, with practical examples of sport management skills and strategies.

5510. WOMEN IN SPORT AND LEISURE. (3 cr, §Rec 5510)

5521. PEDAGOGY I: ELEMENTARY PHYSICAL EDUCATION I. (6 cr; prereq student in postbac PE licensure prog; PEL)

Planning, structuring, communicating, class managing, and evaluating roles of contemporary K-6 physical educator in diverse settings.

5522. PEDAGOGY II: SECONDARY PHYSICAL EDUCATION. (6 cr; prereq student in postbac PE licensure prog; PEL)

Planning, structuring, communicating, class managing, and evaluating roles of contemporary physical educator in grades 6-12 in diverse settings.

5530. BIOLOGICAL AND PHYSICAL FOUNDATIONS OF EDUCATION. (2 cr; prereq student educ teacher licensure program)

Overview of biological and physical development from birth through adulthood and relationship of this development to education.

5540. TECHNOLOGY IN SPORT AND PHYSICAL EDUCATION. (3 cr; prereq Kin major or #)

Current technology for developing materials for physical education and sports science; software and video reviewed and evaluated.

5561-5562-5563. CLINICAL EXPERIENCE I-II-III: PHYSICAL EDUCATION. (6,9,9 cr; prereq student in postbac PE licensure prog or #, 5521, 5522; PEL) Supervised observation and teaching in school physical education.

5620. PRACTICUM: PREVENTION AND CARE OF ATHLETIC INJURIES. (3 cr; prereq Anat 1027 or equiv; PEL)

An overview of problems (recognition, principles, responsibilities) related to athletic injuries in secondary and college programs; demonstration and practice in training techniques and familiarity with use of instruments for athletic rehabilitation.

5720. TOPICS IN KINESIOLOGY. (1-12 cr [max 12 cr]; prereq #)

Current issues related to kinesiology and applied activities.

5740. WORKSHOP: COACHING OF INDIVIDUAL, DUAL, OR TEAM SPORTS. (1-12 cr [max 12 cr]; PEL)

Instruction at advanced level, including analyses of skills, game strategies, specific techniques of coaching, and methods of training and conditioning.

Graduate Programs

5860. LEGAL ASPECTS OF SPORT AND PHYSICAL ACTIVITY. (4 cr, §Rec 5860; prereq 3143 or Rec 3550 or Rec 5460)

Survey of legal considerations involved in sport and physical activity programs in schools, colleges, and the private sector.

5980. RESEARCH METHODOLOGY. (3 cr; prereq ed or grad student; PEL)

Methods and design for research in health, kinesiology, and recreation.

5983. READINGS: KINESIOLOGY. (Cr ar [max 9 cr]; prereq ed or grad student)

Independent study under tutorial guidance.

5985. APPLICATION OF RESEARCH. (3 cr)

Professional research for the practitioner; focus on interrelationships of purpose, methods, findings, conclusions, and implications.

8126. SEMINAR: PSYCHOLOGICAL AND SOCIOLOGICAL DIMENSIONS OF PHYSICAL ACTIVITY. (3 cr; prereq 5126 or #)

Analysis of current literature, theoretical constructs, research methodology and design relative to these dimensions of physical activity; focus primarily on student-selected problems.

8128. PSYCHOLOGY OF SPORT. (3 cr; prereq 5126 or equiv or #)

Emergence of field of sport psychology, current research methodologies, and advanced theory and research.

8132. SEMINAR: MOTOR DEVELOPMENT. (4 cr; prereq 5132 or equiv, stat course or #)

Review and critique of contemporary research literature focusing on motor skill development from before birth to adolescence, emphasizing interaction between physical constraints, environmental constraints, and coordination and control of movement.

8135 (formerly 8330). SEMINAR: MOTOR LEARNING AND HUMAN PERFORMANCE. (3-9 cr [max 9 cr], §8330; prereq 5130 or 5135 or #; offered alt yrs)

Advanced reading and discussion of research on specialized topics in the field.

8320. SEMINAR: BIOMECHANICS. (3-9 cr; prereq 5120)

Application of one or more techniques of analysis to an individually selected problem.

8328. SEMINAR: HISTORY OF SPORT AND PHYSICAL EDUCATION. (4 cr; prereq 5328 or #; A-F only; offered when feasible)

8381. LABORATORY RESEARCH TECHNIQUES. (1-3 cr; prereq 5980 or §5980)

Demonstration and student participation in lab procedures involving assessment of exercise parameters.

8382. BIOMECHANICS: RESEARCH TECHNIQUES. (3 cr; prereq 5120 or #)

Lab course: developing expertise in techniques used for biomechanical research in human motion.

8607. COMPARATIVE PHYSICAL EDUCATION AND SPORT. (4 cr; prereq Educ 5603 or #)

Comparative analysis of selected physical education and sport delivery systems and structures. Physical education and sport policies, practices, systems, and management of prominent sporting countries and of lesser developed nations. Sociocultural impact and issues concerning conduct of sport.

8980. GRADUATE RESEARCH SEMINAR. (1-9 cr; prereq #; S-N only)

Reporting and discussion of student and faculty research activity. Required of all M.A. and Ph.D. candidates.

8981. RESEARCH PROBLEMS. (Cr ar; prereq 8980 or #; S-N only)

Individual problems.

8985. SEMINAR: CONTEMPORARY PROBLEMS.

(3 cr; prereq 5980, #; offered alt yrs)
Individual presentation and class discussion of contemporary problems selected by class members.

Recreation, Park, and Leisure Studies (Rec)

5100. FOUNDATIONS OF RECREATION. (3 cr; prereq MEd or adult spec or grad student) Kane, Schultz
Investigation of the historical, sociological, and educational bases of the recreative use of leisure in contemporary society.

5111. SPORT FACILITIES. (3 cr, §Kin 5111)
Planning areas and facilities for athletics, physical education, and sport; emphasis on current trends and problems in the field.

5160. RECREATION LAND POLICY. (3 cr; prereq 1520 or 5100 or Δ) McAvoy
Environmental considerations in relation to recreation and leisure services.

5180. EMPLOYEE RECREATION SERVICES. (3 cr; prereq 1520 or 5100 or Δ) Schultz
Survey of history, development, and management patterns of employee recreation services in business, government, and industry.

5190. COMMERCIAL RECREATION. (3 cr; prereq 3550 or Δ) Schultz
Survey of the scope and development of profit-making recreation agencies, facilities, and services.

5210. INTRODUCTION TO THERAPEUTIC RECREATION. (3 cr; prereq 1520 or §5100 or Rec major or Δ) Schleien, Tabourne
Relationship of recreation to special populations; milieu and interdisciplinary approaches in delivery of services.

5220. THERAPEUTIC RECREATION SERVICES. (5 cr; prereq 5210 or Δ) Tabourne
Recreation service for the ill, disabled, and other special populations.

5230. RECREATION AND PERSONS WITH DEVELOPMENTAL DISABILITIES. (3 cr; prereq 5210, Δ) Schleien

Issues relating to leisure services for persons with developmental disabilities; approaches to programming in the institution and in the community.

5235. LEISURE AND MENTAL HEALTH. (4 cr; prereq 5210, Psy 3604 or Psy 5604 or #, Δ) Weiss
Exploration and application of concepts of mental health and mental illness to leisure services delivery in institutional and community settings.

5240. RECREATION AND AGING. (4 cr; prereq 3540 or 5100 or Δ) Tabourne

Leisure problems of the aging citizen; modification of program activities; investigation of community resources; trends and developments in recreation planning.

5250. FINANCING LEISURE SERVICES. (3 cr; prereq 3550 or Δ) Schultz

Methods and techniques of financing operations and capital improvements in public park and recreation agencies and non-public community leisure services; examination of sources of revenue, budgeting procedures.

5255. LEISURE EDUCATION FOR SPECIAL POPULATIONS. (3 cr; prereq 5220, PsyS 5110 or #, Δ) Tabourne

Instruction, counseling, and other methods of education for awareness of leisure, self-in-leisure, leisure-related problem solving and decision making, and access to leisure services.

5270. COMMUNITY LEISURE SERVICES AND PERSONS WITH DISABILITIES. (4 cr; prereq 1520, Rec major or Δ) Schleien

Exploration and application of concepts and techniques of normalization and least restrictive environment strategies to leisure service delivery in community settings for a range of individuals with disabilities.

5288. GRANT WRITING IN HUMAN SERVICES. (4 cr)

Identify, develop, and procure financial assistance for programs in human services, including education, recreation, and social programs. Skills and strategies for preparing competitive proposals for grant support through federal agencies and private foundations/corporations.

5299. CLIENT ASSESSMENT AND PROGRAM EVALUATION IN THERAPEUTIC RECREATION.

(4 cr; prereq 5220 or Δ) Schleien
In-depth study and application of client assessment and program evaluation in approaches to therapeutic recreation.

5300. FOUNDATIONS OF OUTDOOR EDUCATION. (3 cr; prereq sr, 1520 or 5100 or #)

McAvoy
Philosophical, historical, and educational foundations of outdoor education.

5310. PROGRAMMING IN OUTDOOR EDUCATION. (4 cr; prereq 5300 or #) McAvoy

Methods, materials, and setting appropriate for developing and conducting outdoor education and environmental interpretation programs; emphasis on development of practical skills.

5350. WILDERNESS OUTDOOR RECREATION PROGRAMMING. (4 cr; prereq 3150) McAvoy
Exploration of leisure and educational resources of wilderness and management of wilderness-based outdoor recreation and outdoor education programs.

5455. RECREATIONAL SPORTS. (3 cr, §Kin 5455) B Anderson

In-depth analysis of processes and benefits of recreational sports programming and participation.

5460. FOUNDATIONS OF SPORT MANAGEMENT.

(3 cr, §Kin 5460; prereq Kin or Rec major or #) Kane
Principles of sport management and fitness areas, including theories and techniques related to marketing, administration, and management of sport enterprises. Organizational theory and policy, with practical examples of sport management skills and strategies.

5510. WOMEN IN SPORT AND LEISURE. (3 cr, §Kin 5510) Kane

Historical, cultural, philosophical, and socio-psychological factors that have shaped the growth and development of women's involvement in sport and leisure, and obstacles to fuller involvement.

5630. PRACTICUM: THERAPEUTIC RECREATION. (3-9 cr; prereq recreation MEd or grad student; S-N only) Schleien, Weiss
Supervised experiences in program operation; administrative and supervisory duties.

5640. PRACTICUM: LEISURE SERVICES. (3-9 cr; prereq recreation MEd or grad student; S-N only) McAvoy, Schultz
Supervised experiences in program operation; administrative and supervisory duties.

5695. PRACTICUM: SPORT MANAGEMENT. (3-9 cr; prereq Δ) Anderson, Kane
Theory and application of principles in developing and managing sport programs, including supervised experiences in program operation.

5750. LEGAL ISSUES IN LEISURE SERVICES. (4 cr; prereq 3550 or Δ) Schultz
Basic legal considerations in delivery of leisure services in public and private sectors.

5860. LEGAL ASPECTS OF SPORT AND PHYSICAL ACTIVITY. (4 cr, §Kin 5860; prereq 3550 or 5460 or Kin 3143) Schultz
Survey of legal considerations involved in sport and physical activity programs in schools, colleges, and the private sector.

5900. WORKSHOP: CONTEMPORARY ISSUES IN LEISURE SERVICES. (1-12 cr {max 12 cr})
Contemporary issues emphasizing administrative and supervisory functions for recreation and allied professionals; individual offerings focus on special issues and/or professional groups.

Graduate Programs

5980. INTRODUCTION TO RESEARCH. (3 cr; prereq MEd or grad student or Δ) Kane
Basic techniques; emphasis on social research methodology; survey of present status of recreation and park research.

5981. PROBLEMS. (Cr ar; prereq MEd or MA student or Δ)
Focus on conduct of recreation programs.

5983. READINGS: RECREATION. (1-3 cr; prereq MEd or grad student or Δ)
Independent study under tutorial guidance.

8310. SEMINAR: RECREATION AND PARK ADMINISTRATION. (1-9 cr; prereq Δ)
Critical study and special problems in recreation, park, and leisure studies.

8320. SEMINAR: THEORETICAL PERSPECTIVES OF LEISURE BEHAVIOR. (3 cr; prereq 5100 or Δ) Kane
Analysis, synthesis, and evaluation of major theoretical paradigms of leisure from social and behavioral sciences in general and leisure science in particular. Examination and development of strategies for application of these theories and research findings.

8370. SEMINAR: ADMINISTRATIVE PROBLEMS IN THERAPEUTIC RECREATION. (3 cr; prereq 5220 or #) Schleien, Tabourne
Examination of organizational patterns, legal aspects, interdepartmental relationships; discussion and case study approach.

8380. SEMINAR: ADMINISTRATIVE PROBLEMS IN RECREATION AND PARKS. (3 cr; prereq 3550 or equiv) Schultz
Investigation of legal, financial, personnel, public relations, political, and philosophical problems in management of federal, state, and local government agencies; discussion and case study approach.

8980. SEMINAR: RESEARCH PROBLEMS. (1-3 cr per qtr [may be repeated for max 3 cr]; prereq 5980, PsyF 5110 or EPsy 5260 or #; S-N only)
Designing, reporting on individual problems. Required of all M.A. and Ph.D. candidates.

8981. RESEARCH PROBLEMS. (Cr ar; prereq 8980 or #; S-N only)
Individual problems.

Landscape Architecture (LA)

Professor: Joan Nassauer, *head*; Roger B. Martin, *director of graduate studies*; Roger D. Clemence; John F. Hart; David G. Pitt

Associate Professor: William R. Morrish; Lance M. Neckar; Peter J. Olin; Robert D. Sykes

Assistant Professor: Julie L. Bargmann; Susan M. Galatowitsch

Adjunct Assistant Professor: Deborah Karasov

Lecturer: Robert J. Gunderson; Barbara Lukermann

Research Associate: David W. Lime

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.L.A. and M.S. (Plan A only).

Curriculum—The M.L.A. prepares students to practice as registered landscape architects. It is a professional degree in an accredited program. Students without previous design experience can expect to take three years to complete the degree; students with advanced standing can expect to take two years.

The M.S. degree program is research-oriented and allows students to focus on specialized areas of landscape architecture. It is a 44-credit program for students with a clear research focus and takes about two years to complete. Students specialize within areas of faculty expertise, which include art and landscape architecture, landscape ecology, landscape architectural history, landscape architectural theory, rural and suburban landscape planning, landscape reclamation, waterway planning and design, landscape perception studies, and transportation design. Prospective students may request a summary of faculty research for a comprehensive description of potential specializations.

Prerequisites for Admission—M.L.A. program applicants must have completed a baccalaureate degree. M.S. program applicants must have completed a baccalaureate degree in landscape architecture or a related discipline. All applicants will also be asked to explain the relationship of their previous academic work and work experience to their proposed graduate study.

Special Application Requirements—

M.L.A. program applicants must apply by February 1 for entry the following fall. The department requires the following materials: a letter of intent, which includes whether or not the applicant is interested in financial aid; three letters of reference; a photocopy of official transcripts; and examples of creative work. Applicants with degrees in related design professions such as architecture or planning should clearly indicate in their letter of intent an interest in being evaluated for advanced standing in design. The Graduate Record Examination (GRE) is not required for entry but can be helpful to applicants applying for fellowships.

M.S. program applicants must apply by February 1 for entry the following fall. The department requires the following materials: GRE scores; a statement of intent outlining research objectives that also includes whether or not the applicant is interested in financial aid; and examples of previous research and/or design work related substantively or methodologically to the applicant's proposed research, or examples of academic or professional work that includes 10 to 30 pages of writings, published or unpublished. Successful applicants will have secured the participation of a faculty adviser before completing their applications.

Degree Requirements—M.L.A. students without previous design experience must take 129 credits of coursework, of which 121 are graduate credits. Students with advanced standing normally must take 90 graduate credits. The core curriculum for both is 54 credits of studio, with one studio required each quarter. Students also take four technology courses, two landscape architectural history courses, and courses in planting design, geographic information systems, ecology, professional practice, and graphics. A total of 16 credits in seminars and in advanced coursework in other disciplines is also required, as is LA 8200 and a research colloquium series.

The M.S. requires 44 graduate credits, which includes a minimum of 7 credits in

landscape architecture, 16 credits for a Plan A thesis, and a minimum of 8 credits in an area of focus outside of landscape architecture. M.S. students are also required to take a 5-credit course on research issues and methods and a colloquium series.

Language Requirement—None.

For Further Information and

Applications—Contact the Department of Landscape Architecture, University of Minnesota, 125 Architecture Building, 89 Church Street S.E., Minneapolis, MN 55108 (612/625-6860; fax 612/625-7525).

LA 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

5131. DIRECTED STUDIES IN LANDSCAPE ARCHITECTURE HISTORY AND THEORY. (1-6 cr; prereq LA student or Δ ; A-F only)
Advanced independent studies.

5133. DIRECTED STUDIES IN LANDSCAPE ARCHITECTURE TECHNOLOGY. (1-6 cr; prereq LA student, Δ ; A-F only)
Advanced independent studies.

5134. DIRECTED STUDIES IN EMERGING AREAS OF LANDSCAPE ARCHITECTURE. (1-6 cr; prereq LA student, Δ ; A-F only)
Advanced independent studies in areas of student's choice.

5140. INTERDISCIPLINARY STUDIES IN LANDSCAPE ARCHITECTURE. (2-6 cr per qtr [max 18 cr]; prereq #; A-F only)
Research, planning, and/or design project. Topics may include energy efficient design, historic preservation, downtown revitalization, agricultural land use, computerized land-use planning, housing.

5200. DIRECTED STUDIES IN LANDSCAPE ARCHITECTURE DESIGN. (1-6 cr, §5132; prereq #; A-F only)
Advanced independent studies.

5201. FIELD TECHNIQUES FOR LANDSCAPE ANALYSIS. (3 cr; prereq LA grad student or BED student or Δ ; A-F only)
Vegetation, soil, and landform description. Applying techniques to agricultural, urban, and natural landscapes. Includes one-week session at Lake Itasca Forestry and Biological Station before fall term and weekly field trips during fall term.

5202. LANDSCAPE ECOLOGY. (3 cr; prereq ecology course or #; A-F only)
Relationships among spatial patterns, temporal patterns, and ecological processes in landscapes. Factors affecting landscape pattern, measurement of landscape pattern, material transport through landscapes, effects of landscape pattern on population dynamics, and landscape planning.

Graduate Programs

5211. MAKING LANDSCAPE SPACE. (6 cr, §3081; prereq BED or BLA student or Δ; A-F only)
Design exploration using three-dimensional models to make outdoor space for human habitation and use, with landforms, structures, and plants. Development of form vocabulary to provide spatial order. Use of metaphorical thinking to imbue designed space with meaning.

5212. ECOLOGICAL INFORMANTS OF DESIGN. (6 cr, §3082; prereq 5211; A-F only)
Draws on landscape ecology, aesthetics, and design arts to help students select and analyze ecological phenomena that influence function and human experience of landscape and to use fundamental aesthetic principles to portray those phenomena in design.

5213. MAKING LANDSCAPE TYPES. (6 cr, §3083; prereq 5211; A-F only)
Theory, precedents, and practice in making fundamental space types in professional landscape architecture. Order, form, and meaning in designing discrete landscape types and types in combination.

5221. PLANTED FORM. (5 cr, §5117; A-F only)
Lectures, presentations, field trips, readings, and projects exploring design principles related to using plants in the landscape. Explores cultural and ecological principles through design projects of various scales.

5228. SEMINAR: TOPICS IN CAMPUS PLANNING. (4 cr; prereq 3093 or #; A-F only)
Lectures, discussion, presentations, field trips, readings, and paper. Contemporary and historic issues in campus planning, use of energy-efficient buildings, efficient land use, and site planning.

5431. HISTORY OF LANDSCAPE ARCHITECTURE: INDIVIDUAL INFLUENCES. (4 cr, §5265; prereq 3413; A-F only)
Lectures, presentations, field trips, readings, papers, and/or projects. Assessment of influences of individuals on formation of the profession, 1800-present.

5562. INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS. (4 cr; prereq jr or sr or grad major in Geog or LA or #; A-F only)
Theory and applications for landscape location and resource analysis and regional planning. Location principles, data structure, variable attributes.

5571. LANDSCAPE CONSTRUCTION: LANDFORM SYSTEMS. (4 cr, §3065; prereq 5211 or #; A-F only)
Theory and professional applications of landform systems for design. Landform typology, representation methods, manipulation techniques, use of survey data, and earthwork construction issues. Landscape integrity assurance and economic performance.

5572. LANDSCAPE CONSTRUCTION: SPATIAL PERFORMANCE. (4 cr, §5063; prereq 5211 or #; A-F only)
Sykes
Theory and application of appropriate standards, proportions, and dimensions for spatial performance in landscape architecture; spatial accommodation of people and automobiles in landscape applications; land use and development controls.

5621. PROFESSIONAL PRACTICE. (4 cr, §5226; prereq terminal yr of study; A-F only)
Office and project management analyzed using case studies. Organizational behavior, marketing, sales, strategic planning, financial and cost accounting, insurance, legal issues and contracts.

5810. VISIONS OF PARADISE: GARDEN DESIGN AND THE GOOD LIFE. (4-6 cr; prereq LA or Arch or BED student or #; A-F only)
Theoretical inquiry and studio exploration into the art of garden design as a lamp to illuminate ideals for living. Aristotelian and Objectivist thought on art and happiness as a whole good life provide the foundation for exploration and artistic expression.

8110. GRADUATE LANDSCAPE PLANNING AND DESIGN. (6 cr; prereq 5101, 5103, 5015 or 5107, grad student; A-F only)
Studio experience in comprehensive landscape planning, or design project in area of student's choice.

8111. DIRECTED STUDIO IN LANDSCAPE ARCHITECTURE. (6 cr; prereq 8222, grad student; A-F only)
Studio experience in comprehensive project execution in landscape planning, or design in area of instructor's specialty.

8200. LANDSCAPE ARCHITECTURAL RESEARCH ISSUES AND METHODS. (5 cr, §8281, §8282; prereq LA student or #; A-F only)
Alternative methodological approaches to landscape architectural research and their appropriateness to contemporary research topics.

8221. DESIGN OF LANDSCAPES FOR DWELLING. (6 cr, §3091; prereq 5213, 5572, LA student or Δ; A-F only)
Design studio. Theory and applications of the meaning of home, dwelling, and associated human behavior issues related to professional design of residential landscape architecture. Studies range from individual home landscapes to neighborhoods as dwelling places.

8222. THE LANDSCAPE ARCHITECTURAL DESIGN OF COMMUNITY PLACES. (6 cr, §3092; prereq 8221, LA student or #; A-F only)
Design studio. Public places as settings for the gathering of people. Historical precedent used as idea resource for designing streets and outdoor public gathering spaces in context of mixed-use urban and suburban settings.

8223. REGIONAL LANDSCAPE DESIGN. (6 cr, §5107; prereq 5562 or FR 5130 or Geog 5562 or PA 5562, 8222, LA student or Δ; A-F only)
Design exploration of landscape ecology, landscape perception, and public policy as informants of design decision making in regional landscapes at or exceeding a township level. Geographic information systems used as design tools.

8231. URBAN LANDSCAPE DESIGN. (6 cr, §5103; prereq LA student or #; A-F only)
Advanced design studio exploring urban and landscape design principles through analysis of case studies and development of strategies from landscape systems within the urban environment.

8232. DESIGN OF RECREATIONAL LANDSCAPES. (6 cr, §5105; prereq 8223; 2 lect, 10 lab hrs per wk; A-F only)
Design studio. Analysis, development, and presentation of designs for diverse recreational landscapes.

8233. SPECIAL PROBLEMS: DESIGN PROPOSAL. (2 cr, §5109; prereq 8223 or 8231; A-F only)
Individual research resulting in proposal for capstone project to be developed in LA 8234.

8234. ADVANCED LANDSCAPE PLANNING AND DESIGN. (6 cr, §5110, §8110; prereq LA grad student in terminal qtr of study; A-F only)
Advanced studies in area of student's choice.

8500. LANDSCAPE ARCHITECTURE RESEARCH PROJECT. (1-6 cr; prereq 8283 or #; A-F only)

8573. LANDSCAPE CONSTRUCTION: STRUCTURAL SYSTEMS. (4 cr, §3067; prereq 5123, LA student or #; A-F only)
Lectures, projects, and exercises on professional design of pavements, enclosures, and decks. Theory and principles of structural design, properties and use of materials, construction communication. Landscape integrity and economic viability as performance issues.

8574. LANDSCAPE CONSTRUCTION: MECHANICAL SYSTEMS. (4 cr, §3069; prereq 8221, LA student or #; A-F only)
Lectures, projects, and exercises on landscape architectural applications of storm water management, urban utilities, irrigation, and electrical and lighting systems and techniques. Systems planning and design; historical precedents; professional design communication; landscape construction, integrity, and performance issues.

8600. LANDSCAPE ARCHITECTURE EDUCATION. (1-4 cr; prereq MLA candidate or #; A-F only)
Planning and execution of undergraduate landscape architecture course under direct supervision of a course instructor.

8801. CONCEPTS OF LANDSCAPE EVALUATION. (4 cr, §8330; prereq LA student or #; A-F only) Nassauer
Philosophical basis for wide-ranging approaches to evaluating qualitative aspects of landscape. Emphasis on aesthetic factors and integration of landscape evaluation into regional design decision making.

8802. PERCEPTION MANIPULATION IN DESIGN OF EXTERIOR SPACE. (4 cr, §8320; prereq LA or Arch grad student or #; A-F only) Martin
Historic and modern design devices that alter sense of spatial control and arrangement to create illusionary situations in exterior environment. Readings, lectures, and research projects inform and test principles of perception distortion in exterior space.

8803. THE SUBLIME, THE BEAUTIFUL, AND THE PICTURESQUE: THEORY AND PRACTICE. (4 cr, §8370; prereq LA or Arch grad student or 3411 or 5431; A-F only) Neckar
Reading, discussion, and research paper on 18th- and early 19th-century theoretical bases for landscape design. Analysis of executed designs, theoretical relationships to current design issues.

8804. LANDSCAPE ECOLOGY AND DESIGN. (4 cr, §8390; prereq LA student or #; A-F only) Nassauer
Readings, discussion, and field investigations to establish a landscape ecological basis for designing ecosystems as part of human settlement. Design and planning implications of scientific conclusions and theory; meaningful techniques for creating high-functioning ecosystems in inhabited landscapes.

8820. SURVEY OF LANDSCAPE ARCHITECTURE RESEARCH. (1-3 cr, §8284; prereq LA student; S-N only) Nassauer
Critical review of invited lectures and discussion on current topics.

Latin

See Classical and Near Eastern Studies.

Law

See American Legal Institutions.

Liberal Studies (MLS)

Professor: Kent Bales (English), *director of graduate studies;* Ronald R. Aminzade (sociology); Terence W. Ball (political science); Subir Banerjee (geology and geophysics); Jean D. Kinsey (agricultural and applied economics); Darrell R. Lewis (educational policy and administration); Paul T. Magee (genetics and cell biology); Naomi B. Scheman (philosophy); David V. Taylor (General College)

Associate Professor: Kevin Dooley (mechanical engineering)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.L.S.

Curriculum—The graduate minor in liberal studies offers an interdisciplinary curriculum that includes four M.L.S. seminars, six elective courses, and a final project course. Although courses for the M.L.S. are scheduled mainly late afternoons and evenings, most graduate-level courses offered during the day are also open to M.L.S. students. Careful selection of

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courses, with the help of the student's graduate faculty adviser, is crucial to insuring a coherently interdisciplinary program of study.

Prerequisites for Admission—In addition to a bachelor's degree, students must indicate an ability to succeed in graduate study.

Special Application Requirements—A statement of purpose, letters of support, an undergraduate transcript, and examples of written work should accompany the application. Graduate Record Examination scores may also be submitted, but are not required.

Master's Degree Requirements—The minimum requirement is 44 credits (normally 11 courses).

Language Requirements—None.

For Further Information and Applications—Contact Continuing Education and Extension (CEE), University of Minnesota, 306 Westbrook Hall, 77 Pleasant Street S.E., Minneapolis, Minnesota 55455 (612/625-3898; fax 612/625-2568; e-mail lundb002@maroon.tc.umn.edu).

Linguistics (Ling)

Professor: Jeanette K. Gundel, *director of graduate studies*; Patricia A. Broen; Andrew D. Cohen; Michael B. Kac; Michael P. Maratsos; Gerald A. Sanders (*emeritus*); Elaine E. Tarone

Associate Professor: Betsy K. Barnes; Bruce T. Downing; Charles R. Fletcher; G. Lee Fullerton; Larry G. Hutchinson; Carol A. Klee; Rocky V. Miranda; Amy L. Sheldon; Joseph P. Stemberger; Nancy J. Stenson; Polly E. Szatrowski

Assistant Professor: Maria D. Sera

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Areas of specialization include language acquisition (first and second), language processing, core linguistics (phonology, syntax, semantics/pragmatics), and the interface of two or more of these areas.

Prerequisites for Admission—There are no specific prerequisites for admission. Students admitted normally have a broad undergraduate background that includes some linguistics courses.

Special Application Requirements—Applicants must submit a completed application, scores from the Graduate Record Examination, two letters of recommendation, and a supplementary questionnaire detailing background, interests, and accomplishments. Applicants wishing to be considered for financial support should apply no later than January 7 of the preceding academic year. Entry is usually in fall quarter but may be permitted in other quarters in exceptional cases.

Degree Program Prerequisites—Consult with the director of graduate studies.

Master's Degree Requirements—Twenty-five credits in the major field, including coursework in phonetics, phonology, syntax, semantics, and field methods. Other coursework is selected in consultation with the student's adviser.

Doctoral Degree Requirements—Same as for the master's degree plus an individualized plan of study (including 8xxx courses) to be determined in consultation with the student's committee. All Ph.D. students must pass preliminary written examinations in phonology, syntax, and their primary and secondary areas of concentration. Papers judged to be of publishable quality by the student's committee can be substituted for examination questions in any of these areas.

Language Requirements—For the M.A. degree, knowledge of one language not native to the student. For the Ph.D. degree, knowledge of two languages not native to the student. Mechanisms for demonstrating knowledge are described in the program's *Information for Graduate Students*.

Minor Requirements for Students Majoring in Other Fields—For the master's degree, 5001, 5201, and 5302, or their equivalents, are required. For the

doctoral degree, six courses approved by the director of graduate studies, including those required for the master's minor, are required.

For Further Information and

Applications—Contact the Program in Linguistics, Institute of Linguistics and Asian and Slavic Languages and Literatures, University of Minnesota, 190 Klaeber Court, 320 16th Avenue S.E., Minneapolis, MN 55455 (612/624-3331).

Ling 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Ling 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Ling 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5001. INTRODUCTION TO LINGUISTICS. (5 cr, §3001; prereq grad standing or #) Phonetics, phonology, morphology, syntax, semantics, and historical-comparative linguistics; language learning and psychology of language; linguistic universals; language in society.

5002. LINGUISTIC ANALYSIS. (4 cr, §5201, §5302; especially recommended for nonmajors; prereq 3001 or 5001 or #) Gundel, Kac, Miranda, Stenson Techniques for analyzing phonological, morphological, and syntactic data from a wide variety of languages; discovering, stating, and justifying generalizations; comparison of diverse languages.

5201-5202. INTRODUCTION TO SYNTAX. (4 cr per qtr; prereq 3001 or 5001 or #) Downing, Gundel, Hutchinson, Kac
5201: Principles of grammar construction and evaluation; examination of syntactic phenomena in a variety of languages. *5202:* Survey of modern syntactic theory.

5211. SEMANTICS. (4 cr; prereq 5011, 5202 or #) Gundel, Hutchinson, Kac Linguistic analysis and explanation of synonymy, analyticity, presupposition, and other meaning phenomena in natural language; comparison of alternative theories of meaning.

5212. LINGUISTIC PRAGMATICS. (4 cr; prereq 5002, 5201 or #) Gundel Analysis and description of linguistic phenomena in relation to beliefs and intentions of language users; speech act theory, conversational implicature, shared knowledge and presupposition, topic-comment structure, discourse coherence.

5301. PHONETICS. (5 cr, §3301, §5003; prereq 3001 or 5001 or §5001 or #) Stemberger Production, acoustics, and perception of speech sounds; practice in production and transcription.

5302-5303. INTRODUCTION TO PHONOLOGY. (4 cr per qtr; prereq 3301 or 5301 or #) Stemberger
5302: Formulation and evaluation of phonological descriptions; phonological processes in a variety of languages. *5303:* Current approaches to phonological theory; metrical, autosegmental, and lexical phonology.

5401-5402. COMPUTATIONAL LINGUISTICS. (4 cr per qtr; prereq 3001 or 5001 or #; some programming experience helpful) Methods and issues in computer understanding of natural language. LISP and Prolog programming languages, with emphasis on their linguistic applications. Lab projects.

5503. INTRODUCTION TO APPLIED LINGUISTICS. (4 cr; prereq 3001 or 3005 or 5001 or #) Cohen, Downing, Stenson, Tarone Role of linguistics in neighboring disciplines; applications to practical fields such as lexicography, orthography, translation, language planning, reading, English and foreign language teaching, bilingual education, education of the deaf and correction of language disorders; computer applications; forensic applications.

5601. INTRODUCTION TO HISTORICAL LINGUISTICS. (4 cr; prereq 5001 or #) Miranda Historical change in phonology, syntax, semantics, and the lexicon; factors underlying language change; linguistic reconstruction; genetic relationship among languages.

5602. PHONOLOGICAL CHANGE AND RECONSTRUCTION. (4 cr; prereq 3601 or 5601, 5302 or #) Miranda Change in phonological systems; factors underlying phonological change; internal and comparative reconstruction in phonology.

5603. SYNTACTIC CHANGE AND RECONSTRUCTION. (4 cr; prereq 3601 or 5601, 5201 or #) Miranda Historical change in morphology and syntax; factors underlying syntactic and morphological change; reconstruction in morphology and syntax.

5691. HISTORY OF LINGUISTICS. (4 cr; prereq 3601 or 5601, 5202, 5303 or #) Examination of various objectives and methods of linguistic analysis from antiquity to the present.

5701. INTRODUCTION TO SECOND-LANGUAGE ACQUISITION. (4 cr; prereq 5002 or 5201, 5302, 5003 or 5301 or #) Cohen, Sheldon, Tarone Overview of second-language acquisition and processing; implications for second-language teaching.

5702. SECOND-LANGUAGE ACQUISITION. (4 cr; prereq 3001 or 5001, 5002 or 5201, 5302, 5701 or §5701 or #) Cohen, Sheldon, Tarone Empirical and theoretical studies of second language acquisition and processing.

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5711-5712. FIELD METHODS IN LINGUISTICS.

(4 cr per qtr; prereq 5202, 5303 or #) Hutchinson, Stenson
Techniques for obtaining and analyzing linguistic data from unfamiliar languages through direct interaction with a native speaker.

5731-5732. A CONTRASTIVE APPROACH TO MODERN ENGLISH. (4 cr per qtr; prereq 3001 or 5001 or #; does not fulfill degree requirements for majors in Ling or ESL)

Linguistic structures of standard English and contrastive analysis of these structures with those of another language. Implications for learning English as a second language.

5741-5742. LINGUISTIC DESCRIPTION OF MODERN ENGLISH. (4 cr per qtr; prereq 3001 or 5001 or #) Downing, Gundel

Word and sentence structure of present-day English.

5801. INTRODUCTION TO LANGUAGE

LEARNING. (4 cr; prereq 3001 or 5001 or #; does not fulfill degree requirements for majors in Ling or ESL) Overview of first and second language learning.

5821. SOCIOLINGUISTICS. (4 cr; prereq 3001 or 5001 or #) Downing, Klee

Social determinants of linguistic diversity, variability, and change; linguistic behavior and social control; methods of community-sited linguistic research.

5910. SEMINAR IN LINGUISTICS. (4 cr; prereq #)

5970. DIRECTED STUDIES. (1-5 cr per qtr; prereq linguistics or ESL major, #, Δ, CLA approval)

8200. TOPICS IN SYNTAX AND SEMANTICS. (4 cr [may be repeated for cr as topics change]; prereq 5206 or #) Gundel, Hutchinson, Kac

8210. SEMINAR IN SYNTAX. (4 cr; prereq 5206, 5211 or #) Gundel, Hutchinson, Kac, Stenson

8211. FORMAL SEMANTICS OF NATURAL LANGUAGE. (4 cr; prereq 5011 or Phil 5201 or #) Hutchinson, Kac

Truth-conditional model-theoretic semantics applied to treatment of opacity, intensionality, quantification, and related phenomena in natural language.

8220. SEMINAR IN SEMANTICS. (4 cr; prereq 5211 or #) Gundel, Hutchinson, Kac

8300. TOPICS IN PHONOLOGY. (4 cr [may be repeated for cr as topics change]; prereq 5304 or #) Stemberger

8310. SEMINAR IN PHONOLOGY. (4 cr; prereq 5304, 5602 or #) Stemberger

8500. SEMINAR: TOPICS IN LINGUISTICS. (4 cr [may be repeated for cr as topics change]; prereq #)

8510. LINGUISTIC STRUCTURES. (4 cr [may be repeated for cr with different languages]; prereq 5202, 5303 or #)

8600. TOPICS IN HISTORICAL LINGUISTICS. (4 cr [may be repeated for cr as topics change]; prereq 5603 or #) Miranda

8731. RESEARCH METHODS IN LANGUAGE ACQUISITION. (4 cr; prereq 5702 or 5805 or CDis 5305 or CPsy 5345 or #)

Critical review of research methods and design in the study of first and second language acquisition.

8820. TOPICS IN LANGUAGE AND COGNITION. (4 cr; prereq 5001 or #) Gundel, Stemberger Language-related issues in cognitive science from linguistic perspective.

8900. INDEPENDENT STUDY. (1-5 cr per qtr; prereq linguistics major, #)

Related courses in other departments may be elected as part of a linguistics major with the approval of the director of graduate studies.

Luso-Brazilian Literature

See Hispanic and Luso-Brazilian Literatures and Linguistics.

Management of Technology (MOT)

Regents' Professor: Vernon W. Ruttan (agricultural and applied economics)

Professor: Yechiel Shulman (mechanical engineering), *director*, Center for the Development of Technological Leadership, and *co-director of graduate studies*; Mary Nichols (strategic management and organization), *co-director of graduate studies*; Carl R. Adams (information and decision sciences); Rajiv Banker (accounting); Avram Bar-Cohen (mechanical engineering); Norman E. Bowie (philosophy); Norman L. Chervany (information and decision sciences); W. Bruce Erickson (strategic management and organization); Arthur V. Hill (operations and management sciences); Ettore F. Infante (mathematics); George John (marketing and logistics management); Tarald O. Kvalseth (mechanical engineering); Timothy J. Nantell (finance); Subbiah Ramalingam (mechanical engineering); Donald R. Riley (mechanical engineering); Kenneth Roering (marketing and logistics management); Roger Schroeder (operations and management sciences); George L. Shapiro (speech-communication); Aaron Shenhar (Center for the Development of Technological Leadership); Andrew Van de Ven (strategic management and organization); Rias J. Van Wyk (Center for the Development of Technological Leadership); Raymond Willis (strategic management and organization)

Associate Professor: Srinivasan Balakrishnan (strategic management and organization); Kevin J. Dooley (mechanical engineering); Edward J. Joyce (accounting); Arthur L. Norberg (history of science and technology); Dennis L. Polla (electrical engineering); Karl Smith (civil and mineral engineering)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.S.MOT. (Plan B).

Curriculum—The management of technology program is an intensive, two-year practitioner-oriented program designed for experienced engineers and scientists who have achieved springboard positions in their organizations and want to manage technological activities. Students enter the program in the fall and advance as a cohort group, taking a prescribed sequence of courses together, including a capstone project. Classes are held for a full day each week, on alternate Fridays and Saturdays, allowing students to carry on their full-time employment responsibilities while participating in the program. In addition to the regular classes, two residency periods of three days each are held at off-campus conference centers at the beginning of fall and spring quarters. Tuition and fees, books, supplies, weekly lunches, parking, and off-campus accommodations for the two residencies are included in an annual comprehensive fee. For current program costs, contact the management of technology graduate program. To maintain the atmosphere of teamwork in small groups and close contact among students, faculty, and invited lecturers, admission to the program is limited.

Prerequisites for Admission—A bachelor's degree in engineering or in a natural science discipline from an accredited program is required. Applicants should also have completed coursework (or can show proficiency) in economics, mathematical modeling, statistics, and computer literacy.

Special Application Requirements—A minimum of five years of professional experience in the applicant's technical field is required (in exceptional circumstances, promising candidates with less experience may be considered). Applicants are required to submit three letters of recommendation, a résumé, a statement of purpose, and

Graduate Record Examination or Graduate Management Admission Test scores (if the applicant already holds a master's or Ph.D. degree, this test requirement is waived). The professional track record of the applicant weighs heavily in the admissions process. A personal interview with the director of graduate studies is required. Admission is in fall quarter only.

Degree Requirements—In addition to course requirements, students must successfully complete an oral examination and a written report on the capstone project.

Language Requirements—None.

For Further Information and Applications—Contact the Management of Technology Graduate Program, Center for the Development of Technological Leadership, University of Minnesota, 107 Lind Hall, 207 Church Street S.E., Minneapolis, MN 55455 (612/624-5747; fax 612/624-7510; e-mail MOT@cdtl.umn.edu).

8111. MARKETING MANAGEMENT IN TECHNOLOGY-BASED ORGANIZATIONS. (4 cr, §MBA 8045; prereq MOT student) Roering
Emphasizes marketing of industrial products. Overall consideration of marketing strategy. Issues of product strategy, including pricing, promotion, product mix, and sales and distribution decisions.

8112. MANAGEMENT ACCOUNTING. (4 cr, §MBA 8035; prereq MOT student) Joyce
Introduction to methods for estimating and analyzing product costs and using cost information for product mix and pricing decisions. Cases from manufacturing firms used for understanding principles of activity-based costing. Uses of cost data in managerial decision making, budgeting and control, and financial statement analysis.

8113. MANUFACTURING FOR COMPETITIVE ADVANTAGE. (4 cr, §MBA 8050, §OMS 5100; prereq MOT student) Hill

Overview of manufacturing functions and impact of manufacturing on competitiveness of firm. Strategic framework used to describe key relationships between operations and other functions in value chain (e.g., design, marketing, distribution) and to show how decisions within operations can be integrated to achieve strategic objectives. Product/process design, production, work force issues, and role of technology.

8121. MANAGING IN A TECHNICAL ENVIRONMENT. (4 cr; prereq MOT student) Erickson
General management principles, with applications to management of professional, research and development, and technical personnel. Discussion, readings, cases, and projects.

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8122. FINANCIAL MANAGEMENT FOR TECHNOLOGY-BASED ORGANIZATIONS.

(5 cr, §MBA 8040; prereq MOT student) Nantell
Development of concept of creating value with the organization. Use of financial methods most important to managers of technology-based organizations, including capital budgeting, projection of financial needs, and management of working capital.

8131. PROBLEM FORMULATION AND MANAGERIAL DECISION MAKING.

(2 cr, §MBA 8070; prereq MOT student) Adams
Basic characteristics of managerial decision making and concept of bounded rationality. General approach to definition of unstructured problems frequently encountered by higher-level management. Specific methods for problem expansion based on different lines of reasoning, such as cause-effect and systems thinking.

8132. QUALITY CONTROL AND MANAGEMENT.

(4 cr, §IEOR 5030; prereq MOT student) Dooley
Concepts, methodologies, and techniques used to continuously improve quality and productivity of products and services. Managerial and technical aspects. Evolution of quality function, definitions of quality, conceptual contributions to quality management, quality as an operational strategy, statistical process control, fault diagnosis, design of experiments, reliability, and quality in product development process.

8133!. COMMUNICATIONS IN A TECHNICAL ENVIRONMENT.

(4 cr; prereq MOT student)
Oral and written communications. Introductory and specialized workshops. Memo writing, presentation skills, visual aid design and integration.

8134. SUPPORT AND CONTROL OF MANUFACTURING PROCESSES.

(4 cr; prereq MOT student) Ramalingam
Overview of mechanical, microelectronic, and process industries with emphasis on discrete product and continuous flow manufacturing. Product realization process, product information content and its significance to design and manufacturing. Current design and manufacturing practices. Impact of information technology on automation of design and manufacture. Concurrent engineering and emphasis on quality and reduced cycle time, integration of design and manufacturing. Tools for computer-aided design and manufacture and standardization.

8212. MANAGING FUNCTIONAL INTERFACES IN NEW PRODUCT DEVELOPMENT.

(4 cr; prereq MOT student) John
Need for and problems of organizational integration in development of product policy and execution of new product development process. Necessary organizational interactions among marketing, R & D, and operations in design and delivery of products.

8213. BUSINESS, GOVERNMENT, AND MACROECONOMICS.

(4 cr, §MBA 8055; prereq MOT student) Erickson
Business-government relations, especially as they affect scientific and technical issues, global competitiveness, and macroeconomic policies while they influence firms' domestic and international strategies and operations. Effects of legal and economic forces on management of firms, especially on their technical strategies.

8214. UNDERSTANDING AND FORECASTING TECHNOLOGY DEVELOPMENT.

(4 cr; prereq MOT student) Van Wyk
Introduction to methods of technology assessment and forecasting, and their application to study of history of technology and industry. Technological developments and their economic, social, and industrial impacts.

8221. PROJECT MANAGEMENT AND LEADERSHIP.

(4 cr, §OMS 8041; prereq MOT student) Shenhar
Principles and methods for planning and controlling a project, including development of a project plan, resource planning and scheduling (PERT/CPM), project monitoring, and termination. Students develop skills for managing interdisciplinary project teams.

8222. TECHNOLOGY COMPETITIVENESS AND DEVELOPMENT.

(2 cr, §Econ 5312; prereq MOT student) Ruitan
Technical change and economic growth, sources of productivity change, economics of research and development, science and technology policy.

8223. ORGANIZATIONAL COMMUNICATION.

(3 cr, §Spch 5441; prereq MOT student) Shapiro
Organizations as open systems, cultures, and politicized environments. Identification and management of problems developing from integration of organization and communication. Ethics and strategies in corporate communications.

8224!. PIVOTAL TECHNOLOGIES FOR THE 1990S.

(4 cr, §ME 8701; prereq MOT student) Bar-Cohen
Guest experts present state-of-the-art in pivotal technologies and principal barriers to their commercialization. In workshops, students work in groups to develop and present concepts for applying these technologies to an industrial setting.

8231. MANAGING INFORMATION RESOURCES IN A TECHNOLOGY-BASED ORGANIZATION.

(3 cr, §IDSc 8101; prereq MOT student) Chervany
Selection of information technologies; discussion of such issues as power and politics of information systems, trade-offs between centralization of computing (for global coordination) and decentralization (for local autonomy and innovation), role of information technology infrastructures, and information systems as competitive weapons.

8232. MANAGING INNOVATION IN A TECHNOLOGICAL ENVIRONMENT. (4 cr; prereq MOT student) Shenhar

Inputs, processes, and outputs of innovation ventures as they develop from concept to implementation. Developing a "road map" to guide innovation managers. Conditions that facilitate and inhibit innovation, typical patterns of innovation development, and adoption of innovations developed elsewhere.

8233. STRATEGIC TECHNOLOGY MANAGEMENT. (4 cr; prereq MOT student) Balakrishnan

Technology from general manager's standpoint, as key strategic resource for building competitive advantage of a firm. Important links between technology and strategic planning. Technology and global competition; creating, acquiring, and leveraging technology competence.

8234. PROJECT. (4 cr; prereq MOT student) Shulman

Practicum carried out in cooperation with each student's home organization. Background research and full development, analysis, and proposed resolution of significant issue, applying concepts and methods learned in program. Faculty adviser provides support and evaluation.

8900. CONFLICT MANAGEMENT. (1 cr; prereq MOT student) Fiutak

Theory and methods for applying conflict management techniques in organizations. Cooperative and competitive models of conflict, basics of bargaining, conflict strategies, communication styles, listening skills, dispute resolution, third-party mediation, and use of computers for conflict mediation.

8910. CORPORATE RESPONSIBILITY. (1 cr; prereq MOT student) Bowie

Principles of stakeholder management. Ethical framework for responsible management of investors, employees, customers, suppliers, and external community. Moral leadership, trust in organizations, and quality control. New metaphors and techniques for managing socially responsible firm.

Professor: Daniel B. Wackman, *director*; Hazel F. Dicken-Garcia; Ronald J. Faber; Irving E. Fang; Donald M. Gillmor; Chin Chuan Lee; Phillip J. Tichenor; Jean W. Ward; William D. Wells

Associate Professor: William A. Babcock; John C. Busterna; Tsan-Kuo Chang; Kenneth O. Doyle, Jr.; Kathleen A. Hansen; Nancy L. Roberts; Dona B. Schwartz; Albert R. Tims, Jr.

Assistant Professor: Michael S. Griffin; Leola A. Johnson

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Two types of M.A. programs are offered: the general mass communication M.A. and the professional M.A. The M.A. program, whether general or professional, emphasizes the theoretical study of mass communication and analysis of media systems. The general mass communication M.A. program is intended for those who wish to pursue teaching and research careers and/or wish to pursue a Ph.D. program. The M.A. professional program is designed primarily for those without undergraduate degrees in journalism who wish to enter professional careers. The professional program combines general study in mass communication with professional skills courses. Individuals who have extensive professional experience in mass communication or B.A. degrees in journalism and are interested in graduate work ordinarily are encouraged to enter the general rather than the professional M.A. program. Although both programs provide options for Plan A (thesis) or Plan B (project), the general program usually follows Plan A and the professional program, Plan B.

The doctoral program offers training for academic careers primarily in communication instruction, research, or policy. Areas of specialization include media sociology, communication law and regulation, media ethics, media management and economics, international mass communication, history of mass communication, visual communication, research theory and methodology, advertising, and mass communication technology.

Special facilities include the Minnesota Journalism Center for Professional Studies, the Silha Center for the Study of Media Ethics and Law, the China Times Center, the Institute for Documentary Photography, the Eric Sevareid Library, and the SJMC Research Division.

Prerequisites for Admission—The minimum requirement for admission is the B.A. or equivalent.

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Special Application Requirements—In addition to Graduate School requirements, a department application, letters of recommendation, academic work samples, and scores from the General (Aptitude) Test of the Graduate Record Examination (GRE) are required. For students whose native language is not English, scores are required from the Test of English as a Foreign Language (TOEFL), but not from the GRE. Admission is in fall quarter; the application deadline is January 15.

Prerequisites for Graduate Study—M.A. professional students without an undergraduate major in journalism must complete up to four undergraduate courses (12 to 16 credits), chosen in consultation with an adviser. One of the four courses may be a key lecture course carrying graduate credit, and may therefore count toward the degree. Students may also satisfy certain prerequisite requirements through special examination. Prerequisite courses are completed during the student's first year of graduate study. The adviser may not require a student to take specific coursework beyond the minimum required. A statement signed by the adviser indicating how the graduate program prerequisites have been met must be attached to the student's graduate program proposal.

Master's Degree Requirements—For Plan A, a minimum of 36 credits plus a thesis are required. Coursework must include two designated proseminars, two additional mass communication seminars, 12 credits in other journalism and mass communication seminars or courses, and 8 credits in other departments, in addition to the thesis. Plan A students must also register for 16 master's thesis credits (*Jour 8777*). For Plan B, coursework must include two designated proseminars, two additional mass communication seminars, 12 credits in other journalism and mass communication courses or seminars, 8 credits in other departments, and 8 credits inside or outside the department for a minimum of 44 credits, plus a master's project in lieu of a master's

thesis. A final oral examination is required for both Plan A and Plan B students. All graduate coursework must be taken on an A-F grading basis.

Doctoral Degree Requirements—In consultation with an adviser, students select a dissertation field and supporting coursework. Areas of specialization may be tailored to suit students' interests, including media sociology, communication law and regulation, media ethics, media management and economics, international mass communication, history of mass communication, visual communication, research theory and methodology, advertising, and mass communication technology. Students complete 8 credits of required proseminars and a minimum of 12 credits in methodology courses, 40 credits in the dissertation area and supporting courses, and 27 credits in departments outside of the school. Doctoral students must also register for 36 doctoral thesis credits (*Jour 8888*). All graduate coursework must be taken on an A-F grading basis. The written and oral preliminary examinations cover the proseminars and methodology courses, dissertation area, and supporting coursework.

Language Requirements—For the master's program, foreign language study is recommended for students in international mass communication. Doctoral students pursuing international or cross-cultural study are expected to have high language proficiency, or obtain it, in the appropriate area. Doctoral students in other areas are encouraged to consult advisers regarding the appropriateness of language study for their chosen specialization.

Minor Requirements for Students Majoring in Other Fields—For the Ph.D., approval by the adviser and the director of graduate studies in mass communication is required. Written preliminary examinations are required of all minors. For the M.A., Graduate School requirements for the minor are applicable.

For Further Information and Applications—Contact the Graduate Studies Center, School of Journalism and Mass Communication, University of Minnesota, 18 Murphy Hall, 206 Church Street S.E., Minneapolis, MN 55455 (612/625-4054).

Jour 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Jour 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Jour 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Journalism and Mass Communication (Jour)

5131.* INTERPRETIVE REPORTING. (4 cr; prereq jour major, 3004, 3121 or 3173 or 5155, Δ, pass 40 wpm keyboarding test with 6 or fewer errors) Huntzicker, Ward

Advanced problems in reporting about government, politics, social problems, and the arts.

5141.* OPINION WRITING IN AMERICA. (4 cr; prereq jour major, 3004, 3xxx writing course, Δ; offered 1994-95 only)

Oral and written analysis of major political, economic, and social developments. Persuasive communication in newspapers and magazines; columnists; commentators.

5155.* ADVANCED REPORTING METHODS. (4 cr; prereq jour major, 3004, 3101, pass 40 wpm keyboarding test with 6 or fewer errors, Δ)

Investigative techniques for mass media, including quantitative research methods, use of records and documents, analysis of statistics, advanced interviewing, and methods for adverse conditions.

5159. CASE STUDIES IN PUBLIC RELATIONS.

(4 cr; prereq jour major, 3004, 3159, Δ) Tims
Case study approach to application of public relations principles to solution of problems in business, government, education, and community. For sharpening perceptions, insights, and judgments in examining practical and ethical questions.

5170. ARTS AND ENTERTAINMENT

REPORTING. (4 cr; prereq for jour students: jour major status, 3004, 3101, pass 40 wpm keyboarding test with 6 or fewer errors, Δ; prereq for others: #, Δ; offered 1994-95 only)

News and feature writing about arts and entertainment industry. Assignments follow flow of Twin Cities arts/entertainment news, with emphasis on campus events. Weekly writing assignments, readings, and guest lectures from local artists and journalists.

5171.* ARTS REVIEWING. (4 cr; prereq for jour students: jour major status, 3004, 3101, pass 40 wpm keyboarding test with 6 or fewer errors, Δ; prereq for prof writers, reporters, perform arts majors, studio arts majors: #, Δ)

Book, theatre, visual media reviews. Analysis of leading critics and critical periodicals. Weekly reviews.

5174.* MAGAZINE EDITING AND PRODUCTION. (4 cr; prereq jour major, 3004, 3173 or 3321 or 5302, #, Δ) Roberts

Writing, editing, illustration, design, layout, photocomposition of a single-issue magazine.

5182su.* SUPERVISION OF SCHOOL PUBLICATIONS. (4 cr; prereq for jour students: jour major status, 3004, D; prereq for others: #, D; offered when feasible)

5221.* PUBLICATION GRAPHICS. (4 cr; prereq jour major or minor, 3004, 8 cr in 3xxx or 5xxx courses in art and design or #, Δ)

Role of printing processes in graphic communication. Technique and production of illustration. Significant developments in graphic arts technology.

5251.* PSYCHOLOGY OF ADVERTISING. (4 cr; prereq jour major or minor, 3004, Psy 1001, Δ) Faber
Psychological principles, research techniques, and applications in advertising and selling. Consumer attitudes and behavior. Psychological mechanisms upon which effectiveness of advertisements and commercials depends.

5261.* ADVERTISING: MEDIA ANALYSIS. (4 cr; prereq jour major, 3004, 3201 or #, Δ) Tims
Print and electronic media, their role in advertising; selection and scheduling; rate structures and policies; evaluation and use of media and market measurements and data.

5263.* ADVERTISING CAMPAIGN PLANNING. (4 cr; prereq jour major, 3004, 5261, Mktg 3000 or #, Δ) Faber, Wells

Development of campaign strategy and tactics. Emphasis on planning and decision-making skills needed to design effective advertising campaigns.

5272. ADVANCED ADVERTISING COPYWRITING. (4 cr; prereq jour major, 3004, 3241, Δ; offered 1994-95 only)

Formulating creative strategy and writing advertising copy for print and broadcast media.

5274.* ADVERTISING IN SOCIETY. (4 cr; prereq jour major or minor, 3004, Δ) Busterna
Advertising as an institution. Social and economic criticism. Ethics. Regulation and self-regulation.

5302.* ADVANCED PHOTOGRAPHIC COMMUNICATION. (4 cr; prereq jour major, 3004, 3301 or #, Δ) Schwartz

Practice and analysis of photography as information, including photojournalism and documentary. Historical and aesthetic foundations; economic, institutional, and ethical issues. Shooting assignments.

Graduate Programs

5303.* PROJECTS IN PHOTOGRAPHIC COMMUNICATION. (4 cr; prereq jour major, 3004, 5302 or #, Δ) Schwartz

Advanced projects in documentary photography; conceptualizing and researching stories, establishing and maintaining subject rapport, structuring visual narratives. Documentary history and aesthetics.

5316.* THEORIES OF VISUAL COMMUNICATION. (4 cr; prereq jour major, 3004, 3006 or #, Δ) Schwartz

Perspectives on study and analysis of visual communication; contributions from sociology, anthropology, psychology, and history. Message structure, systems of production, and use of visual media.

5441.* ELECTRONIC NEWSGATHERING. (4 cr; prereq jour major, 3004, 3451 or 5302, Δ; lect, lab, news production hrs)

Modern television news reporting. Demonstrations and field exercises in planning, lighting, shooting, editing, and scripting typical broadcast news assignments.

5442.* ADVANCED TELEVISION NEWS. (4 cr; prereq jour major, 3004, 3451, pass 40 wpm keyboarding test with 6 or fewer errors, Δ; lect, lab, news production hrs) Fang

Preparation and delivery of television newscasts. Current problems of the industry. Legal and ethical considerations. Social impact of electronic journalism.

5444.* TELEVISION AND RADIO DOCUMENTARY. (4 cr; prereq jour major, 3004, 3451 or 5174 or 5302, Δ; lect and news production hrs, field and lab hrs as needed; offered 1994-95 only) Fang, Griffin

Scope and techniques. Production of television or radio news documentaries of broadcast quality.

5501.* COMMUNICATION AND PUBLIC OPINION I. (4 cr; prereq jour major or minor, 3004, Δ) Doyle, Lee
Theories of communication process and of persuasion and attitude change. Functions of interpersonal and mediated communication in diffusion of information and in opinion formation.

5531.* COMMUNICATION AND PUBLIC OPINION II. (4 cr; prereq jour major, 3004, 5501 or Soc 5355, Δ) Chang, Doyle

Advanced study of theories and research findings on opinion formation, persuasion, and diffusion of information. Social science contributions to studies of the process and effects of mass communication.

5541.* MASS COMMUNICATION AND PUBLIC HEALTH. (3 cr, §PubH 5394; prereq for jour students: jour major or minor or grad status, 3004, Δ; prereq for public health and epidemiology PhD and MS students: #, Δ; prereq for all: 12 cr social or behavioral sciences) Finnegan

Role, function, and effects of mass media on public health; planned and unplanned effects; review and analysis of literature to understand how theories, models, and assumptions of mass communication research relate to public health.

5601.* HISTORY OF JOURNALISM. (4 cr; prereq jour major or minor, 3004, Δ) Dicken-Garcia, Roberts
Development of American newspapers and periodicals, from beginnings in Europe to present day; rise of radio and television; relation of communications developments to political, economic, and social trends.

5606.* LITERARY ASPECTS OF JOURNALISM. (4 cr; prereq jour major or minor, 3004, #, Δ) Roberts
Literary aspects of journalism as exemplified in and influenced by works of English and American writers, past and present. Lectures, discussions, weekly papers.

5611.* DEVELOPMENT OF AMERICAN BROADCASTING. (4 cr; prereq jour major or minor, 3004, Δ) Fang

Historical and economic development of radio and television in the United States; government regulation, industry self-regulation, forms of social control, contemporary broadcasting issues; the journalist as broadcaster.

5615.* HISTORY OF VISUAL COMMUNICATION IN THE MASS MEDIA. (4 cr; prereq jour major or minor, 3004, Δ) Griffin

Social history of photography, film, and video. Informational, documentary, propaganda, and entertainment functions of visual communication. Rise and influence of visual media industries and public image making.

5721.* MASS MEDIA AND U.S. SOCIETY. (4 cr; prereq jour major or minor, 3004, Comp 3027 or #, Δ) Hansen, Ward

Economic, political, and social determinants of character and content of mass communication in United States. Structure and functioning of mass media. Problems, prospects, and criticism. Professionalism, technology, and reform.

5725.* THE MANAGEMENT OF MEDIA ORGANIZATIONS. (4 cr; prereq jour major or minor, 3004, Δ)

Media organizations as businesses; economics of mass media; markets, finances, organizational structure, and management practices of principal media industries; issues in media management.

5726.* CASE STUDIES IN MODERN MEDIA MANAGEMENT. (4 cr; prereq for jour student: jour major or minor status, 3004, Δ; prereq for others: #, Δ; 5725 recommended)

How media managers make decisions dealing with money, marketing, product, personnel, and production information. Interaction between quality, price, service, and the limits of technology.

5728. NEWS MEDIA ECONOMICS. (4 cr; prereq jour major or minor, 3004, D; offered when feasible)

5731H.* HONORS COURSE: COMMUNICATIONS PROBLEMS AND ISSUES. (4 cr; prereq jour major or minor, 3004, sr, #, Δ, honors div reg) Hansen, Roberts, Wells

Individual project and topical seminar of major problems and issues of communication.

5741. MINORITIES AND MASS MEDIA. (4 cr; prereq jour major or minor, 3004, Δ) Johnson
Relationships between mass media and communities of color in United States. Issues of content and control.

5777.* CONTEMPORARY PROBLEMS IN FREEDOM OF SPEECH AND PRESS. (4 cr; prereq jour major or minor, 3004, Δ) Gillmor
Legal and constitutional derivation of freedom of speech and press with emphasis on case law, judicial theories, doctrines, tests and values. Symbolic, commercial, compelled speech, speech plus, petition and assembly, leading press cases, legal research techniques.

5801.* INTERNATIONAL COMMUNICATION. (4 cr; prereq jour major or minor, 3004, Δ) Chang, Lee
Structures, processes, and consequences of international mass communication. Problems in the free flow of information. Roles of international organizations. Mass communication in social, political, economic development; implications for conflict resolution.

5825.* WORLD COMMUNICATION SYSTEMS. (4 cr; prereq jour major or minor, 3004, Δ) Chang
Mass media systems of the world, described and analyzed regionally and nationally, with special reference to historical roots, social, economic, and cultural context, contemporary conditions and prospects, and the relevance of journalism and mass communication to international affairs.

5970.* ADVANCED PROJECTS IN JOURNALISM. (1-4 cr per qtr [max 8 cr]; prereq jour major or minor, 3004, B avg, #, Δ, □)
Independent study; projects.

5970H.* HONORS COURSE: ADVANCED PROJECTS IN JOURNALISM. (1-4 cr per qtr [max 8 cr]; prereq jour major or minor, 3004, B avg, #, Δ, □, honors div reg)
Independent study; projects.

5990.* SPECIAL TOPICS IN MASS COMMUNICATION. (1-4 cr per qtr [max 8 cr]; prereq jour major or minor, 3004, #, Δ)
Topics announced in *Class Schedule*.

8010-8020.* STUDIES IN MASS COMMUNICATION. (4 cr per qtr) Chang, Dicken-Garcia, Faber, Griffin
8010: Historical development of mass communication studies in social sciences, humanities, and legal areas; survey of research literature using individualistic and structural approaches to mass communication. *8020:* Survey of literature on history of mass communication; cultural and humanistic approaches to study of mass communication; legal/ethical issues in mass communication.

8501.* SEMINAR: THE PROCESS OF QUANTITATIVE MASS COMMUNICATION RESEARCH. (4 cr; prereq 12 cr soc sci, statistics course or ¶) Doyle, Wackman
Survey of quantitative research methods. Relationship between theory and research, concept explication, measurement, instrumentation, and design issues. Methods such as social surveys, content analysis, and experimentation.

8502.* SEMINAR: MASS COMMUNICATION RESEARCH DESIGN. (4 cr; prereq 8501, statistics course or ¶) Doyle, Faber
Application of social research methods to theoretical issues and problems in mass communication studies. Advanced issues in theory testing, problem definition, sampling and design considerations. Students design projects and gather data.

8503.* SEMINAR: MASS COMMUNICATION RESEARCH ANALYSIS. (4 cr; prereq 8502, statistics course or ¶) Doyle
Quantitative analysis of mass communication research. Analysis strategies, application of multivariate models, and reporting of research findings. Students analyze data from projects conducted in 8502.

8513.* SEMINAR: ETHNOGRAPHIC METHODS IN MASS COMMUNICATION RESEARCH. (4 cr; prereq proseminars or #, Δ) Schwartz
Theoretical foundations in anthropology and sociology; field projects.

8516.* SEMINAR: COMMUNICATION ANALYSIS. (4 cr; prereq course in statistics, #; offered when feasible)

8560.* SEMINAR: HISTORY OF MASS COMMUNICATION. (4 cr; prereq 5601, #, Δ) Dicken-Garcia
Research methods; development of a research project.

8580.* SEMINAR: PROBLEMS IN INTERNATIONAL COMMUNICATION RESEARCH. (4 cr; prereq 5801 or 5825 or #, Δ) Chang
Research strategies and designs relating to telecommunications and mass communication, with emphasis on comparative and cross-cultural analysis and Third World developmental concerns.

8620.* SEMINAR: ADVERTISING RESEARCH. (4 cr; prereq 5251 or #, Δ) Faber
Advertising as persuasive communication. Current research findings and theory related to advertising decision-making process. Measurement issues in advertising and market research.

8630.* SEMINAR: VISUAL COMMUNICATION RESEARCH. (4 cr; prereq 5316, proseminars or #, Δ) Griffin
Research in visual communication. Theoretical approaches, analysis of research methods, development of research designs and projects.

8640.* SEMINAR: BROADCAST NEWS. (4 cr; prereq 5442 or #) Fang
Major issues in broadcast journalism; confrontations between federal government and network news departments; historical studies of broadcast news.

8650.* SEMINAR: MASS COMMUNICATION THEORY. (4 cr; prereq proseminars, #, Δ) Lee, Tims
Research paradigms, concepts, and findings that offer promise for development of a general theory of mass communication.

Graduate Programs

8651.* SEMINAR: MASS MEDIA AND SOCIAL CHANGE. (4 cr; prereq statistics course, #, Δ)

Research designs; procedures for quantitative studies of media control, content, audiences, and effects; structural models for mass media research; relationships between research and decision making.

8652.* SEMINAR: PUBLIC OPINION AND PROPAGANDA. (4 cr; prereq 5531, #, Δ; offered when feasible)

8660.* SEMINAR: HISTORY OF MASS COMMUNICATION. (4 cr; prereq 5601, #, Δ) Roberts

Research in history and development of U.S. mass media.

8661.* SEMINAR: HISTORY OF MASS COMMUNICATION. (4 cr; prereq 5601, #, Δ) Dicken-Garcia, Roberts

Theories and models in historical literature; major research paper.

8662.* SEMINAR: LITERARY ASPECTS OF JOURNALISM. (4 cr; prereq 5606, #, Δ) Roberts

Research in literary aspects of journalism exemplified in careers and works of English and American writers.

8663.* SEMINAR: DEVELOPMENT OF AMERICAN BROADCASTING. (4 cr; prereq 5611; offered when feasible)

8670, 8671, 8672.* COMMUNICATION AGENCIES AS SOCIAL INSTITUTIONS. (4 cr per qtr; prereq 5721 or equiv or #, Δ) Babcock, Johnson, Ward

Influence and effects of mass communication, internal dynamics of media organizations, criticism and modes of reform. Theoretical frameworks for analysis.

8673.* SEMINAR: MEDIA MANAGEMENT. (4 cr; prereq #, Δ; 5725 or 5726 recommended) Busterna

Management issues in media organizations; relation to dynamics of organization structure, employees, markets, and economics/finances.

8675. SEMINAR: ISSUES IN INFORMATION ACCESS AND COMMUNICATION. (4 cr; prereq 5731 or equiv or #, Δ; offered alt yrs) Hansen

Information access issues as they relate to mass communication concerns. Societal, industry, technological, and policy aspects and developments that affect information access, particularly through mass media.

8677.* GOVERNMENT AND MASS COMMUNICATION: ADMINISTRATIVE LAW. (4 cr; prereq 5777 or #, Δ; offered when feasible)

8678.* GOVERNMENT AND MASS COMMUNICATION: CONSTITUTIONAL LAW. (4 cr; prereq 5777 or #, Δ) Gillmor

Problems of constitutional and tort law affecting press and theories that underlie them.

8679.* GOVERNMENT AND MASS COMMUNICATION. (4 cr; prereq 5777 or #, Δ)

Research tutorial.

8680.* SEMINAR: INTERNATIONAL MASS COMMUNICATION. (4 cr; prereq 5801 or 5825 or 5826, reading knowledge of foreign language; offered when feasible)

8681, 8682.* SEMINAR: INTERNATIONAL MASS COMMUNICATION. (4 cr per qtr; prereq 5801 or 5825 or #, Δ) Lee

Main problems and currents of international mass communication. Focus on concepts, research, and policy relevant to global development, including issues of freedom and constraint, media technology, and role of journalism in world affairs.

8683.* MASS COMMUNICATION PROBLEMS OF DEVELOPING COUNTRIES. (4 cr; prereq 8681 or 8682 or #; offered when feasible)

8684.* SEMINAR: INTERNATIONAL BROADCASTING AND WORLD AFFAIRS. (4 cr; prereq 5801 or 5825 or #, Δ; offered when feasible)

8970.* ADVANCED PROJECTS IN MASS COMMUNICATION. (1-4 cr per qtr [max 8 cr]; prereq grad major or minor in mass communication, #, Δ) Individual research.

8990.* SPECIAL PROBLEMS IN MASS COMMUNICATION. (4 cr per qtr; prereq #, Δ) Special topics for seminars.

Materials Science and Engineering

See Chemical Engineering.

Mathematics (Math)

Regents Professor: James B. Serrin, Jr.

Professor: Eugene B. Fabes, *head*; Donald W. Kahn, *director of graduate studies*; Alfred Aeppli; Stephen B. Agard; Greg W. Anderson; Donald G. Aronson; John Baxter; Thomas Berger; John A. Eagon; Paul H. Edelman; Robert Ellis; Mark Feshbach; Avner Friedman; Bert Fristedt; Paul B. Garrett; J. Gil de Lamadrid; Jay Goldman; Lawrence F. Gray; Leon W. Green; Robert D. Gulliver II; Morton Harris; Dennis Hejhal; Ettore F. Infante; Naresh Jain; Max A. Jodeit, Jr.; Harvey Keynes; Nicolai V. Krylov; Walter Littman; Mitchell B. Luskin; Albert Marden; Charles McCarthy; Richard McGehee; William Messing; Norman G. Meyers; Willard Miller, Jr.; Richard Moeckel; Wei-Ming Ni; Johannes C. C. Nitsche; Peter J. Olver; Marian B. Pour-El; Karel Prikry; Edgar Reich; Peter A. Rejto; Joel Roberts; Mikhail Safonov; David Sattinger; George R. Sell; Yasutaka Sibuya; Steven I. Sperber; Dennis W. Stanton; Marvin L. Stein; David A. Storvick; Vladimir Sverak; Peter J. Webb; Hans F. Weinberger; Dennis E. White

Associate Professor: George Brauer; Bennett Chow; Bernardo Cockburn; Jack F. Conn; David Frank; E. Gebhard Fuhrken; Lisl N. Gaal; Hillel Gershenson; Laurence Harper; Howard Jenkins; Gennady Lyubeznik; Chester L. Miracle; Wayne Richter; Charlotte T. Striebel

Adjunct Associate Professor: Blaise Morton

Assistant Professor: Scot Adams; Satyanad Kichenassamy; John S. Lowengrub; Victor Reiner; John M. Sullivan

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B), M.S. (Plan A and Plan B), and Ph.D.

Curriculum—Special areas of research include ordinary and partial differential equations; probability; real, complex, harmonic, functional and numerical analysis; differential and algebraic geometry; topology; group theory and ring theory; logic and combinatorics; number theory, automorphic forms.

See also Control Science and Dynamical Systems, and Fluid Mechanics in this bulletin for Ph.D. programs that rely heavily on mathematics.

Prerequisites for Admission—A solid background in single and multivariable calculus and a minimum of 15 credits of mathematics at the upper division level, including three-quarter sequences in analysis and abstract algebra, are required.

Entering students are ordinarily admitted to the master's degree program. Transfer to the Ph.D. program is made when the written Ph.D. preliminary examination is passed (and does not require earning a master's degree).

Special Application Requirements—The Graduate Record Examination Subject (Advanced) Test in mathematics is generally expected.

Master's Degree Requirements—There are two options: Plan A and Plan B. Under Plan A, students must write a thesis and complete a minimum of 28 credits of graduate-level coursework. Plan B allows more breadth; students must complete at least 48 credits of graduate-level coursework, of which 50% could be in areas outside of mathematics. At least one three-quarter 8xxx mathematics sequence is required under each plan; additional 8xxx coursework may be required depending on the student's program. A final oral examination is required.

For further information, see the *Graduate Studies Announcement* publication.

Doctoral Degree Requirements—The written preliminary examinations, given twice each year, cover real analysis, complex analysis, algebra, and manifolds and topology. Students ordinarily pass the examination by the end of their second year. After passing the written examination and completing the coursework for the program, students may take the preliminary oral examination for the Ph.D. degree. This examination is given at the convenience of students and faculty, and tests the thesis area and the minor or supporting program. Students normally take this examination by their fourth year, depending on their level of preparation.

If a supporting program is chosen, it may consist partly or entirely of mathematics courses.

For further information, see the publication *Requirements for the Ph.D. Degree in Mathematics*.

Language Requirements—For the master's degree—none. For the doctoral degree, two foreign languages are required from among the following: French, German, Russian, and Italian.

Minor Requirements for Students Majoring in Other Fields—For the master's degree minor, a three-quarter 8xxx or 5xxx sequence is required. For the Ph.D. minor in mathematics, coursework must include 1) a three-quarter 8xxx sequence or a three-quarter 5xxx sequence that has two quarters of 5xxx coursework as prerequisites, or one of the following sequences: 5282-5283-5284, 5341-5342-5343, 5571-5572-5573 or 5612-5613-5614; and 2) any three-quarter 8xxx or 5xxx sequence or any two two-quarter 8xxx or 5xxx sequences.

For Further Information and Applications—Contact the School of Mathematics, University of Minnesota, 127 Vincent Hall, 206 Church Street S.E., Minneapolis, MN 55455 (612/625-1306).

Graduate Programs

Note—Certain 5xxx courses are acceptable only for satisfaction of the minor requirements in mathematics and may not be counted toward the total credits required for a master's or doctoral program in mathematics. Such courses are designated by the phrase "does not carry grad cr for math majors."

Because topics courses are offered only when feasible, primarily to serve the needs of Ph.D. candidates, all advanced students are urged to request useful topics by February 1 before the academic year containing the desired courses.

"Offered alternate years," for the mathematics course listing only, means offered regularly, but not annually, and not necessarily every other year.

Math 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Math 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Math 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5005, 5006, 5007. THE DIVERSITY OF MATHEMATICS. (4 cr; prereq elem educ major, 1005-1006 or equiv, 10 more cr college-level math; does not carry grad cr for math majors)
Mathematics enrichment topics for elementary school instructors. *5005*: number theory, including prime numbers and congruences, and fractions and decimals. *5006*: polyhedra, regular and semi-regular map coloring, graph theory and applications. *5007*: analysis of two-person mathematical games.

5056. THEORY OF INTEREST. (4 cr; prereq 1252 or equiv)

Application of compound interest formulas to determine present value, payment schedules, and effective interest and discount rates for installment loans, annuities, sinking funds, bonds, and other securities, including differing payment periods and interest conversion periods.

5057-5058-5059. ACTUARIAL MATHEMATICS I-II-III. (4 cr per qtr; prereq 5056, 1 qtr 5xxx probability or statistics; carries grad cr for actuary math majors only)
Survival function; actuarial notation; actuarial present values for life insurance and life annuities. Equivalence principle; net premiums and reserves; multiple life functions and multiple decrement models; valuation of pensions. Further topics at instructor's discretion.

5081. FUNDAMENTAL TOPICS IN ANALYSIS.

(4 cr; prereq ¶3531H or 3211 or equiv; does not carry grad cr for math majors)

Primarily for prospective secondary teachers. To develop analytic abilities and to broaden perspective on and enhance interest in mathematics. May include real number systems, theory of sets, continuous functions, and properties of limits.

5082. FUNDAMENTALS OF ALGEBRA. (4 cr; prereq 3511H or 3212 or 3142 or 3221 or equiv; does not carry grad cr for math majors)

Primarily for prospective secondary teachers. Number theory, including fundamental theorem of arithmetic and congruences; at least one general algebraic structure—group ring, or field; equivalence relations; possibly other topics. Proofs by mathematical induction and by contradiction.

5083. FUNDAMENTALS OF GEOMETRY. (4 cr; prereq 3142, 3211 or 3211, 3221 or 3212 or 3511H or equiv; does not carry grad cr for math majors)

Primarily for prospective secondary teachers. One non-Euclidean geometry, including attention to the axiomatic approach; topics involving three or more dimensions; some use of transformations; possibly other topics. Proofs by contradiction.

5151. ELEMENTARY SET THEORY. (4 cr; prereq one 32xx Math course or equiv or #)

Basic properties of operations on sets, cardinal numbers, simply ordered sets, well-ordered sets, ordinal numbers, axiom of choice, axiomatics.

5152. ELEMENTARY MATHEMATICAL LOGIC.

(4 cr; prereq one 32xx Math course or equiv or #)

Grammar and semantics of first and second order languages; relational structures; a deductive system for first order logic; completeness theorem; axiomatics of formal theories.

5162-5163-5164. MATHEMATICAL LOGIC. (4 cr per qtr; prereq 1 yr calculus or equiv or Phil 5202 or #)

5162: Theory of computability: notion of algorithm, Turing machines, primitive recursive functions, recursive functions, Kleene Normal form, Recursion Theorem. *5163*: Probability and truth in formal systems: propositional and predicate logic, models of axiom systems, Gödel Completeness Theorem, nonstandard analysis. *5164*: Gödel Incompleteness Theorem: decidable and undecidable theories, models of arithmetic.

5209. THEORY OF NUMBERS. (4 cr; prereq one 32xx Math course or equiv or #; does not carry grad cr for math majors)

Rigorous introduction to elementary theory of numbers developed up to classical results about congruences to a prime modulus (e.g., Fermat's Theorem). Another advanced topic such as continued fractions, Gaussian integers, or quadratic reciprocity usually covered.

5232-5233. COMPUTER-ORIENTED LINEAR

ALGEBRA. (4 cr per qtr, §5242-5243, §5247, §5284; prereq 1261, 3261 or 3142 or equiv or #; does not carry grad cr for math majors)

Linear transformations on finite dimensional vector spaces. Linear dependence, matrix algebra, inner products, orthogonality, matrix inversion presented from algorithmic viewpoint, with students constructing and running illustrative computer programs. Eigenvalues and eigenvectors, Jordan canonical form, polar representation of linear transformations, determinants.

5242-5243. LINEAR ALGEBRA WITH

APPLICATIONS. (4 cr per qtr, §5232-5233, §5247, §5284; prereq 1261, 3261 or 3142 or equiv or #; does not carry grad cr for math majors)

Systems of linear equations, finite dimensional linear spaces, bases, linear transformations, matrices, determinants, eigenvalues, reduction to canonical forms, quadratic and bilinear forms, applications.

5245-5246-5247. INTRODUCTION TO MODERN

ALGEBRA I-II-III. (4 cr per qtr, §5282 for 5245, §5284 for 5246, §5284 for 5247; prereq three 32xx Math courses or equiv or #; does not carry grad cr for math majors)

Basic algebra at more concrete level than 5282-5283-5284. Group theory, including normal subgroups, homomorphism, theories of Lagrange and Cayley. Ring theory, including ideals, integral domains, Euclidean rings, polynomial rings; fields. Linear algebra, including an abstract approach to vector spaces; linear transformations and their structure.

5282-5283-5284. FUNDAMENTAL STRUCTURES

OF ALGEBRA. (4 cr per qtr; prereq one soph-level sequence or #, some previous abstract math recommended)

Theory course, principally for students planning mathematics graduate work. Group theory: normal subgroups, homomorphisms, automorphisms, and the theorems of Lagrange, Cayley, and Sylow. Ring theory: rings, ideals, integral domains, Euclidean rings, polynomial rings, fields. Linear algebra—abstract approach to vector spaces, linear transformations, and the theory of canonical forms including the Jordan and rational canonical forms.

5331-5332-5333. GEOMETRY I-II-III. (4 cr per qtr,

§3161 for 5331, §5083 for 5332; prereq 1261 or equiv; does not carry grad cr for math majors)

Advanced Euclidean geometry; axiomatic and analytic hyperbolic geometry; projective geometry; symmetry and geometrical transformations and their connections to linear algebra, group theory, and complex arithmetic; finite geometries, convex geometrical figures.

5341-5342. INTRODUCTION TO TOPOLOGY. (4 cr

per qtr; prereq one soph-level sequence or #, some previous abstract math recommended)

Set theory: axiom of choice, Zorn's lemma. Metric spaces: completeness, compactness, continuity. Basic point set topology: countability and separation axioms, Urysohn's lemma, compactness, connectedness, product spaces.

5343. INTRODUCTION TO ALGEBRAIC TOPOLOGY. (4 cr; prereq 5342)

Classification of two-manifolds, fundamental group, homology theory.

5375-5376-5377. DIFFERENTIAL GEOMETRY.

(4 cr per qtr; prereq 3252 or equiv or # for 5375; 5375, 3261 or 3142 or equiv for 5376-5377)

Plane and space curves. Frenet formulas, elementary theory of surfaces. Differential forms. Advanced theory of surfaces, integral geometry, Riemannian geometry.

5381-5382. INTRODUCTION TO BASIC

ALGEBRAIC GEOMETRY. (4 cr per qtr; prereq multivariable calculus, 3521H-3531H or 3551H-3552H, #)

Geometry of polynomials defining curves and surfaces. Uses computer algorithms and packages for manipulating polynomials.

5404. VARIATIONAL PROBLEMS. (4 cr; prereq

3252, 3261 or equiv or #; offered when feasible)

5428. MATHEMATICAL MODELS IN ECONOMICS AND THE SOCIAL, ACTUARIAL, AND MANAGEMENT SCIENCES. (4 cr; prereq 3261

or equiv or #; does not carry grad cr for math majors) Mathematical models and associated mathematical techniques for describing behavior of and for optimizing various systems. How to find a model for a given situation.

5447-5448-5449. MATHEMATICAL

THERMODYNAMICS. (4 cr per qtr; primarily for math majors interested in applications, for engineers, for scientists; prereq 5567, 5568 or 5607 or 5613 or #; offered when feasible)

5457-5458-5459. METHODS OF APPLIED

MATHEMATICS. (4 cr per qtr; prereq 3252, 3261 or equiv; 3262 recommended)

Modern analytic tools used in applications of mathematics; emphasis on technique. Linear algebra, ordinary and partial differential equations, calculus of variations, Fourier series, complex variables, optimization, numerical methods.

5463-5464-5465. THE MATHEMATICS OF

INDUSTRIAL PROBLEMS. (4 cr per qtr; prereq 2 yrs calculus including §3262 or equiv, familiarity with FORTRAN, Pascal or C, #)

Industrial problems such as crystal precipitation, air quality modeling, color film developing, laser semiconductors. Theoretical foundations and computational methods involving ordinary and partial differential equations, calculus of variations, and numerical analysis.

5473-5474-5475. ANALYSIS OF NUMERICAL

METHODS. (4 cr per qtr; prereq 3252, 3261 or equiv; some computer skills recommended)

Interpolation and approximation by polynomials. Solution of linear and nonlinear systems of equations. Methods for eigenvalue problems. Numerical integration. Numerical solution of ordinary differential equations. Selected topics if time permits.

5477-5478-5479. APPLIED NUMERICAL ANALYSIS OF PARTIAL DIFFERENTIAL EQUATIONS. (4 cr per qtr; prereq 5242 or equiv, 5608 or equiv, 5513 or equiv, computer skills or #) Numerical methods for the partial differential equations of linear and nonlinear elasticity, compressible and incompressible fluid flow, multiphase flow, heat transfer, and other selected systems of partial differential equations.

5512-5513. DIFFERENTIAL EQUATIONS WITH APPLICATIONS I-II. (4 cr per qtr; prereq 3261 or equiv or #; 3262 recommended; does not carry grad cr for math majors)
5512: Applications, review of special techniques, and numerical approximation for first-order equations. Euler and Runge-Kutta methods with error analysis. Applications and power series solutions for second-order equations. 5513: Applications and Laplace transforms for second-order linear equations. First-order linear systems with elementary linear algebra. Phase-plane analysis with applications. Boundary value problems and an introduction to partial differential equations.

5514. INTEGRAL EQUATIONS. (4 cr; prereq 3261 or 5512 or equiv or #; does not carry grad cr for math majors)
Integral equations; Fredholm formula, Neumann series, Laplace transforms, successive approximations, and numerical methods. Relation of integral equations to systems of linear algebraic equations and to differential equations.

5521-5522-5523. INTRODUCTION TO ORDINARY DIFFERENTIAL EQUATIONS. (4 cr per qtr; prereq one soph-level sequence or #; abstract math recommended)
5521: Existence and uniqueness theorems; successive approximations; differential inequalities; linear systems; fundamental matrix solutions; linear systems with constant coefficients; variation of parameters. 5522: Phase plane analysis; Poincaré-Bendixson theory; linear and nonlinear oscillations; stability theory; asymptotic behavior of solutions; control theory. 5523: Power series solutions, majorant method; regular and irregular singular points; error estimates, perturbation methods.

5531-5532-5533. DYNAMICAL SYSTEMS AND CHAOS. (4 cr per qtr; prereq multivariable calculus, linear algebra)
Introduction to dynamical systems theory, emphasizing iteration of mappings of line, circle, and plane. Fixed points, periodic points, stability, bifurcations, invariant Cantor sets, rotation number, Smale horseshoe, fractal dimension, Julia sets, Mandelbrot sets, nonlinear oscillations, computer experiments.

5567. FOURIER SERIES AND BOUNDARY VALUE PROBLEMS. (4 cr; prereq 3261 or equiv or #; 3262 recommended; does not carry grad cr for math majors)
Partial differential equations of theoretical physics. Fourier series, proof of convergence, orthogonal systems. Sturm-Liouville systems, solution of boundary value problems by separation of variables, applications.

5568. ELEMENTARY THEORY OF COMPLEX VARIABLES. (4 cr, §3541, §5572; prereq 3252 or equiv)
Derivative and integral of a function of a complex variable. Cauchy's integral theorem and formula, residues. Application to evaluation of integrals, conformal mapping.

5569. OPERATIONAL MATHEMATICS. (4 cr, §5573; prereq 5568)
Laplace transforms, Fourier transforms, inversion theorems; applications to differential equations.

5571-5572-5573. ELEMENTARY PARTIAL DIFFERENTIAL EQUATIONS. (4 cr per qtr, §5568 for 5572 and for 5573; prereq 5613 or §5608)
Partial differential equations of theoretical physics, one-dimensional wave equation, characteristics, classification of second-order equations, heat and Laplace equations, uniqueness, maximum principle, orthogonal systems, Fourier series, separation of variables. Complex numbers, derivatives and integrals of analytic functions, elementary functions and their geometry, Cauchy's integral theorem and formula, Laurent expansions, evaluation of contour integrals by residues. Fourier and Laplace transforms and their inversion, method of residues, applications to ordinary and partial differential equations, applications to heat, wave, and Laplace equations.

5606-5607-5608. ADVANCED CALCULUS: A RIGOROUS APPROACH. (4 cr, §5612 for 5606, §5613 for 5607, §5614 for 5608; prereq 3252 or equiv, §3262; does not carry grad cr for math majors)
Basic analysis course at a more concrete level than 5612-5613-5614. Foundations of analysis: completeness of the line, limits, convergence, continuity, integration. Analysis on the line and in Euclidean space. Other topics chosen by instructor.

5612-5613-5614. INTRODUCTION TO ANALYSIS. (4 cr per qtr; principally for non-math grad students and math undergrads planning grad work; prereq 3252 or equiv, §3262)
Theory of real numbers; elements of point set theory; limits; differentiation; multivariable analysis.

5679. PROBABILITY. (4 cr, §5681, §Stat 5131; prereq 3252 or equiv; not recommended for those going on in probability or statistics; does not carry grad cr for math majors)
Probability spaces, expectation; conditional probability and expectation, probability distributions and densities, repeated trials and independence.

5681-5682-5683. PROBABILITY AND STOCHASTIC PROCESSES. (4 cr per qtr, §5679 and §Stat 5131 for 5681; prereq 3252 or equiv; §3262 recommended)
Logical development and various applications of probability. Probability spaces, random variables and their distributions and expected values, law of large numbers and central limit theorem, generating functions. Topics from many random walks and Markov chains, branching processes. Poisson point processes, martingales, stationary sequences, second-order processes, stochastic differential equations.

5701. ENUMERATIVE COMBINATORICS. (4 cr; prereq 3251 or equiv; 3xxx linear algebra recommended)
Basic enumeration. Sets, permutations, distributions, partitions, generating functions (exponential and ordinary), recurrence relations, methods of inclusion-exclusion, and Polya theory.

5702. GRAPH THEORY AND OPTIMIZATION. (4 cr; prereq 3251 or equiv; 3xxx linear algebra recommended)
Basic concepts in graph theory. Connectedness, Hamiltonian and Eulerian paths, trees, colorings, and matchings. Topics in optimization: networks, flows, spanning trees, and graph algorithms. Definitions and examples of designs, Latin squares, and codes.

5703. CONSTRUCTIVE COMBINATORICS. (4 cr; prereq 5701, knowledge of a computer language)
Algorithmic and bijective approaches to permutations, subsets, trees, tableaux, partitions, ranking and unranking algorithms. Connections with generating functions. Lagrange inversion formula.

5900. TUTORIAL COURSE IN ADVANCED MATHEMATICS. (Cr ar; prereq #)
Qualified students whose needs are not met by courses offered may make arrangements to study the content of other graduate courses regularly offered by the department.

8000!. PREPARATION FOR TEACHING COLLEGE MATHEMATICS. (2 cr; prereq math PhD student beyond 1st yr in good standing, #)
Teaching/learning, incorporating new approaches in teaching, issues in math education, components and expectations of being a college math professor.

8140-8141-8142. APPLIED LOGIC. (3 cr per qtr; prereq #)
8140: Theory of computability; Turing machines, partial recursive functions, recursive functions, primitive recursive functions, Kleene Normal Form, Smn-theorem, recursion theorem, reducibilities and degrees of unsolvability; complexity of computation-polynomial time, nondeterministic polynomial time, and polynomial space computabilities, $P=NP$ problem. *8141:* Propositional and predicate logic with selected applications to computer science (e.g., program verification, machine proving, database theory). *8142:* Selected topics.

8150-8151-8152. AXIOMATIC SET THEORY. (3 cr per qtr; prereq 5162-5163-5164 or #; offered alt yrs)
Axiomatic development of set theory, set theory as a foundation for mathematics. Consistency and independence of the axiom of choice, the continuum hypothesis and other questions, theory of types, theory of categories and other alternative systems.

8166-8167-8168. RECURSION THEORY. (3 cr per qtr; prereq 5162-5163-5164 or #; offered alt yrs)
Detailed analysis of the concept of computability—including a discussion of the various equivalent definitions of this concept; primitive, general, and partial recursive functions—the enumeration theorem and the recursion theorem: recursive and recursively enumerable sets (including the priority method); relation between recursively enumerable sets and formal theories, creative and effectively inseparable theories; arithmetical and analytic hierarchies—including a discussion of constructive ordinals; higher order computability.

8172-8173-8174. MODEL THEORY. (3 cr per qtr; prereq 5164 or #; offered alt yrs)
Study of the interrelationship between formal languages (first order, as well as higher order, infinitary, etc.) and model structures based on the notion of satisfaction (two-valued, as well as other, e.g., Boolean valued); basic theorems (e.g., Lowenheim-Skolem theorems, compactness theorems); characterization of classes (e.g., EC, PC); preservation of properties under algebraic constructions; ultraproducts; special kinds of structures (e.g., homogeneous, saturated); applications to classical branches of mathematics.

8181-8182-8183. FORMAL LANGUAGES AND AUTOMATA. (3 cr per qtr; prereq 5162, ¶5163, ¶5164; offered when feasible)

8190-8191-8192. TOPICS IN LOGIC. (1-3 cr per qtr; prereq 5164 or #)

8200-8201-8202. GENERAL ALGEBRA. (3 cr per qtr; prereq 5284 or #)
8200: Sets with compositions. Groups and semigroups with operators. Homomorphism theorems. Jordan-Hölder theorem. Abelian groups. Finitely generated groups. Rings, modules, and fields. Ideals and quotients. Commutative rings, especially polynomial and power series algebras. Unique factorization. Prime fields, finite fields. Finite field extensions. *8201:* Vector spaces and modules. Duality, space of linear maps. Multilinear algebra; tensor products; special algebras. Application to algebraic field extensions; Galois theory. Transcendental field extensions. Valuations. *8202:* Simple and semisimple rings. Chain conditions on rings and modules. Wedderburn theory. Representations of finite groups.

8203-8204-8205. ALGEBRAIC GEOMETRY. (3 cr per qtr; prereq 8202, #; offered alt yrs)
Basic concepts of algebraic geometry: properties of curves, surfaces, varieties, schemes, morphisms, and cohomology of coherent sheaves.

8206-8207-8208. ALGEBRAIC NUMBER THEORY. (3 cr per qtr; prereq 5342, 8202 or #; offered alt yrs)
Local and global fields, decomposition of primes, generalized L-functions, local and global class field theory.

8209-8210. HOMOLOGICAL ALGEBRA. (3 cr per qtr; prereq 8202 or #; offered when feasible)

8211-8212. COMMUTATIVE ALGEBRA. (3 cr per qtr; prereq 8202 or #; offered when feasible)

Graduate Programs

8245-8246-8247. GROUP THEORY. (3 cr per qtr; prereq 8202 or #)

Sylow theorems, p -groups, nilpotent groups, solvable groups, the Jordan-Holder theorem for groups with operators, automorphism groups, permutation groups, representation theory for finite groups, finite simple groups, free groups, free products.

8250-8251-8252. TOPICS IN GROUP THEORY. (1-3 cr per qtr; prereq #)

8263-8264-8265. TOPICS IN ALGEBRAIC GEOMETRY. (1-3 cr per qtr; prereq #)

8266-8267-8268. TOPICS IN NUMBER THEORY. (1-3 cr per qtr; prereq #)

8270-8271-8272. LIE GROUPS AND LIE ALGEBRAS. (3 cr per qtr; prereq 8202 or #)
Groups of matrices, topological groups, local groups, Lie algebras and Lie groups. Structure theorems, classification of semisimple Lie algebras. Topics in homogeneous spaces and representations.

8290-8291-8292. TOPICS IN ALGEBRA. (1-3 cr per qtr; prereq 8202 or #)

Topics vary depending on instructor and demand. Consult the instructor about topics to be covered during a particular quarter.

8300-8301-8302. MANIFOLDS/TOPOLOGY. (3 cr per qtr; prereq 5282-5283, 5341 or #)

Covering spaces and the fundamental group; homology and cohomology of topological spaces, invariance of domain, degree of a mapping; smooth manifolds, Sard's Theorem, differential forms, tensor fields, integration on manifolds; metric geometry, curvature, Gauss-Bonnet Theorem.

8306-8307-8308. ALGEBRAIC TOPOLOGY. (3 cr per qtr; prereq 5342 or #; offered alt yrs)

Axiomatic homology theory; various homology and cohomology theories; introduction to homotopy theory.

8330-8331-8332. DIFFERENTIAL TOPOLOGY. (3 cr per qtr; prereq 5342 or #; offered alt yrs)

General introduction to algebraic topology, as far as is needed for development of special tools of differential topology. Theory and applications of differentiable sheaves.

8342-8343-8344. TOPOLOGICAL DYNAMICS. (3 cr per qtr; prereq 5341 or #; offered when feasible)

8360-8361-8362. TOPICS IN TOPOLOGY. (1-3 cr per qtr; prereq 8308 or #)

8365-8366-8367. RIEMANNIAN GEOMETRY. (3 cr per qtr; prereq 5377 or #)

Differentiable manifolds. Riemannian metric. Exterior differential calculus. Methods of global differential geometry. Differential equations of mathematical physics. Tensor algebra.

8370-8371-8372. TOPICS IN GEOMETRY. (1-3 cr; prereq #)

8380-8381-8382. TOPICS IN ADVANCED DIFFERENTIAL GEOMETRY. (1-3 cr per qtr; prereq #)

8406-8407-8408. ADVANCED METHODS OF APPLIED MATHEMATICS. (3 cr per qtr; prereq 5459 or equiv or #)

Fundamental linear problems; linear transformations and quadratic forms, orthogonal series, linear integral equations, calculus of variations, eigenvalue problems and expansions, singular eigenvalue problems and expansions.

8430-8431-8432. MATHEMATICAL THEORY OF FLUID DYNAMICS. (3 cr per qtr; prereq 5573, 5602 or #)

Equations of continuity and motion. Kinematics, Bernoulli's theorem, stream function and velocity potential. Applications of conformal mapping. Foundations of thermodynamics. One-dimensional flow. Plane flow of gas, characteristic method, hodograph method. Singular surfaces, shock waves and shock layers. Viscous flow, Navier-Stokes equations, exact solutions; uniqueness, stability, and existence theorems.

8441. VARIATIONAL METHODS IN EIGENVALUE PROBLEMS. (3 cr; prereq 5573 or #)

Minimum, maximum-minimum, and minimum-maximum characteristics of eigenvalues and eigenvectors ("natural frequencies" and "normal modes") of various differential operators occurring in mathematical physics. Methods yielding upper and lower bounds for eigenvalues. Approximation of eigenvectors.

8445-8446-8447. NUMERICAL ANALYSIS OF ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS. (1-3 cr per qtr; prereq 5567, 5571 or equiv, 5513 or equiv)

Finite element and finite difference methods for elliptic boundary value problems (e.g., Laplace's equation) and solution of the resulting linear systems by Gaussian elimination, SOR, conjugate gradients. Numerical methods for parabolic equations (e.g., heat equation) and hyperbolic equations (e.g., wave equation). Methods for the system of linear elasticity, Navier-Stokes equation, and systems of nonlinear conservation laws.

8450-8451-8452. TOPICS IN NUMERICAL ANALYSIS. (1-3 cr per qtr; prereq #)

8460-8461-8462. MATHEMATICAL PROBLEMS IN THEORETICAL PHYSICS. (3 cr per qtr; prereq #)
Topics vary yearly.

8470-8471-8472. TOPICS IN THE MATHEMATICAL THEORY OF CONTINUUM MECHANICS. (1-3 cr; prereq 5573 or #)
Topics vary yearly.

8480-8481-8482. SELECTED TOPICS OF CELESTIAL MECHANICS. (1-3 cr per qtr; prereq #)

8500-8501-8502. THEORY OF ORDINARY DIFFERENTIAL EQUATIONS. (3 cr per qtr; prereq 5614 or equiv, 5521 or #)
Existence and uniqueness theorems, linear and nonlinear differential equations, singular points and series solutions, eigenvalue problems, oscillation and comparison theorems, stability of solutions, periodic solutions, Poincaré-Bendixson theory, equations of Duffing and van der Pol.

8540. TOPICS IN DIFFERENTIAL AND DIFFERENCE EQUATIONS. (1-3 cr; prereq #)

8550-8551-8552. THEORY OF PARTIAL DIFFERENTIAL EQUATIONS. (3 cr per qtr; prereq 5614 or equiv, 5521 or #)
Derivation of special equations. First-order equations. Classification. Cauchy-Kowalewski theorem. Hyperbolic equations; general theory of characteristics, first-order systems, energy method, special topics. Elliptic equations; maximum principle and applications, general theory of the Laplace equation, potential theory, boundary value problems. High order parabolic equations.

8560-8561-8562. CALCULUS OF VARIATIONS AND MINIMAL SURFACES. (3 cr per qtr; prereq 5614 or equiv, 5521 or #: offered when feasible)**8570-8571-8572. INFINITE DIMENSIONAL DYNAMICAL SYSTEMS.** (3 cr per qtr; prereq 5614 or equiv, 5521 or #)

Existence, uniqueness, and continuity theorems for differential-delay equations and nonlinear parabolic partial differential equations. Concepts from dynamical systems, including stability, dichotomies, and finite dimensional structures. Existence and approximation of invariant manifolds. Bifurcation theories in infinite dimensions.

8590-8591-8592. TOPICS IN PARTIAL DIFFERENTIAL EQUATIONS. (1-3 cr per qtr; prereq 8609, 8552 or #)

8600-8601-8602. REAL ANALYSIS. (3 cr per qtr; prereq 5614 or equiv or 8702 or #)
Review of fundamental concepts of analysis, elementary set theory. Measures and measure spaces, measurable functions, Borel and Lebesgue measure. Integration, fundamental convergence theorems, Radon-Nikodym theorem, Fubini's theorem. Differentiation of functions of a single variable; arc length. Metric, linear, and Banach spaces; L_p spaces, representation of linear functionals; $C(X)$ spaces, Riesz representation theorem, Stone-Weierstrass theorem, Hilbert space, compact operators.

8620-8621-8622. THEORY OF SINGULAR INTEGRALS. (3 cr; prereq 8602 or equiv or #)
Differentiation of multiple integrals, maximal functions, covering theorems; BMO; singular integrals, scalar and vector-valued; Littlewood-Paley theory, multilinear singular integrals operators; Stein's work on differentiation through surface averages, dimensional invariance of maximal constants for $p > 1$; multiplier theory, relation to differentiation theory; restrictions of Fourier transforms; Hp theory.

8640-8641-8642. TOPICS IN REAL ANALYSIS. (1-3 cr per qtr; prereq 8602 or #)

8650-8651-8652. THEORY OF PROBABILITY. (3 cr per qtr; prereq 8602 or #)
Topics in modern probability theory, including recent advances in limit theorems and introduction to stochastic processes.

8653-8654. INTRODUCTION TO STOCHASTIC PROCESSES. (3 cr; prereq 8650 or 8656 or 8600, 5681-5682 or #)

Weak convergence of measures, Kolmogorov's consistency theorem, Brownian motion, Poisson process, conditioning, martingales, Markov processes, stationary processes, stochastic integration, stochastic control and filtering. Emphasis on parts of theory most useful to applied fields.

8656-8657-8658. MEASURE THEORY AND PROBABILITY. (3 cr per qtr; prereq 5614 or #)
Measure and measure spaces, measurable functions, integration, fundamental convergence theorems, Radon-Nikodym theorem, Fubini theorem, Kolmogorov consistency theorem. Random variables, distribution functions, characteristic functions, expectation, conditional expectation, martingales, sums of independent random variables, limit theorems including rates of convergence and the Berry Esseen theorem.

8668-8669-8670. INTRODUCTION TO COMBINATORIAL THEORY. (3 cr per qtr; prereq #)
8668: Basic enumeration, including sets and multisets, permutation statistics, inclusion-exclusion, permutations with restricted position, Ferrers diagrams, integer and set partitions, unimodal sequences, involutions, and Polya theory. 8669: Partially ordered sets, including lattices, distributive and semimodular lattices, chains, incidence and Mobius algebras, Mobius inversion, Zeta polynomials, Eulerian and binomial posets, generating functions, P-partitions, and Sperner theorems. 8670: Further topics in enumeration, including symmetric functions, Schensted correspondence, and standard tableaux; non-enumerative combinatorics, including graph theory and coloring, matching theory, connectivity, flows in networks, codes, and extremal set theory.

8672, 8673, 8674. TOPICS IN COMBINATORIAL THEORY. (1-3 cr per qtr; prereq #)

Combinational geometry, matroids, enumeration, ordered sets and Mobius inversion. Graph theory, coloring problems, matching theory, design, large sets, statistical physics, finite geometry, linear programming and algorithms.

8690-8691-8692. TOPICS IN THE THEORY OF PROBABILITY. (1-3 cr per qtr; prereq 8652 or #)

8700-8701-8702. COMPLEX ANALYSIS. (3 cr per qtr; prereq 5614 or equiv or 5573 or #)
Review of fundamental concepts of analysis, real and complex numbers, analytic functions and conformal mapping. Cauchy's theorem and related concepts, sequences of analytic functions. Taylor and Laurent series, infinite products; residue calculus; the argument principle. Analytic continuation, algebraic functions.

8790-8791-8792. TOPICS IN THE THEORY OF ANALYTIC FUNCTIONS. (1-3 cr per qtr; prereq 8702 or #)

Graduate Programs

8800-8801-8802. FUNCTIONAL ANALYSIS. (3 cr per qtr; prereq 8602 or #)

Basic properties of topological, locally convex and Banach spaces; theorems of Hahn-Banach, Krein-Milman, Mazur, Banach-Steinhaus, Eberlein; also open mapping, closed graph, uniform boundedness, Riesz convexity theorems; resolvents, spectra, spectral theorem in Hilbert space, integration of vector-valued functions.

8990-8991-8992. READING AND RESEARCH. (Cr ar)

Mathematics Education

See Curriculum and Instruction.

M.D./Ph.D.

A central theme of the M.D./Ph.D. program, a dual-degree program in the School of Medicine and the Graduate School, is the interface between basic biomedical science and clinical practice, and the constant interplay between them. The training period, which is typically about seven years, combines coursework, fundamental biomedical research, and clinical training culminating in a dissertation, a Ph.D. degree, and an M.D. degree. Students selected for the program receive a yearly stipend approximately equal to or greater than that received by predoctoral trainees supported by the National Institutes of Health (NIH) and also have their tuition paid. This support extends throughout the training period. The program at the University of Minnesota has been awarded a Medical Scientist Training Program grant by NIH.

Curriculum—The M.D./Ph.D. training period is divided into three phases: 1) two years of basic biomedical sciences coursework. During this period students select an area of basic biomedical science, choose a research adviser to supervise their thesis research, and begin their research; 2) approximately three years of coursework and research leading to the Ph.D. thesis. This research can be done in *any* graduate program approved by the Graduate School and the M.D./Ph.D. advisory committee, but most likely would be in anatomy, cell and developmental biology, biochemistry, genetics, microbiology, neuroscience, pathobiology, pharmacology, physiology,

biomedical engineering, or biomedical science; and 3) approximately one year of clinical rotations.

Research projects take place in the laboratories of carefully selected, outstanding faculty who act as preceptors in the program. Research projects for the Ph.D. portion of the program have recently been carried out in the following areas: animal virology, biochemistry, cell biology, developmental biology, immunobiology, mechanism of pathogenicity, neurobiology, physical biochemistry, and plant biology.

Prerequisites for Admission—Applicants must have had excellent grades as undergraduates, outstanding scores on the MCAT examination or Graduate Record Examination, and strong letters of recommendation. Applicants must also have taken part in some research as undergraduates and have at least one letter of reference from a research adviser.

It is also possible for students in their first year of Medical School or Graduate School to transfer to the M.D./Ph.D. program; essentially the same prerequisites apply.

Special Application Requirements—Applications must be submitted to the Medical School through the American Medical College Application Service and to the Graduate School through the M.D./Ph.D. program. An M.D./Ph.D. selection committee reviews the applications and makes a recommendation to the Graduate School and to the Medical School admissions committees. Once accepted, students are admitted by the Graduate School to any participating graduate program of their choice. The deadline for application to the combined M.D./Ph.D. program is December 15.

For Further Information and Applications—Contact the M.D./Ph.D. Program, Medical School, University of Minnesota, Box 293 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/625-3680; fax 612/626-6800; e-mail mdphd@lenti.med.umn.edu).

Mechanical Engineering and Industrial Engineering

Regents' Professor: Richard J. Goldstein, *head*; Ernst R. G. Eckert (*emeritus*); Benjamin Y. H. Liu

Professor: Darrell A. Frohrib, *co-director of graduate studies*; Thomas H. Kuehn, *co-director of graduate studies*; Sant Ram Arora; Avram Bar-Cohen; Perry L. Blackshear (*emeritus*); Max Donath; Arthur G. Erdman; Edward A. Fletcher; Joachim V. R. Heberlein; Warren E. Ibele; David B. Kittelson; Francis A. Kulacki; Tarald O. Kvalseth; Jack L. Lewis; Virgil A. Marple; Peter H. McMurry; Katsuhiko Ogata; Suhas V. Patankar; Emil Pfender; David Y. H. Pui; Subbiah Ramalingam; James W. Ramsey; Donald R. Riley; Yecheiel Shulman; Terrence W. Simon; Ephraim M. Sparrow; Patrick J. Starr; Kim A. Stelson; Kumar K. Tamma

Associate Professor: Thomas R. Chase; Jane H. Davidson; Kevin J. Dooley; William K. Durfee; Steven L. Girshick; Barney E. Klamecki; Charles J. Scott; Paul J. Strykowski

Assistant Professor: John Abraham; Saifallah Benjaafar; John C. Bischof; David L. Hofeldt; Shahruk A. Irani; Susan C. Mantell; Jeffrey H. Vogel

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—Mechanical Engineering: M.S.M.E. (Plan A and Plan B), M.M.E., and Ph.D.; Industrial Engineering: M.S.I.E. (Plan A and Plan B), M.I.E., and Ph.D.

Curriculum—Coursework and research for all graduate degrees are offered in arc technology; bioengineering; biomechanics; combustion; computer-aided design; computer-aided manufacturing; computer graphics; control systems; design; energy conservation; environmental control; environmental engineering; fluid mechanics; heat and mass transfer; history of science and technology; human factors engineering; industrial engineering; innovative methodologies; integration of structural and environmental systems; lubrication; manufacturing engineering; particle technology; plasma chemistry; plasma heat transfer; power, propulsion, and applied thermodynamics; socio-economic systems; solar energy; solar processing and thermochemistry; statistics; structures; systems dynamics; technology assessment; thermal energy storage; thermal environmental engineering; thermodynamics;

transportation; tribology; vibration; and interdisciplinary finite element methodology. Additional instructional and research programs can be formulated.

Prerequisites for Admission—An undergraduate degree in engineering or in a closely related scientific field such as physics, chemistry, or mathematics, is required. Unusually well-qualified students may be admitted directly to the Ph.D. program with a baccalaureate degree.

Special Application Requirements—Graduate Record Examination General Test scores are required for admission and also are used occasionally in evaluating requests for financial aid. For the Ph.D. program, three letters of recommendation from senior faculty members at the previous educational institution are required, including one from the master's degree adviser. Students are admitted in the fall and spring quarters only.

Master's Degree Requirements—For the M.S.M.E. and M.S.I.E. degrees, students are required to complete two credits of graduate seminars. The final examination is oral. For Plan B students, the number of Plan B papers required is from one to three, depending on their length, and is determined in consultation with the adviser. The papers may derive from any of the courses offered for majors in the graduate program or may address topics chosen by a graduate faculty member and the student. For the M.M.E. and M.I.E. degrees, see Professional Master's Degree in Engineering in the General Information section of this bulletin.

Doctoral Degree Requirements—Students are required to complete three credits of graduate seminars.

Language Requirements—None.

For Further Information and Applications—Contact the Mechanical Engineering and Industrial Engineering Programs, University of Minnesota, 121 Mechanical Engineering, 111 Church Street S.E., Minneapolis, MN 55455 (612/625-2009; fax 612/624-1398; e-mail gradinfo@me.umn.edu).

Graduate Programs

IEOR 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

IEOR 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

IEOR 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

ME 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

ME 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

ME 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Mechanical Engineering (ME)

Graduate Credit Courses for Nonmajors

5190. ADVANCED ENGINEERING PROBLEMS. (2-4 cr; open to upper div students; prereq approved department permission form)
Special investigations in various fields of mechanical engineering and related areas including independent study project.

5254. DESIGN MORPHOLOGY WITH APPLICATIONS. (4 cr; prereq upper div mechanical engineering major, 3201-3203-3205, 3303, 5342; 2 lab hrs per wk)
Detailed study of design problem formulation and structure of the open-ended solution process based on design morphology. Case studies and student projects.

5260. ENGINEERING MATERIALS AND PROCESSING. (4 cr; prereq Chem 1014, Phys 1291, AEM 3016, MatS 3400, CSci 3101 or similar course in engineering computer language [FORTRAN], upper div ME student; 3 lect and 1 rec hrs per wk, safety glasses required)
Introduction to materials and processing including physical and metallurgical properties, consolidation, etc. Material processing including machining, welding, and deformation processes.

5342. HEAT TRANSFER. (4 cr; prereq 3301, CE 3400 or AEM 3200, upper div IT or grad student or forest products student; 4 lect hrs per wk)
Steady and unsteady conduction of heat. Convection heat transfer in boundary layer and duct flows; forced and free convection; condensation and boiling; heat exchanger. Heat transfer by thermal radiation; radiative properties of black bodies and real surfaces.

Advanced Courses in Mechanical Engineering

Design and Controls

5203. ADVANCED ANALYSIS AND SYNTHESIS OF MECHANISM SYSTEMS. (3-4 cr; prereq 3203 or equiv, IT or grad student; computer programming desirable)
Analytical methods of kinematic, dynamic, and kinetoelastodynamic analysis and synthesis of mechanisms. Computerized design for function, path, and motion generation based on Burmeister theory.

5205. CREATIVITY IN ENGINEERING DESIGN. (3-4 cr [1 cr term paper option]; prereq 3203, 3205, 3303, 5342 or equiv, IT or grad student; 3 lect hrs per wk)

Role of creative action at various stages in morphology of the design process. Creative decision making in developing design criteria, alternative solutions, and their evaluation.

5207. EXPERIMENTAL STRESS ANALYSIS. (4 cr; prereq AEM 3016, IT upper div or grad student; 3 lect and 3 lab hrs per wk)
Experimental application and theoretical evaluation of methods of stress analysis. Strain gages, surface coatings, photoelasticity techniques. Design of transducing systems using strain.

5209. FRICTION AND LUBRICATION. (3-4 cr [1 cr term paper option]; prereq CE 3400, AEM 3200 or equiv, IT or grad student; 3 lect hrs per wk)
Solid friction mechanism and boundary lubrication. Hydrodynamic and hydrostatic lubrication theory applied to bearing design. Introduction to gas bearings.

5220. COMPUTER-AIDED DESIGN. (4 cr; prereq 3020, IT or grad student, 3rd-yr ME courses, FORTRAN programming; 3 lect and 1 rec hrs per wk)
Application of computer-aided design techniques to engineering design. Engineering design projects/case studies using computer implementation of selected numerical techniques, design optimization, and computer graphical presentation of results.

5221. COMPUTER GRAPHICS IN DESIGN. (4 cr; prereq 5220 or #, IT or grad student; 3 lect and 2 lab hrs per wk)
Introduction to software techniques and hardware for applications of computer graphics to mechanical engineering design. Modeling and analysis of systems using graphical techniques to enhance human-machine interaction.

5225. FINITE ELEMENTS IN MECHANICAL DESIGN. (4 cr; prereq 3205, 5342, programming, IT or grad student)
Introduction to fundamentals of finite element analysis, oriented to mechanical engineering design applications. Extensive examples from industry; student projects involve actual set-up and solution of descriptive problems using industry-accepted analysis codes and interactive graphics for model generation.

5226. FINITE ELEMENT METHODS IN MECHANICAL ENGINEERING I. (4 cr; prereq Math 3221, AEM 3016, FORTRAN programming, IT upper div or grad student)
Introduction to computational methods, direct stiffness approach, elasticity, and energy methods. Interpolation, development of simple finite elements, assembling, and solution methods. Programming considerations and design application.

5227. FINITE ELEMENT METHODS IN MECHANICAL ENGINEERING II. (4 cr; prereq 5226 or #, programming, IT upper div or grad student) Fundamental concepts of FEM; variational and weighted residual methods; interpolation functions; linear/higher-order elements; methodology and formulation for one-end two-dimensional problems in structural mechanics and heat transfer; axi-symmetric problems; solution schemes for linear/nonlinear static/steady-state models; computer implementation.

5244. VIBRATION ENGINEERING. (4 cr; prereq 3201 or equiv, IT or grad student; 4 lect hrs per wk) Applications of theory of vibration to design and optimization of isolators, detuning mechanisms, viscoelastic suspensions and structures.

5255. ENGINEERING DESIGN PROJECT. (4 cr [may be repeated for cr]; prereq 5254, ME upper div; 1 lect and 2 lab hrs per wk) Participation in solution of systems design problems with well-developed criteria, order-of-magnitude evaluation of alternatives, and generation of preliminary design.

5271. ROBOTICS. (3-5 cr [2 cr lab option]; prereq IT or grad student, 5283 or equiv) Analysis and design of computer control of multi-degree-of-freedom mechanical systems. Robotics, multijointed manipulator kinematics, dynamics, control and integration with sensors. Position, velocity, path, force control. Lab projects.

5272. NON-CONTACT SENSING. (3-5 cr [2 cr lab option]; prereq IT or grad student, 5271 or equiv) Optical- and acoustic-based sensing for inspection and closed loop control. Integration with robots. Mathematics of image processing as used in sensors for inspection, part classification, tracking, and ranging. Lab projects.

5275. COMPUTER CONTROLLED EXPERIMENTATION. (4 cr; prereq 5283 or equiv; 3 lect and 2 lab-rec hrs per wk) A/D and D/A conversion, Sampling Theorem, DFT and FFT, analog and digital filter design, simulation, real time micro- and mini-computer control.

5283. INDUSTRIAL INSTRUMENTATION AND AUTOMATIC CONTROL. (4 cr; prereq 3201 or equiv, IT or grad student; 2 lect and 2 lab hrs per wk) Basic theory of linear feedback control systems. Transfer function representation of electromechanical, pneumatic, and hydraulic components. Industrial automatic controllers. Root-locus and frequency-response methods of analysis and design.

5284. CONTROL SYSTEMS. (4 cr; prereq 5283 or equiv, IT or grad student; 4 lect hrs per wk) State-space analysis of discrete-time and continuous-time control systems. Z-transform method, Liapunov stability analysis. Controllability and observability. Introduction to optimal control and adaptive control.

5285. CONTROL SYSTEMS LABORATORY. (2 cr; prereq IT major, 5283 or equiv) Experiments that illustrate and apply control theory to mechanical engineering systems. Measurement techniques, calibration, timing of controls, characterization of sensors and control circuits.

5288. MODELING AND SIMULATION OF DYNAMIC SYSTEMS. (4 cr; prereq 5283 or equiv, IT or grad student; 3 lect and 1 lab-rec hrs per wk) Generalized approach to developing models for describing complex dynamic interactions between mechanical, electrical, fluid, and thermal systems. Analog and digital simulation. Applications to electromechanical devices, transducers, hydraulic power, and thermofluid systems.

8203. ADVANCED PLANAR LINKAGE SYNTHESIS. (3 cr; prereq 5203) Burmester Theory: review, special cases, alternate formulations; dimensional synthesis of complex linkages; solution rectification; application of graph theory to mechanism synthesis; optimization as linkage synthesis technique.

8210. ADVANCED VIBRATION ENGINEERING. (3 cr; prereq 5244) Advanced dynamics of vibration; vibration in mechanical, electrical, and equivalent systems.

8211-8212-8213. ADVANCED APPLIED DYNAMICS. (3 cr per qtr; prereq 5244) Application of principles of dynamics to selected mechanical engineering problems.

8221. ADVANCED COMPUTER GRAPHICS TOPICS. (4 cr; prereq 5221 or equiv) Advanced 3D computer graphics topics in computational geometry, including 3D curve and surface algorithms, geometric modeling. Applications in computer-aided design and manufacturing.

8226. FINITE ELEMENT METHODS FOR NONLINEAR/LINEAR TRANSIENT/DYNAMIC PROBLEMS. (4 cr; prereq 5227, programming course or #) Concepts and techniques of Finite Element Methods; introduction to nonlinear/linear and transient/dynamic problems in engineering; formulations for conduction/convection/radiation, phase change and convective diffusion models; structural dynamics and wave propagation; stability, convergence, and accuracy for algorithms in structural dynamics and computational heat transfer.

8227. THE FINITE ELEMENT METHOD IN METAL-FORMING PROCESSES. (4 cr; prereq 5227, AEM 8511, AEM 8522, programming course or #) Finite Element Method (FEM) fundamentals; material and geometric nonlinearities; FEM for inelastic small and finite deformation problems; constitutive equations for finite deformation inelasticity; adaptive and deforming FEM techniques; applications to metal-forming operations (e.g., extrusion, rolling, casting).

8280. MULTIVARIABLE CONTROL SYSTEMS I.

(4 cr; prereq 5283 or equiv)

Integrated state space and frequency domain description of linear multivariable feedback control systems based on models of physical process; realizations and structures of multi-input, multi-output linear systems; multivariable system analysis, stability, controllability, observability, poles, zeros, and modal properties; Eigenstructure assignment; multivariable Nyquist criterion in singular value-based robustness test; impact of unstable poles, nonminimum phase zeros and time delays; extensive computer-aided homework.

8281. MULTIVARIABLE CONTROL SYSTEMS II.

(4 cr; prereq 8280)

Unified computer-aided design of multivariable feedback control systems using time and frequency domain concepts; loop-shaping concepts via singular value plots; performance and robustness trade-offs; derivation of LQR and its properties in frequency domain; Kalman filter and its properties in time and frequency domain; linear quadratic gaussian compensator with loop-transfer recovery; recent methods in compensator design; extensive computer-aided homework.

Production Engineering

5262. MATERIAL WORKING AND FABRICATION PROCESSES.

(4 cr; prereq 5260, IT or grad student; 3 lect and 1 rec hrs per wk)

Theory and application of joining techniques, welding, brazing, and adhesive bonding. Metal forming operations, rolling, swaging, drawing, and similar operations. Inspection and test methods to control and evaluate fabrication processes including X-ray, magnetic, metallographic, and chemical methods.

5264. MATERIAL CONSOLIDATION PROCESSES.

(4 cr; prereq 5260, IT or grad student; 3 lect and 1 rec hrs per wk)

Theory and practice of material consolidation including casting and powder metal processes. Composite materials techniques.

5268. PROPERTIES AND FABRICATION OF PLASTICS.

(4 cr; prereq 5260, IT or grad student; 3 lect and 1 lab-rec per wk)

Materials, equipment, and processes for fabrication of plastics. Principles of products and tool design. Hydraulic and temperature circuit control for equipment.

5270. MATERIALS—DESIGN REQUIREMENTS.

(4 cr; prereq 5260, IT or grad student; 3 lect and 1 rec hrs per wk)

Fundamental properties of engineering materials including fabrication, treatment, physical and corrosive properties. Failure mechanism, cost and value analysis as related to material selection and specification.

Thermodynamics and Heat Transfer

5343. INTRODUCTION TO THERMAL DESIGN.

(4 cr; prereq 5342, 5254 or equiv, upper div IT or grad student)

Elements of thermal design. Development of design philosophy and governing relations for thermal configurations, including barriers and enclosures; longitudinal, radial and pin-fins; longitudinal fin arrays. Case studies from diverse thermal application areas, e.g., furnaces and ovens, HVAC systems, solar energy use, and electronic equipment.

5344. THERMODYNAMICS OF FLUID FLOW.

(4 cr, §AEM 5201; prereq CE 3400 or AEM 3200, IT or grad student; 4 lect hrs per wk)

Compressible flow of gases in engineering systems such as nozzles, ducts, combustion chambers, ramjets, pipe lines. Isentropic flow in variable area passages. One-dimensional discontinuities. Flow with wall friction, heat transfer, and mass transfer.

5345. HEAT TRANSFER IN ELECTRONIC EQUIPMENT.

(4 cr; prereq IT or grad student, 5342;

3 lect and 1 rec hrs per wk)

Development and application of analytical models of thermal phenomena in electronic equipment. Thermal characteristics and thermal failure modes of microelectronic components. Packaging configurations used for various microelectronic applications.

5346. INTERMEDIATE HEAT TRANSFER.

(4 cr; prereq 5342, upper div IT or grad student; 4 lect hrs per wk)

Heat transfer fundamentals related to applications. Conduction across thermal contacts, through composite materials, and in unsteady state. Convection in complex fluid flows. Simple turbulence models. Phase change processes (boiling, condensation, melting, freezing). Radiation between surfaces and through participating media. Mass transfer fundamentals and applications; analogy between heat and mass transfer.

5351. COMPUTATIONAL HEAT TRANSFER.

(4 cr; prereq 5342, IT or grad student)

Numerical solution of heat conduction and duct flows. Use of computer program to solve complex problems involving steady and unsteady conduction, fully developed flow and heat transfer in ducts, and other special applications. Case studies illustrate design optimization.

8310. ADVANCED THERMODYNAMICS.

(3 cr; prereq 3303)
Critical examination of thermodynamic principles, equations of state for liquids, gases, and mixtures. Interpretation of thermodynamic functions and applications to processes, reactions, and equilibrium states.

8311. STATISTICAL AND NONEQUILIBRIUM THERMODYNAMICS.

(3 cr; prereq 8310)
Elements of statistical thermodynamics. Equilibrium considerations, equations of state, heat capacities. Transport property predictions, thermal conductivity, viscosity, diffusion. Irreversible effects, metastability, mechanism of two-phase equilibrium. Nonequilibrium effects.

8326. BOILING HEAT TRANSFER AND MULTIPHASE FLOW. (3 cr; prereq 5342 or #)

Phenomena pertaining to boiling heat transfer and multiphase flow; superheat, nucleation, bubble dynamics, interfacial phenomena, boiling crisis, film boiling; flow patterns in two-component two-phase flows, two-phase critical and supercritical flows.

8330. CONDUCTION. (3 cr; prereq 5342)

Steady and unsteady heat conduction with and without heat sources. Change of phase. Classical and approximate solutions.

8331. CONVECTION. (3 cr; prereq 5342)

Fundamentals and applications of heat transfer in presence of fluid motions. Heat transfer in fluids flowing around bodies and in tubes and ducts. Externally driven flows (forced convection) and buoyancy-induced flows (natural convection). Laminar and turbulent flow regimes. Application to heat exchange devices with complex geometries. Convection mass transfer and vapor-liquid phase change.

8332. RADIATION. (3 cr; prereq 5342)

Heat radiation of black bodies and nonblack bodies. Radiation between surfaces and through participating media.

8334. TURBULENT CONVECTION. (3 cr; prereq 8331)

Heat and mass transfer in turbulent flows; turbulent transport, turbulence modeling, high speed flows, viscous dissipation, variable property effects, transpiration, and film cooling.

8351. COMPUTATION OF FLUID FLOW AND HEAT TRANSFER. (3 cr; prereq 5342)

Finite-difference methods of solving equations of motions and energy. Mathematical models for turbulence, radiation, and combustion; their computing implications. Application of prediction procedures to practical situations.

8352. ADVANCED COMPUTATION OF FLUID FLOW AND HEAT TRANSFER. (3 cr; prereq 8351 or #; 3 lect and 1 rec hrs per wk)

Use of computer program to solve complex problems involving fluid flow, heat transfer, and chemical reaction. Advanced models for turbulence and chemical reaction. The finite-element method and other methods of fluid flow computation.

8360. INTRODUCTION TO PLASMA TECHNOLOGY. (3 cr; prereq 5342 or #)

Atomic theory; kinetic gas theory, fundamentals of gaseous electronics; thermal excitation and ionization; nonequilibrium and equilibrium plasmas; local thermodynamic equilibrium (LTE); introduction to irreversible thermodynamics of a fully ionized plasma; plasma equations; thermodynamic functions; collisions cross sections.

8361. INTRODUCTION TO PLASMA TECHNOLOGY. (3 cr; prereq 8360 or #)

The plasma state; plasmas generation; glow discharges; arcs; rf-discharges sparks and pulsed discharges; shock waves. Plasma diagnostics; potential probes; magnetic probes; plasma spectroscopy; microwave diagnostics; short-time and high-speed photography; enthalpy probes; laser methods; interferometry.

8362. INTRODUCTION TO PLASMA TECHNOLOGY. (3 cr; prereq 8360, 8361 or #)

Plasma heat transfer; transport equations; transport properties; heat transfer with and without current flow; electric and magnetic field effects. Plasma applications; arc furnaces; extractive metallurgy; plasma synthesis; plasma welding, spraying, and cutting; MHD power generation; nonthermal plasma processing; thermonuclear fusion.

8370. EXPERIMENTAL METHODS IN HEAT TRANSFER. (3 cr; 3 lect hrs per wk)

Planning experiments: uncertainty, qualification, visualization, analogies; temperature, pressure, heat flux and flow measurements; signal processing and analysis.

8372. OPTICAL DIAGNOSTICS OF FLOW SYSTEMS. (3 cr; prereq IT grad student)

Experimental techniques for measuring velocity, temperature, chemical composition, and particulates in high-temperature flows; basic principles of optics and spectroscopy, instrumentation; laser Doppler anemometry; use of emission and absorption; laser-induced fluorescence; light scattering techniques.

Power, Propulsion, and Applied Thermodynamics

5442. VAPOR CYCLE POWER SYSTEMS. (4-5 cr [1 cr term paper option]; prereq 3303, IT or grad student; 4 lect hrs per wk)

Vapor cycle analysis, regeneration, reheat, compound cycle modifications, combined gas turbine-vapor cycle systems, binary systems. Combustion problems, solar, nuclear, and unusual energy sources for space power systems. Variety of configurations evaluated using steam cycle computer code.

5443. TURBOMACHINERY. (4-5 cr [1-2 cr term paper option]; prereq 3301 or equiv, IT or grad student; 3 lect hrs per wk)

Thermodynamic analysis of energy transfer between fluid and rotor; dimensional analysis; principles of axial, mixed, and radial flow pumps, fans, compressors, and turbines; cascade performance; computer flow simulations; applications to propulsion systems and power plants.

5446. AN INTRODUCTION TO COMBUSTION.

(4 cr; prereq 5342 or equiv, IT or grad student; 4 lect hrs per wk)

Flame propagation, quenching and ignition in a gaseous mixture; combustion of solid and liquid particles, and gaseous jets. Applications to selected propulsion systems.

Graduate Programs

5455. ROCKET PROPULSION. (3-5 cr [1-2 cr term paper option]; prereq 3303, IT or grad student; 3 hr lect per wk)

Mode of operation and performance limitations of chemical rockets with liquid, and solid, thermal and electromagnetic propellant acceleration and the thermodynamics of the propulsion process.

5460. INTERNAL COMBUSTION ENGINES. (4 cr; prereq 3301, IT or grad student; 4 lect hrs per wk)

Principles of power production, fuel consumption, and emissions of gasoline and diesel engines; fuel-air cycle analysis, combustion flames, knock phenomena, air flow and volumetric efficiency, mixture requirements, ignition requirements and performance.

5461. ADVANCED INTERNAL COMBUSTION ENGINES. (4-5 cr [1 cr term paper option]; prereq 5460, IT or grad student; 4 lect hrs per wk)

Traditional alternate fuels; engine lubrication and friction; engine emissions and measurement techniques; turbocharging; heat transfer and cooling; computer-based cycle modeling.

5462. GAS TURBINES. (4 cr; prereq 3301, IT or grad student; 4 lect hrs per wk)

Gas turbine cycles, regeneration, reheat, and intercooling. Axial and radial flow compressors and turbines; burner types and combustion efficiency; emissions and noise. Matching of compressor and turbine. Turbojet, fanjet, and turboprop engine performance.

5480. BIOLOGICAL FLUID FLOW. (3-4 cr [1 cr term paper option]; prereq IT or grad student, CE 3400, AEM 3200 or equiv; 3 lect hrs per wk)

Introduction to rheology and fluid dynamics of biological fluids. Blood flow, biological pumping, self-propelled particles, unusual viscoelastic behavior of biological fluids, and other fluid motions.

8443. APPLIED THERMODYNAMICS I. (3 cr; prereq 3303 or equiv)

Practical problems involving use of classical thermodynamics and thermochemistry. Equilibrium composition and flame temperature calculations. Chemical potential, fuel cells, and batteries. Efficient use of fuel, with emphasis on application of second law of thermodynamics.

8444. APPLIED THERMODYNAMICS II. (3 cr; prereq 8443 or equiv)

Application of statistical thermodynamics to calculation of thermodynamic properties, equilibrium constants, and energetics and kinetics of chemical reactions, with emphasis on application to combustion phenomena and exhaust product composition.

8445. APPLIED THERMODYNAMICS III. (3 cr; prereq 8444 or equiv)

Combustion phenomena, ignition, burning limits, propagation, and quenching. Effects of exothermic chemical reactions on flow phenomena in sub- and supersonic flows.

Environmental Engineering

5603. THERMAL ENVIRONMENTAL ENGINEERING. (4 cr; prereq 3303, 5342 or equiv; 4 lect hrs per wk)

Thermodynamic properties of moist air; H-W diagram for moist air; solar radiation; heat and water vapor transmission in structures; effects of thermal environments upon people, processes, and materials; thermal loads, thermal environmental control systems.

5604. HEATING AND COOLING LOADS IN BUILDINGS. (4 cr; prereq 5603; 4 lect hrs per wk)

Transient heat transfer through structures; lighting and other internal gains; ventilation; winter and summer design loads; seasonal energy estimation methods; computer simulation programs; codes and standards.

5605. REFRIGERATION AND AIR CONDITIONING SYSTEMS. (4 cr; prereq 3303, IT or grad student; 4 lect hrs per wk)

Vapor compression and absorption refrigeration systems; heat pumps; heat exchangers; piping and duct layout and sizing; operations and control of building air conditioning systems.

5609. AIR POLLUTION. (4 cr; prereq 3303 or #, IT or grad student; 4 lect hrs per wk)

Air pollution sources, atmospheric transport, transformations and fate. Air pollution meteorology, dispersion, and models. Basic chemistry of secondary pollutant formation, aerosol growth, air pollutant-visibility relationships. Standards and regulations.

5610. AIR POLLUTION CONTROL. (4 cr; prereq 3303, IT or grad student; 4 lect hrs per wk)

Control devices and techniques for gases and particulate emissions from stationary and mobile sources. Cyclones, electrostatic precipitators, bag houses, wet and dry scrubbers, combustion modification, and alternate fuels.

5613. PRINCIPLES OF PARTICLE TECHNOLOGY. (4 cr; prereq 3303, IT or grad student; 4 lect hrs per wk)

Definition, theory, and measurement of particle properties; particle statistics; fluid dynamics; optical, electrical, and thermal behavior of particles.

5614. PRINCIPLES OF PARTICLE TECHNOLOGY. (4 cr; prereq 5613, IT or grad student; 4 lect hrs per wk)

Gas cleaning, particle transport, comminution, classification, surface properties, packed beds, powder behavior, and miscellaneous topics.

5616. AEROSOL MEASUREMENT. (2 cr; prereq 5613, 5614 or #, IT or grad student; 3 lect-lab hrs per wk)

Principles of aerosol measurement. Modern aerosol instrumentation. Optical techniques, inertial collectors, electrical mobility techniques, Beta attenuation and piezoelectric mass sensing techniques, condensation nuclei counters and diffusion batteries.

5617. ADVANCED AEROSOL MEASUREMENT.

(4 cr; §5616; prereq 5613 or #, IT or grad student)
Principles and techniques of airborne particle measurement. Modern aerosol instrumentation: inertial collectors, optical particle counters, differential mobility particle sizer, condensation nucleus counters, aerodynamic particle sizer. Aerosol generation and instrument calibration. Aerosol measurement in clean room and source emission measurement. Data analysis and interpretation.

5620. CLEAN ROOM TECHNOLOGY AND

PARTICLE MONITORING. (4 cr; prereq IT or grad student, 3303 or #; 3 lect and 2 lab hrs per wk)
Fundamentals of clean room technology for microelectronics manufacturing; particle mechanics and filtration; filter performance and testing; airborne and liquid-borne particulate contaminants; optical particle counters, condensation nucleus counter, wafer surface scanner; clean room design and operation; exhaust ventilation; high purity gas and water supply systems.

8600. PSYCHROMETRICS AND AIR

CONDITIONING. (3 cr; prereq 5603; 3 lect hrs per wk)
Moist air properties, psychrometry and humidity measurement, processing of moist air; thermal loads for structures; air distribution; noise control; selected environmental and air conditioning topics.

8613. FUNDAMENTALS OF AEROSOL

BEHAVIOR. (4 cr; prereq 5613, 5614 or #; 4 lect hrs per wk)
Kinetic theory applications to aerosol systems, including free molecules and transition regime treatments of transport phenomena; analytical and numerical solutions to aerosol dynamics problems; homogeneous nucleation theory; light scattering and absorption.

General

5712. SOLAR ENERGY UTILIZATION. (4 cr; prereq 3303, 5342 or equiv, IT or grad student; 4 lect hrs per wk)

History and potential of solar energy; clear and cloudy sky solar radiation availability on surfaces of various orientations; flat plate and concentrating solar collectors; solar thermal storage; solar heating and cooling systems; computer simulation codes; power generation.

5990. TOPICS IN MECHANICAL ENGINEERING.

(4 cr [may be repeated for cr]; prereq submission of approved dept permission form, #, IT upper div or grad student)

Current topics; may vary quarterly.

8701, 8702. DESIGN STUDIES IN ENGINEERING I, II.

(3 cr per qtr; prereq grad student or Δ)
Interdisciplinary design exercises, primarily in mechanical and electrical engineering. Student teams create engineering design for selected problems. Written reports and oral presentations. Case study lectures on methodology.

8770-8771-8772. MECHANICAL ENGINEERING RESEARCH.

(Cr ar; prereq Δ)

8773-8774-8775. GRADUATE SEMINAR.

(1 cr per qtr; for grads and staff)
Recent developments in industrial engineering and operations research.

8800. MODERN DEVELOPMENTS IN MECHANICAL ENGINEERING.

(1 cr per qtr)
Seminars on special topics in engineering science of importance to mechanical engineers. Invited scholars deliver a five-lecture series on each topic; two to five topics examined each quarter.

Industrial Engineering (IEOR)

Graduate Credit Courses for Nonmajors

The following courses may be taken for graduate credit by students majoring in fields other than industrial engineering upon the approval of the student's adviser and the mechanical engineering graduate committee.

5010. INTRODUCTION TO WORK ANALYSIS.

(4 cr; prereq 3000, IT or grad student; 3 lect and 1 rec hrs per wk)

Fundamentals of methods engineering, work measurement, and plant layout. Charting techniques, process charts, predetermined time systems, work sampling, time study, master standard data, cross charting, line balancing.

5020. ENGINEERING COST ACCOUNTING, ANALYSIS, AND CONTROL.

(4-5 cr; prereq IT or grad student; 3000 and ME 3900 recommended; 3 lect and 1 rec hrs per wk)
Basic accounting concepts, financial statements, analysis and control of current assets such as cash, receivables, and inventory, income-tax planning, cost analysis, standard costs for product costing, time value of money, qualification of risk and uncertainty, utility theory, cost of capital and capital structure, capital budgeting under capital rationing, management decisions, and investment decisions.

5030. QUALITY CONTROL AND RELIABILITY.

(4 cr; prereq Math 1231, ME 3900, IT or grad student; 3000 recommended; 3 lect and 1 rec hrs per wk)

History of quality control, quality policies and objectives, economics of quality, design for system effectiveness, reliability and maintainability, statistical aids to reliability, quality specifications, inspection, acceptance sampling, vendor relations, process control, motivation for quality, quality assurance, and quality control engineering.

5040. INTRODUCTION TO OPERATIONS

RESEARCH. (4 cr; prereq Math 1231, IT or grad student; 3000 recommended; 3 lect and 1 rec hrs per wk)
Linear programming, algebra and geometry of linear models, simplex method, sensitivity testing, and duality, network models, network algorithms, and dynamic models.

Graduate Programs

5180, 5181. APPLIED INDUSTRIAL ENGINEERING. (3-5 cr per qtr [1-2 cr term paper option]; prereq 3000, 5010, 5020, 5030, 5040, Δ) Industrial engineering surveys and programs, case problems, studies in local plants.

Advanced Courses in Industrial Engineering

5050. ENGINEERING ECONOMIC ANALYSIS. (4 cr; prereq 3000 or #, IT or grad student; 3 lect and 1 rec hrs per wk)

Fundamental principles and techniques of economic analysis of engineering projects including economic measures of effectiveness, time value of money, cost estimation, depreciation, taxes, break-even, replacement and investment analysis.

5070. INTRODUCTION TO HUMAN FACTORS ENGINEERING. (4 cr; prereq #, IT or grad student or public health major; 3 lect and 1 rec-lab hrs per wk) Analysis and design of operations, machines, equipment, work stations, and work environments relative to capabilities, limitations, and needs of the human operator. Topics include human-machine systems, displays, controls, human-machine interface layout, work station design, anthropometry, work physiology and biomechanics, illumination, noise, toxicology, climate.

5071. HUMAN FACTORS IN SYSTEM DESIGN. (4 cr; prereq 5070 or 5010, IT or grad student; 1 lect-rec and 3 fieldwork hrs per wk)

Application of theory and principles from 5070 and 5010 to analysis and design of real industrial work settings in local industry.

5221. INDUSTRIAL PLANTS. (3-5 cr; prereq 5010, IT or grad student; 3 lect and 1 rec hrs per wk)

Layout of production and service facilities in manufacturing operations, analysis of materials flow, development of materials handling systems, and industrial packaging techniques.

5311. MANAGEMENT FOR ENGINEERS. (4-5 cr; prereq 3000, IT or grad student; 4 lect hrs per wk) Historical development of management concepts. Organizational systems and authority relationships. Planning, communication, and management responsibility.

5321. INDUSTRIAL SAFETY. (4 cr; prereq, IT or grad student; 3000 recommended; 4 lect hrs per wk) Definition and philosophy of safety, safety training, safety requirements for production processes, equipment and plants, industry standards, safety devices, and product safety.

5351. ANALYSIS OF PRODUCTION PROCESSES. (4 cr; prereq 5020, background in all industrial engineering areas [3000, 5010, 5030, 5040 recommended], IT or grad student)

Case course of problems in production engineering and production management. Analysis of production problems from selected industries. Development of ability to recognize and diagnose industrial problems.

5361. INVENTORY AND PRODUCTION CONTROL. (4 cr; prereq 3000, 5040, ME 3900, IT or grad student; 3 lect and 1 rec hrs per wk)

Forecasting techniques and analysis of inventory systems, aggregate planning, capacity decision, scheduling techniques, line balancing, use of linear programming and dynamic programming models in design, operation, and control of production and distribution systems.

5441. OPERATIONS RESEARCH II. (4 cr; prereq 5040, IT or grad student; 3 lect and 1 rec hrs per wk) Dynamic programming, integer programming, nonlinear and probabilistic models.

5442. OPERATIONS RESEARCH III. (4 cr; prereq 5441, IT or grad student; 3 lect and 1 rec hrs per wk) Optimization in probability models, Markov chains, queuing theory, and simulation.

5445. TOPICS IN MANAGEMENT SCIENCE. (3-5 cr [1-2 cr term paper option]; 5010, 5020, 5030, 5040, IT or grad student; 3 lect hrs per wk) Specialized topics in management science. Analytical tools for decision making and management of the production function. Emphasis on topics appearing in current literature. Topics vary quarterly.

5446. TOPICS IN INDUSTRIAL ENGINEERING. (4 cr [may be repeated for cr]; prereq IT or grad student; 5010, 5020, 5030, 5040 recommended; 4 lect hrs per wk)

Current topics; may vary quarterly.

5550. DESIGN AND ANALYSIS OF EXPERIMENTS I. (4 cr; prereq ME 3900, IT or grad student; 3 lect and 1 rec hrs per wk)

One-factor experiments, analysis of variance, estimation and comparison of effect, orthogonal contrasts, fixed, random, and mixed models, incomplete block designs.

5551. DESIGN AND ANALYSIS OF EXPERIMENTS II. (4 cr; prereq 5550, ME 3900, IT or grad student; 3 lect and 1 rec hrs per wk)

Designs involving crossed, nested, and mixed classifications; orthogonal polynomials, block confounding, fractional, factorial designs, computer programs for analysis.

5701. TECHNOLOGY ASSESSMENT. (4 cr; prereq upper division; 4 lect hrs per wk)

Unintended consequences of specific technologies on society. The history, institutional structures, and methodology of technology assessment; specific technology assessments. One or more class projects.

5703. ENGINEERING PROJECT MANAGEMENT. (4 cr, \$CE 5703; prereq IT sr or grad student)

Broad practical understanding of project management, including project planning, scheduling, budgeting, staffing, task and cost control, and how to communicate with, motivate, and manage team members.

8110-8111-8112. ADVANCED INDUSTRIAL ENGINEERING. (3 cr per qtr; prereq #)

Manufacturing policy; production engineering, plant operation, engineering economy, and industrial development.

8310-8311-8312. PRODUCTION ENGINEERING PROBLEMS. (3-5 cr per qtr; prereq #)

Application of industrial engineering principles to solution of manufacturing problems in local plants.

8410-8411-8412. INDUSTRIAL ENGINEERING RESEARCH. (3-5 cr per qtr; prereq #)

Research studies in selected areas of industrial engineering, production, and management; work of thesis quality but lesser scope.

8420. LINEAR PROGRAMMING. (3 cr; prereq 5040 or #; 3 lect hrs per wk; offered when feasible)**8430. NONLINEAR PROGRAMMING.** (3 cr; prereq 5040 or #; offered when feasible)**8440. DYNAMIC PROGRAMMING.** (3 cr; prereq 5505 or #; offered when feasible)**8450. QUEUING THEORY.** (3 cr; prereq 5442 or #; offered when feasible)**8460. STOCHASTIC PROGRAMMING.** (3 cr; prereq 8420, 8430 or #; offered when feasible)**8470. ADVANCED INVENTORY AND PRODUCTION CONTROL.** (3 cr; prereq 5361 or #; offered when feasible)**8773-8774-8775. GRADUATE SEMINAR.** (1 cr per qtr; S-N only)

Presentation and discussion of recent developments in industrial engineering and operations research.

Mechanics

See Aerospace Engineering and Mechanics.

Medical Physics

See Biophysical Sciences and Medical Physics.

Medicinal Chemistry (MedC)

Professor: Rodney L. Johnson, *interim head*; Patrick E. Hanna, *director of graduate studies*; Yusuf J. Abul-Hajj; Herbert T. Nagasawa; Philip S. Portoghese; Wayne T. Shier; Emil J. Staba; Robert Vince

Associate Professor: Simon M. N. Efang; Rory P. Rimmel

Assistant Professor: David M. Ferguson; William B. Gleason; Deborah A. Kallick; Carston R. Wagner

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A only) and Ph.D.

Curriculum—The program emphasizes the application of chemical principles to research on the action of drugs on biological systems. Areas of research include drug design and synthesis; chemical aspects of drug metabolism; chemical mechanisms of drug toxicity and carcinogenicity; computer-assisted drug design; pharmaceutical cell systems; delivery systems for gene therapy; nuclear magnetic resonance spectroscopic analysis of drug-protein interactions; design of catalytic antibodies; and development of radiopharmaceuticals.

Prerequisites for Admission—Applicants should have a B.S. or M.S. degree in an appropriate related science field such as pharmacy, chemistry, or biology. All applicants should have completed undergraduate chemistry through elementary organic chemistry. Undergraduate coursework in biochemistry and biology is desirable but not required.

Special Application Requirements—Scores from the General (Aptitude) Test of the Graduate Record Examination and at least three letters of recommendation from college-level faculty are required. Students usually are admitted fall quarter only. Admissions are generally for the Ph.D. program only.

Master's Degree Requirements—Courses and credits are arranged on an individual basis. A final oral examination is required.

Doctoral Degree Requirements—All students must complete a core curriculum composed of advanced courses in organic chemistry (11 credits), biochemistry (12 credits), and medicinal chemistry (8-12 credits). Pharmacology coursework is also required of most students.

Ph.D. students must participate in the department seminar program, successfully complete a cumulative examination requirement, and prepare an original research proposal.

Language Requirements—None.

Graduate Programs

Minor Requirements for Students Majoring in Other Fields—Requirements include an introductory course (5600), advanced medicinal chemistry courses (8xxx level).

For Further Information and Applications—Contact the Department of Medicinal Chemistry, College of Pharmacy, University of Minnesota, 8-101 Health Sciences Unit F, 308 Harvard Street S.E., Minneapolis, MN 55455 (612/624-9919; fax 612/624-2974).

MedC 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

MedC 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

MedC 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5200. THE NEW DRUG DEVELOPMENT PROCESS. (1 cr)

New drug development process in U.S. pharmaceutical industry.

5320s. THERAPEUTIC AGENTS I. (3 cr; prereq Phar 5440) Staff

Factors involved in drug absorption, distribution, excretion, metabolism, mechanism of action, receptor interaction, and rational drug design; therapeutic properties and uses of individual pharmacological drug categories from structure-activity standpoint. Agents used as pharmaceutical aids and adjuncts.

5330f. THERAPEUTIC AGENTS II. (2 cr, §MChM 5330; prereq BioC 5501) See 5320 for description.

5340w. THERAPEUTIC AGENTS III. (3 cr, §MChM 5340; prereq BioC 5001) See 5320 for description.

5350s. THERAPEUTIC AGENTS IV. (4 cr, §MChM 5350; prereq BioC 5001) See 5320 for description.

5495f. VISTAS IN MEDICINAL CHEMISTRY RESEARCH. (1 cr) Staff

Selected topics of contemporary interest in pharmaceutical sciences.

5600f. GENERAL PRINCIPLES OF MEDICINAL CHEMISTRY. (4 cr; prereq Phcl 1009, BioC 5001)

Hanna, Johnson, staff
General principles of drug design and molecular bases of recognition of receptor sites.

8100.* MEDICINAL CHEMISTRY SEMINAR. (Cr ar; required of all majors in medicinal chemistry) Vince

8114f. NATURAL TOXINS. (2 cr, §Phcg 8114; prereq #; offered when feasible) Shier

8116f. STEROID DRUGS. (2 cr, §Phcg 8116; prereq #; offered when feasible) Abul-Hajj

8206w. OPIOID TOPICS. (1 cr; prereq #) Portoghesi
Topics in opiate and opioid-related research. Offered jointly with Department of Pharmacology.

8500w. DESIGN OF CHEMOTHERAPEUTIC AGENTS. (3 cr; prereq MedC 5600 or #; offered alt yrs) Vince

Modern aspects of drug design, with emphasis on chemotherapeutic agents. Strategies for enzyme inhibition and metabolic blocks in development of anticancer, antimicrobial, and antiviral agents.

8600w. CHEMICAL ASPECTS OF DRUG METABOLISM AND BIOACTIVATION. (3 cr; prereq 5600 or #; offered alt yrs) Hanna, staff
Chemical aspects of drug metabolism and toxicity. Mechanisms of biotransformations of drugs and other xenobiotics.

8700s. ADVANCED CONCEPTS IN DRUG DESIGN. (2 cr; prereq MedC 5600 or #; offered alt yrs) Wagner, staff
Current approaches to rational design of drugs.

8760. DESIGN OF PEPTIDOMIMETICS. (2 cr; prereq 5600 or #; offered alt yrs) Johnson
Current approaches to designing peptidomimetics of biologically active peptides. Rationale behind structures used in designing peptidomimetics and synthetic routes used to synthesize them.

8800. MEDICINAL CHEMISTRY LABORATORY TECHNIQUES. (Cr ar; prereq Chem 3303 or #) Staff

8900. RESEARCH IN MEDICINAL CHEMISTRY. (Cr ar; prereq Chem 3303 or #) Staff
Study and experimental investigation of topics in the area of natural products and synthetic organic medicinal agents.

Medieval Studies (MeSt)

Regents' Professor: Rutherford Aris (chemical engineering and materials science)

Professor: F. R. P. Akehurst (French and Italian); Bernard S. Bachrach (history); Caesar E. Farah (history); Evelyn S. Firchow (German); Barbara A. Hanawalt (history); Donna G. Cardamone Jackson (music); Calvin B. Kendall (English); Anatoly Liberman (German); Andrew MacLeish (English); Susan J. Noakes (French and Italian); Thomas S. Noonan (history); William D. Phillips, Jr. (history); Kathryn L. Reyerson (history); Robert P. Sonkowsky (Classical and Near Eastern studies); David J. Wallace (English); Anthony N. Zahareas (Spanish and Portuguese)

Associate Professor: Rita Copeland (English); G. Lee Fullerton (German); Kaaren E. Grimstad (Scandinavian languages and literature); Michal A. Kobialka (theatre arts and dance); Nita Krevans (Classical and Near Eastern studies); Ronald L. Martinez (French and Italian); John W. Steyaert (art history); Ray M. Wakefield (German)

Assistant Professor: Joseph D. Alcherms (Classical and Near Eastern studies); Oliver P. Nicholson (Classical and Near Eastern studies)

Adjunct Assistant Professor: Stephanie C. Van D'Elden (English)

Course of Study—Minor in medieval studies, applicable to master's (M.A. and M.F.A.) and doctoral programs.

Curriculum—The medieval studies minor offers a structured interdisciplinary program that provides graduate students with an opportunity to take courses with faculty who participate in the Center for Medieval Studies. The program focuses on acquisition of Latin, paleography, and other skills, as well as encourages a broad knowledge of various disciplines within medieval studies.

Prerequisites for Admission—Admission to a medieval studies graduate minor is contingent upon prior admission to a master's or doctoral degree-granting program in the Graduate School.

Minor Requirements—The master's minor requires a total of 9 credits: two courses in medieval studies outside the student's major department, including a Latin course (Latin 34xx taken as 8120, or any Latin course at the 5xxx level or above), and either one MeSt core course (5610, 8110, 8120, or 8130) or one MeSt colloquium course (8010, 8020, or 8030). The doctoral minor requires 18 credits: courses in medieval studies outside the student's major department, including an additional Latin course at the 5xxx level or above.

Language Requirements—Latin.

For Further Information—Contact the Center for Medieval Studies, University of Minnesota, 304 Walter Library, 117 Pleasant Street S.E., Minneapolis, MN 55455 (612/626-0805; fax 612/626-7735; e-mail cmedst@maroon.tc.umn.edu).

5610. TOPICS IN MEDIEVAL STUDIES. (2-5 cr; prereq one-yr work on Middle Ages, reading knowledge of appropriate language[s])
From fall of Rome through end of Middle Ages (ca. 500 B.C. to ca. 1500 A.D.). Current topics specified in *Class Schedule*.

8010, 8020, 8030. MEDIEVAL STUDIES COLLOQUIUM. (1 cr per qtr; prereq #)
Lectures by and discussions with faculty and visiting speakers.

8110, 8120, 8130. SEMINAR IN MEDIEVAL STUDIES. (1-5 cr per qtr; prereq #; offered when feasible)

Microbial Ecology

Regents' Professor: Eville Gorham (ecology, evolution, and behavior)

Professor: Martin Dworkin (microbiology); Arnold Fredrickson (chemical engineering); Greg Germaine (dentistry); Richard Hanson (microbiology); David McLaughlin (plant biology); Robert Megard (ecology, evolution, and behavior); Jean-Alex Molina (soil science); Philip Regal (ecology, evolution, and behavior); Palmer Rogers (microbiology); G. David Tilman (ecology, evolution, and behavior)

Associate Professor: Michael J. Sadowsky (microbiology; soil science), *director of graduate studies;* Randall Hicks¹ (biology); Timothy J. Kurtti (entomology); Lawrence P. Wackett (biochemistry; Biological Process Technology Institute)

Assistant Professor: Linda L. Kinkel (plant pathology)

Course of Study—Minor in microbial ecology, applicable to master's (M.S. only) and doctoral programs.

Curriculum—Microbial ecology is an area of interdisciplinary research concerned with the relationships of microorganisms to their natural environment. The microbial ecology program offers a core curriculum of coursework in microbiology, microbial physiology, microbial genetics, microbial ecology, and theoretical ecology as well as additional courses and opportunities to interact with others interested in microbial ecology. The microbial ecology seminar series allows students and faculty to hear and interact with microbial ecologists from other universities. The curriculum encourages interdisciplinary interaction, communication, and synthesis.

Prerequisites for Admission—To be admitted to the microbial ecology graduate minor, a student must be admitted to a master's or doctoral degree-granting program within the Graduate School, should have broad training in the biological sciences, and must be accepted by the director of graduate studies of the microbial ecology minor program. All students are expected to have had the equivalent of introductory microbiology (MicB 5105) and general ecology (Biol 5041), but may fulfill deficiencies in these areas by taking these courses while in the program.

¹ *University of Minnesota, Duluth*

Graduate Programs

Special Application Requirements—

Consult the director of graduate studies. Students are admitted each quarter.

Minor Requirements—For master's students, 12 credits are required, all of which must be from outside the student's major department. These 12 credits must include at least one laboratory course in microbiology (e.g., MicB 5322) and one ecology (EBB) course from the list below; the remaining courses, which are to be chosen with the guidance and approval of the director of graduate studies, can come from any of the other courses listed below. For doctoral students, a total of 24 credits are required, 17 credits of which must come from five required core courses (listed below). Contact the director of graduate studies for potential alternatives to these required courses. The remaining credits must come from at least two courses chosen from the additional courses listed below, but may not be in the student's major area.

Language Requirements—None specific to the minor program.

For Further Information and

Applications—Contact Dr. Michael Sadowsky, Microbial Ecology Minor Program, University of Minnesota, 246 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108 (612/624-2706; e-mail sadowsky@soils.umn.edu).

Core Courses

Biol 5041. ECOLOGY

EEB 5052. THEORETICAL POPULATION ECOLOGY

MicB 5105. BIOLOGY OF MICROORGANISMS

MicB 5321. PHYSIOLOGY OF BACTERIA

MicB 5611. MICROBIAL ECOLOGY

MicB 8112. MICROBIAL GENETICS

Additional Courses

CE 5515. WATER AND WASTEWATER MICROBIOLOGY

CE 8505. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS

EEB 5601. LIMNOLOGY

EEB 5608. ECOSYSTEMS: FORM AND FUNCTION

EEB 8602. ADVANCED LIMNOLOGY

MicB 5322. MICROBIAL DIVERSITY AND PHYSIOLOGY LABORATORY

PBio 5103. ALGAE, FUNGI, AND BRYOPHYTES

PIPa 5206. BIOLOGY OF FUNGI

PIPa 5211 (formerly 8111). FUNGAL GENETICS

Soil 5515. SOIL DEVELOPMENT, CLASSIFICATION, AND GEOGRAPHY

Microbial Engineering (MicE)

Professor: Peter Carr (chemistry); Gary M. Dunny (Biological Process Technology Institute; microbiology); Anthony Faras (microbiology; Institute of Human Genetics); Arnold Fredrickson (chemical engineering and materials science); James Fuchs (biochemistry); Richard Hanson (microbiology); Alan B. Hooper (genetics and cell biology); Wei-Shou Hu (chemical engineering and materials science); Theodore Labuza (food science and nutrition); Larry McKay (food science and nutrition); Palmer Rogers (microbiology); Irwin Rubenstein (plant biology); W. Tom Shier (pharmacognosy); James Zissler (microbiology)

Associate Professor: Friedrich Srien (Biological Process Technology Institute; chemical engineering and materials science), *director of graduate studies;* Robert J. Brooker (Biological Process Technology Institute; genetics and cell biology); Michael Flickinger (Biological Process Technology Institute; biochemistry); R. Scott McIvor (laboratory medicine and pathology; Institute of Human Genetics); Bernard Reilly (microbiology; oral sciences); Michael J. Sadowsky (soil science; microbiology); Janet Schottel (biochemistry); Peter Southern (microbiology); Robert T. Tranquillo (chemical engineering and materials science); Lawrence P. Wackett (Biological Process Technology Institute; biochemistry)

Assistant Professor: Chang-Ho Park (agricultural engineering); David H. Sherman (Biological Process Technology Institute; microbiology); C. Rick Wagner (medicinal chemistry)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.S. (Plan A and Plan B)

Curriculum—Microbial engineering is an interdisciplinary program that combines an understanding of basic principles in microbiology, molecular biology, chemical engineering, and related sciences with development of technical knowledge and know-how in industrial microbiology. In

addition to the major coursework, Plan B students participate in preceptorships at local private company research laboratories. Plan A students conduct research and write a thesis guided by a faculty member. Supporting courses may be chosen from specific fields including biochemistry, food science, genetics and cell biology, or pharmacognosy.

Prerequisites for Admission—A baccalaureate degree in biological sciences, biochemistry, chemistry, or chemical engineering is preferred. Undergraduate coursework should include one year each of calculus, organic chemistry, physics, microbiology, and basic chemical engineering, as well as a background in basic biology, physical chemistry, biochemistry, and genetics. Deficiencies may be made up during the first year of graduate studies.

Special Application Requirements—Three letters of recommendation, scores from the General Test of the Graduate Record Examination, and an autobiographical statement including occupational goals must be submitted to the director of graduate studies. Applications are accepted at any time, but the majority of students are accepted for fall quarter. To receive full consideration for financial aid, students must apply for fall quarter admission by February 1.

Degree Requirements—The two-year program is planned by the student and adviser. Coursework is required in a specialized program of microbiology, molecular biology, immunobiology, and chemical engineering. In addition, students are required to present two seminars and assist in instructing one course in advanced microbiology, molecular biology, or biochemical engineering. At the end of the first year, Plan B students participate in an eight- to twelve-week industrial research preceptorship, which may form the basis of a Plan B paper. Plan A students complete a research thesis during the second year. Supporting coursework may be chosen from specified fields including biochemistry, food

science, genetics and cell biology, or pharmacognosy. Proficiency in computer programming and one computer language must be demonstrated. A Plan B paper or Plan A research thesis and an oral final examination are required.

Language Requirements—None.

For Further Information and Applications—Contact the M.S. Program in Microbial Engineering, Institute for Advanced Studies in Biological Process Technology, University of Minnesota, 240 Gortner Laboratory, 1479 Gortner Avenue, St. Paul, MN 55108 (612/624-6774; fax 612/625-1700).

MicE 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

5990. TEACHING PRACTICUM. (0-1 cr)
To satisfy teaching assistant requirement for microbial engineering M.S. degree.

8990. BIOTECHNOLOGY SEMINAR. (1 cr)
Student presentations of thesis research; required for M.S. degree.

Note—The following courses are selected for major and minor programs; other courses are also available. Descriptions of all courses can be found in the course listings of the respective departments.

BioC 5744. ANALYTICAL BIOCHEMISTRY. (4 cr; prereq lab work in analytical and organic chemistry, #)

Biol 5003. GENETICS. (4 cr, §GCB 3022, §5022, prereq 5001)

ChEn 5001. COMPUTATIONAL METHODS IN CHEMICAL ENGINEERING AND MATERIALS SCIENCE. (4 cr, §MatS 5001; prereq chem engr or mat sci major)

ChEn 5101-5102-5103. PRINCIPLES OF CHEMICAL ENGINEERING I-II-III. (4 cr per qtr; prereq 5001 or ¶5001, IT student)

ChEn 5104. UNIT OPERATIONS AND SEPARATION PROCESSES. (4 cr; prereq 5101, upper div ChEn or MatS major)

ChEn 5301. CHEMICAL REACTOR ANALYSIS. (4 cr; prereq 5202, upper div ChEn or MatS major)

ChEn 5751, 5752, 5753. BIOCHEMICAL ENGINEERING I, II, III. (3 cr per qtr; prereq Biol 5001 for 5752 and 5753, sr or grad student in ChEn or #)

ChEn 5756. BIOCHEMICAL ENGINEERING LABORATORY. (2 cr; prereq 5751 or 5752)

Graduate Programs

ChEn 5780. PRINCIPLES OF MASS TRANSFER IN ENGINEERING AND BIOLOGICAL ENGINEERING. (3 cr; prereq upper div engineering or science student)

FScN 5120. FOOD MICROBIOLOGY. (5 cr; prereq 1102, 3112, VPB 3103 or MicB 5105 or #)

FScN 5123. FOOD FERMENTATIONS AND BIOTECHNOLOGY. (3 cr; prereq 5120)

FScN 5555. FREEZING AND DEHYDRATION OF FOODS. (5 cr; prereq 1102, 5135; offered alt yrs)

FScN 8323. MICROBIAL STARTER CULTURES. (3 cr; prereq 5123, Biol 5001 or #)

MicB 5218. IMMUNOLOGY. (3 cr; prereq Biol 5001)

MicB 5232. MEDICAL MICROBIOLOGY. (3 cr; prereq 5105 or 3103 or 8110 or Biol 5013, 5216 or 5218)

MicB 5234. IMMUNOLOGY AND MEDICAL MICROBIOLOGY LABORATORY. (3 cr; prereq 5218 or ¶5218, 5232 or ¶5232)

MicB 5321. PHYSIOLOGY OF BACTERIA. (3 cr; prereq 3103 or 5105 or Biol 5103 or VPB 3013, Biol 5001, 10 cr organic chemistry, 3 cr genetics)

MicB 5322. MICROBIAL DIVERSITY AND PHYSIOLOGY LABORATORY. (3 cr; prereq 5321 or ¶5321 or equiv)

MicB 5352. APPLIED MICROBIOLOGY. (4 cr; prereq 5321 or #)

MicB 5424. BIOLOGY OF VIRUSES. (3 cr; prereq 5105 or Biol 5004 or Biol 5013, Biol 5003)

MicB 5425. VIROLOGY AND MICROBIAL GENETICS LABORATORY. (3 cr, §Biol 5125; prereq 5424 or ¶5424, Biol 3021 or Biol 5001, Biol 5003 or GCB 3022 or GCB 5022)

MicB 8110. STRUCTURE, FUNCTION, AND METABOLISM OF BACTERIA. (3 cr; prereq beginning microbiology, organic chemistry, biochemistry, general biology or #)

MicB 8112. MICROBIAL GENETICS. (3 cr; prereq grad major in micro or #)

MicB 8125. MICROBIAL ECOLOGY AND DEVELOPMENT. (3 cr; prereq coursework in micro and cell biol and biochem or #)

MicB 8216. FRONTIERS OF IMMUNOLOGY I: MOLECULAR IMMUNOLOGY. (3 cr, §Path 8216; prereq Biol 5001 or equiv or #)

MicB 8217. FRONTIERS OF IMMUNOLOGY II: CELLULAR IMMUNOLOGY. (3 cr, §Path 8217; prereq Biol 5001 or equiv or #)

MicB 8218. FRONTIERS OF IMMUNOLOGY III: CLINICAL IMMUNOLOGY. (4 cr, §Path 8218; prereq 8216, 8217)

Microbiology (MicB)

Professor: Ashley T. Haase, *head*; Arthur G. Johnson, *chair*, Department of Microbiology, UMD¹; Patrick Schlievert, *director of graduate studies*; Dwight L. Anderson; P. Patrick Cleary; Gary M. Dunny; Martin Dworkin; Anthony J. Faras; Gregory R. Germaine; Beulah H. Gray; Richard Hanson; Alan B. Hooper; Margaret K. Hostetter; Russell C. Johnson; M. Colin Jordan; Tucker W. LeBien; Paul T. Magee; Larry L. McKay; Harry T. Orr; Peter G. W. Plagemann; Paul Quie; Palmer Rogers; Walter Sauerbier; Lawrence B. Schook; Janet Schottel; Richard J. Ziegler¹; James F. Zissler

Associate Professor: Alice Adams¹; Russell F. Bey; Kathleen F. Conklin; Michael C. Flickinger; Dale S. Gregerson; Ronald R. W. Jemmerson; Marc K. Jenkins; Omelan A. Lukaszewicz¹; R. Scott McIvor; Robert D. Nelson; Bernard E. Reilly; Michael J. Sadowsky; Stewart Scherer; Peter Southern; Lawrence P. Wackett; Carol L. Wells

Assistant Professor: Donna Fontana; Ambika Mathur; Daniel L. Mueller; Leslie A. Schiff; David H. Sherman

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A only) and Ph.D.²

Curriculum—Areas of specialization include general microbiology, microbial ecology, bacterial physiology, bacterial development, bacterial and phage genetics, medical microbiology, immunology, virology, animal cell culture, genetic engineering, and cancer biology. For students specializing in immunology, an internal supporting program in immunology for the Ph.D. degree is available.

Prerequisites for Admission—College coursework, including a year of general chemistry, followed by organic chemistry, physics, calculus, and one academic year or the equivalent of courses in the biological sciences supplemented by courses in biochemistry, genetics, physical chemistry, and immunology.

¹ University of Minnesota, Duluth

² For information on the master's and doctoral degree programs offered in conjunction with the University of Minnesota, Duluth, please contact the director of graduate studies on the Twin Cities campus, or the program director or Graduate School office on the Duluth campus.

Special Application Requirements—The following must be submitted to the department: three letters of recommendation; scores from the General (Aptitude) Test of the Graduate Record Examination; and a brief description of reasons for seeking an advanced degree, areas of interest within microbiology and reasons for these interests, and career objectives. Applicants are encouraged to apply for fall quarter admission only, because the core curriculum begins in fall. Applications should be submitted by January 1; those received after that date are considered only if space in the desired program is available.

Degree Requirements—A recommended core curriculum for both the M.S. and Ph.D. degrees is completed during the first and second years of graduate study and consists of approximately 26 credits of coursework in microbiology. Additional coursework is taken in a minor or supporting field. Students are also required to give presentations at journal clubs and to attend department seminars.

Master's Degree Requirements—The final examination for the master's degree is a closed oral examination and covers all areas of microbiology as well as the student's thesis research.

Doctoral Degree Requirements—Preliminary written and oral examinations are taken following the second year of graduate study. Students are also required to present a thesis research seminar approximately one year before completing their degree.

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—Contact the department office for information about the required minor curriculum.

For Further Information and Applications—Contact the Department of Microbiology, University of Minnesota, Box 196 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/624-5947; fax 612/626-0623; e-mail micro@lenti.med.umn.edu).

MicB 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

MicB 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

MicB 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5105f, w.s.¹ BIOLOGY OF MICROORGANISMS. (5 cr, §3103, §Biol 5013; prereq 5 cr biol sci, Biol 5001 or #) Dunny, Hanson, Sherman
Lectures, demonstrations, and lab exercises in taxonomy, anatomy, physiology, biochemistry, and ecology of microbes. Some emphasis on molecular structure in relation to bacterial function.

5201f. MICROBIOLOGY FOR DENTAL STUDENTS. (8 cr) Anderson, Liljemark, Reilly
Nature and diversity of microorganisms; bacterial anatomy; nutrition and growth; variation and genetic exchange; fundamentals of immunology; pathogenic bacteria, fungi, and viruses; principles of sterilization and disinfection; chemotherapy; development and ecology of the oral flora; microbiology of dental caries and periodontal disease.

5205w. MICROBIOLOGY FOR MEDICAL STUDENTS. (5 cr; prereq regis med fr or #) Schlievert, staff
Basic medical aspects of immunology, parasitology, mycology, medical bacteriology, and virology with emphasis on pathogenesis. Principles and techniques enabling diagnosis, treatment (especially chemotherapy), and prevention of infectious disease.

5206s. MICROBIOLOGY FOR MEDICAL STUDENTS. (5 cr; prereq regis med fr or #)
(Continuation of 5205) Lecture and lab.

5218w. IMMUNOLOGY. (3 cr; prereq Biol 5001 recommended) Gray
Cellular, protein, and genetic bases of humoral immunity; methods for measuring antibodies and antigens. T lymphocytes: interaction of T helper cells with B lymphocytes and other T cells in cell-mediated immunity. Clinical immunology: immunodeficiency, allergy, auto-immunity, transplantation.

5232w. MEDICAL MICROBIOLOGY. (3 cr; not open to med students; prereq 5105 or 3103 or 8110 or Biol 5013, 5216 or 5218) Cleary
Pathogenic bacteria and fungi; mechanisms of pathogenicity and virulence; properties of microorganisms and their animal hosts that influence the outcome of host-parasite relations analyzed from genetic and metabolic view.

5234w.¹ IMMUNOLOGY AND MEDICAL MICROBIOLOGY LABORATORY. (3 cr; prereq 5218 or §5218, 5232 or §5232) Cleary, Gray
Principles that determine outcome of host-parasite interactions. Methods basic to host defense and immunology, including immunochemical and microbiological methods for diagnosing infectious disease.

¹ *Microscope required. Students may obtain use of microscope by purchasing a \$6 microscope card from the bursar.*

Graduate Programs

5235f. MICROORGANISMS AND DISEASE. (3 cr, §5233; prereq 10 cr chemistry, 5 cr biological sciences or #; not open to microbiology majors) Johnson
Lectures on nature of microorganisms, immunology, medical bacteriology, virology, mycology, and principles of disease control.

5321f. PHYSIOLOGY OF BACTERIA. (3 cr; prereq 3103 or 5105 or Biol 5013 or VPB 3103, Biol 5001, 10 cr organic chem, 3 cr genetics) Rogers
Chemical and physical organization of bacteria as related to function; growth; energy metabolism including oxidations and fermentations; nutritional requirements; antimicrobial agents; autotrophic mechanisms; microbial differentiation.

5322f. MICROBIAL DIVERSITY AND PHYSIOLOGY LABORATORY. (3 cr; prereq 5321 or ¶5321 or equiv) Dworkin, Rogers
Isolation from natural sources; physiology and metabolism of wide variety of microorganisms, such as *Clostridium*, yeast, *Caulobacter*, myxobacteria, *Leptospira*, photosynthetic bacteria, *Bdellovibrio*, luminescent bacteria, and others. Lab only.

5352s. APPLIED MICROBIOLOGY. (4 cr; prereq 5321 or #) Flickinger
Microbial adaptation to various environments; role of microorganisms in earth's biogeochemical cycles. Application of microbial systems to industrial processes; basic principles of fermentation technology; microbial bioconversions and product formation. Biodegradation of chemicals.

5424s. BIOLOGY OF VIRUSES. (3 cr; prereq 5105 or Biol 5004 or Biol 5013, Biol 5003) Plagemann
Structure, composition, and properties of bacterial, plant, and animal viruses; their interaction with cells and effects on host cell metabolism; biochemistry of viral replication; techniques used in study of viruses and viral infections; viral tumorigenesis.

5425s. VIROLOGY AND MICROBIAL GENETICS LABORATORY. (3 cr, §Biol 5125; prereq 5424 or ¶5424, Biol 3021 or Biol 5001, Biol 5003 or GCB 3022 or GCB 5022) Plagemann, Sauerbier, Schiff
Modern techniques: animal cell culture, virus infectivity titrations, analysis of viral nucleic acids and proteins by radiolabeling, gel electrophoresis and blot hybridizations, cell transformation by tumor viruses and DNA, analysis and mapping of mutants in microorganisms.

5611s. MICROBIAL ECOLOGY. (3 cr, §Soil 5605; prereq 3103 or 5105 or Biol 5013 or Soil 5610 or #) Sadowsky
Interrelationship of microorganisms with terrestrial, aquatic, and organismal environments; survey of bacterial, fungal, and algal components of ecosystems; evolution and structure of microbial communities; population interactions within ecosystems; quantitative and habitat ecology; biogeochemical cycling; and biotechnological approaches to study of microbial ecology.

5992f,w,s,su. PRACTICUM: TEACHING. (1 cr; prereq micro grad major or #) Staff
Supervised experience in lab instruction: development of skills in effective use of instructional materials, tests and measurement.

8110f. STRUCTURE, FUNCTION, AND METABOLISM OF BACTERIA. (3 cr; prereq beginning micro, biochem, organic chem, general biol or #) Dworkin, Rogers
Physiology of eubacteria and archaebacteria with emphasis on their organismic diversity. Structure, motility, chemotaxis, metabolism, phototrophy, growth, transport, and molecular evolution. Lectures and discussion.

8112w. MICROBIAL GENETICS. (3 cr; prereq grad major in micro or #) Zissler
Lecture and discussion in molecular genetics.

8125w. MICROBIAL ECOLOGY AND DEVELOPMENT. (3 cr; prereq coursework in micro and cell biol and biochem or #) Fontana, Sadowsky
Relationships between microorganisms, environments, and other organisms, with emphasis on specificity of interactions; cell-cell interactions regulating development of microbial systems.

8216f. FRONTIERS OF IMMUNOLOGY I: MOLECULAR IMMUNOLOGY. (3 cr, §Path 8216; prereq Biol 5001 or equiv or #) Jemmerson, Pennell
Molecular basis of immunological recognition: B and T cells; immunoglobulin and T-cell receptor genes and mechanisms of expression; antigen processing and presentation; signal transduction in lymphokines, MHC gene products, and components of complement.

8217w. FRONTIERS OF IMMUNOLOGY II: CELLULAR IMMUNOLOGY. (3 cr, §Path 8217; prereq Biol 5001 or equiv or #) Jenkins
Overview of B-cell/T-cell interactions, major histocompatibility complex, cell surface markers, B-cell development and responses, negative regulatory mechanisms, T-cell responses, PMNs, and macrophages.

8218s. FRONTIERS OF IMMUNOLOGY III: CLINICAL IMMUNOLOGY. (4 cr, §Path 8218; prereq 8216, 8217; offered alt yrs) Gray
Antibody-mediated hypersensitivity, cellular hypersensitivity, autoimmunity, transplantation, tumor immunology, immunocytology, immune deficiencies.

8231s. ADVANCED TOPICS IN MICROBIAL PATHOGENESIS. (3 cr; prereq micro grad student or #)
Contemporary approaches and insights into complex interactions of microorganisms with their hosts that result in disease.

8421s. VIROLOGY AND TUMOR BIOLOGY. (3 cr; prereq undergrad biochem course, grad major in micro or #) Conklin, Schiff, Southern
Structure and replication of animal viruses; basic mechanisms of viral tumorigenesis; emphasis on expression and reproduction of genome, recent developments. Lectures, assigned readings, and discussion.

8910f,w,s. SEMINAR. (1 cr; prereq #) Staff

8911f,w,s. COLLOQUIUM IN MICROBIOLOGY.

(1 cr; prereq #) Staff

Series of independent units, each led by staff member. Several units offered each quarter; students may participate in one or more. Topics include mechanisms of immune response, biochemical aspects of animal virus replication, developmental microbiology, genetics of phage lambda and tumor viruses, comparative metabolism of animal and bacterial cells, epidemiology, mechanisms of pathogenesis, molecular aspects of regulation, carcinogenesis, industrial microbiology, microbial ecology, and regulation of metabolism.

8990f,w,s,su. RESEARCH IN MICROBIOLOGY.

(Cr ar; prereq micro grad major or #) Staff

Graduate students with requisite preliminary training may elect research project outside their thesis work.

Mineral Engineering¹

Professor: Steven L. Crouch, *head*; Patrick L. Brezonik; Andrew Drescher; Charles Fairhurst; Malcolm T. Hepworth; Kenneth J. Reid; Michael J. Semmens

Associate Professor: Emmanuel M. Detourmay; Efi Foufoula-Georgiou; Catherine E. French; Joseph F. Labuz; Karl A. Smith; Raymond L. Sterling; Vaughan R. Voller

Assistant Professor: Randal J. Barnes; David E. Newcomb

Research Associate: Peter A. Cundall

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B), M.Min.E., and Ph.D.

Curriculum—The program is administered in the Department of Civil Engineering. The master of mineral engineering degree (M.Min.E.) is designed for engineering graduates who are interested in design, operations, or management.

Prerequisites for Admission—Adequate preparation in undergraduate subjects and in the sciences fundamental to mineral engineering is required. A bachelor's degree in mineral engineering is required for the M.Min.E. program. Applicants to these programs who have B.S. degrees in other fields (e.g., geology, physics, chemistry) are required to make up deficiencies in the basic engineering curriculum.

Special Application Requirements—None.

Degree Requirements—For the M.Min.E. degree, see Professional Master's Degree in Engineering in the General Information section of this bulletin. All students should consult the department publication *General Information Bulletin for Graduate Students* for further information.

The final examination for all master's degrees is oral.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Civil Engineering, University of Minnesota, 122 Civil Engineering Building, 500 Pillsbury Drive S.E., Minneapolis, MN 55455 (612/625-5522).

Note—Courses in the mineral engineering program fall under two designators: Mineral Engineering (MinE) and Metallurgical Engineering (MetE). Students should also see the course offerings listed under Geological Engineering in this bulletin.

MinE 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

MinE 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

MinE 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Mining Engineering (MinE)

8601-8602-8603.* SEMINAR: MINERAL ENGINEERING. (Cr ar; prereq #)

Metallurgical Engineering (MetE)

5100. CHEMICAL METALLURGY I. (4 cr; prereq Chem 1031, Chem 1032, Chem 5534 or #; 3 lect and 1 rec hrs per wk)

Introduction to metallurgical thermodynamics, metallurgical equilibria and activity concept; Hess's law and Kirchoff equation (thermochemistry), 1st law of thermodynamics, 2nd law of thermodynamics, entropy, heat capacity, Gibbs-Helmholtz, Van't Hoff (isochore and isotherm), 3rd law of thermodynamics, and Clausius-Clapeyron, as applied to metallurgical systems.

¹ No new students are being accepted for the mineral engineering program. See programs in civil engineering and geological engineering.

Graduate Programs

5101. CHEMICAL METALLURGY II. (4 cr; prereq MetE/MatS 5100 or #; 3 lect hrs and 1 rec hr per wk) Δ Go-T relationships; surface tension and interfacial phenomena. Kinetics: quantitative relationship between rate of reaction and reactant concentration; order of reaction; molecularity; effect of temperature and state of division of reactants on rate; theories of reaction kinetics; catalysis; diffusion and mass transfer; nucleation; experimental techniques.

5102. CHEMICAL METALLURGY III. (4 cr; prereq MatS/MetE 5101 or #; 3 lect and 1 rec hrs per wk) Electrochemistry: evaluation of conductivity theory, mean ionic activity concept, transport numbers; electrode potentials, Nernst equation, polarization and kinetics of electrode processes, E-pH, E-log i curves, electrolytic and galvanic cells; electrolysis, decomposition voltage, discharge potential, current and energy efficiency, electro winning and electrorefining, experimental techniques.

5500, 5501. METALLURGICAL ENGINEERING DESIGN I, II. (4 cr per qtr; prereq #; 12 design hrs per wk)

Practicum project in metallurgical engineering.

5503. METALLURGICAL ENGINEERING DESIGN III. (4 cr; prereq IT student for undergrads)

Practicum project in metallurgical engineering. Student chooses topic, subject to individual faculty member approval, in experimental lab investigation, plant design project, technical feasibility study or critical literature review.

5800. MINERAL PROCESSING I. (4 cr; prereq #; 3 lect and 3 lab hrs per wk)

Introduction to unit operations of mineral processing. Size reduction, classification, mineral separation, and auxiliary operations. Application of physical and chemical principles to mineral processing problems.

5801. MINERAL PROCESSING II. (4 cr; prereq #; 3 lect and 3 lab hrs per wk)

Principles of mineral processing. Chemical, physical, and engineering aspects of size reduction; fine particle measurement and processing; classification; mineral separation including gravity, flotation, electric, and magnetic. Auxiliary operations including dewatering, sampling and analysis, material handling, and process monitoring. Integration of operations and processes on a plant basis.

5900. METALLURGICAL HEAT TRANSFER AND FLUID FLOW. (4 cr; prereq #; 4 lect hrs per wk)

Fluid flow and heat transfer concepts in metallurgical systems. Theory and correlation to industrial practice. Applications to temperature measurements, thermal insulation, and heating and cooling of solid bodies.

5901. PRINCIPLES OF METALS EXTRACTION.

(4 cr; prereq 5102 or #; 3 lect and 1 rec hrs per wk) Evaluation of (a) pyrometallurgical, hydrometallurgical, and electrometallurgical extraction of metals from their concentrates, e.g., extraction of Cu, Ni, Pb, Zn, Mg, Al, Ti, ironmaking, and steelmaking, (b) metal melting and recycling.

5902. PYROMETALLURGICAL PROCESSES. (4 cr; prereq 5901 or #; 3 lect and 1 rec hrs per wk)

Thermodynamic and kinetic evaluation of (a) pyrometallurgical unit operations for the extraction of nonferrous and ferrous metals from their concentrates, (b) structure and functions of slags, fluxes and refractories.

5903. HYDROMETALLURGY. (4 cr; prereq 5100, 5101, 5102 or #; 3 lect and 3 lab hrs per wk)

Preparation of ores, concentrates, and secondary metals; thermodynamic, kinetic, electrochemical, and mineralogical aspects of leaching; practical leaching systems; purification of leach solutions by chemical precipitation, ion exchange, and solvent extraction; recovery of values in purified solutions; application in practice with flowsheets.

5941. SPECIAL PROBLEMS IN EXTRACTIVE METALLURGICAL ENGINEERING. (1-6 cr; prereq sr or grad student)

Literature survey, research, design, feasibility studies in metallurgical engineering.

5942. SPECIAL PROBLEMS IN EXTRACTIVE METALLURGICAL ENGINEERING. (1-6 cr; prereq grad student)

Literature survey, research; design, feasibility studies in metallurgical engineering.

8000. APPLIED PROCESS METALLURGY I. (3 cr; prereq #)

Modern developments in mineral processing and metals extraction; future trends.

8921, 8922, 8923.* RESEARCH IN EXTRACTIVE METALLURGICAL ENGINEERING. (Cr ar; prereq #)

8930.* PHYSICAL CHEMISTRY OF HIGH TEMPERATURE METALLURGICAL REACTIONS I. (3 cr; prereq 5910 or #)

Physicochemical approach to the reactions of iron and steelmaking. Thermodynamics of liquid steel. Reactions in liquid metal solutions.

Molecular Biology

See Biochemistry, Molecular Biology and Biophysics.

See Molecular, Cellular, Developmental Biology and Genetics.

Molecular, Cellular, Developmental Biology and Genetics

Regents' Professor: James G. White (laboratory medicine and pathology)

Professor: Steven C. McLoon (cell biology and neuroanatomy), *director of graduate studies;* Dwight L. Anderson (microbiology); G. Eric Bauer (cell biology and neuroanatomy); Robert M. Brambl (plant biology); Jaroslav Cervenka (oral sciences); Bianca M. Conti-Fine (biochemistry); William P. Cunningham (genetics and cell biology); James W. Curtisinger (ecology, evolution, and behavior); Martin Dworkin (microbiology); Edward H. Egelman (cell biology and neuroanatomy); Robert P. Elde (cell biology and neuroanatomy); Franklin D. Enfield (genetics and cell biology); Stanley L. Erlandsen (cell biology and neuroanatomy); David P. Fan (genetics and cell biology); Anthony J. Faras (microbiology); James A. Fuchs (biochemistry); Leo T. Furcht (laboratory medicine and pathology); Burt G. Gengenbach (agronomy and plant genetics); Gordon D. Ginder (medicine); Perry B. Hackett (genetics and cell biology); David W. Hamilton (cell biology and neuroanatomy); Robert K. Herman (genetics and cell biology); William S. Herman (genetics and cell biology); Mark C. Herzberg (preventive sciences); Alan B. Hooper (genetics and cell biology); Ross G. Johnson (genetics and cell biology); Norman S. Kerr (genetics and cell biology); Richard A. King (medicine); William Krivit (pediatrics); Ryoko Kuriyama (cell biology and neuroanatomy); Hon Cheung Lee (physiology); Paul A. Lefebvre (genetics and cell biology); Paul C. Letourneau (cell biology and neuroanatomy); Richard W. Linck (cell biology and neuroanatomy); Dennis M. Livingston (biochemistry); Charles F. Louis (veterinary pathobiology); Paul T. Magee (genetics and cell biology); Matthew K. McGue (psychology); Larry L. McKay (food science and nutrition); Robert G. McKinnell (genetics and cell biology); David J. McLaughlin (plant biology); Jack H. Oppenheimer (medicine); Harry T. Orr (laboratory medicine and pathology); Ronald L. Phillips (agronomy and plant genetics); Stephen S. Rich (laboratory medicine and pathology); Howard W. Rines (agronomy and plant genetics); R. Paul Robertson (medicine); Irwin Rubenstein (plant biology); Walter Sauerbier (microbiology); Burton L. Shapiro (dentistry); W. Thomas Shier (medicinal chemistry); Carolyn D. Silflow (genetics and cell biology; plant biology); Michael J. Simmons (genetics and cell biology); Akhouri Sinha (genetics and cell biology); D. Peter Snustad (genetics and cell biology); David A. Somers (agronomy and plant genetics); Robert L. Sorenson (cell biology and neuroanatomy); Clifford J. Steer (medicine); Howard C. Towle (biochemistry); Brian G. Van Ness (biochemistry); Clare K. Woodward (biochemistry)

Associate Professor: Judith G. Berman (plant biology); Susan A. Berry (pediatrics); Martin Blumenfeld (genetics and cell biology); Robert J. Brooker (Biological Process Technology Institute; genetics and cell biology); Aristidis S. Charonis (laboratory medicine and pathology); Kathleen F. Conklin (microbiology); John F. Doebley (plant biology); J. Stephen Gantt (plant biology); Stuart F. Goldstein (genetics and cell biology); Betsy A. Hirsch (laboratory medicine and pathology);

Victoria Iwanij (genetics and cell biology); David C. LaPorte (biochemistry); James B. McCarthy (laboratory medicine and pathology); R. Scott McIvor (laboratory medicine and pathology); Neil E. Olszewski (plant biology); Mary E. M. Pierpont (pediatrics); Bernard E. Reilly (oral sciences); Janet L. Schottel (biochemistry); Sarah J. Schwarzenberg (pediatrics); Thomas A. Sellers (epidemiology); Jocelyn E. Shaw (genetics and cell biology); Effie C. Tsilibary (laboratory medicine and pathology); Chester B. Whitley (pediatrics); Susan M. Wick (plant biology)

Assistant Professor: Frederick T. Boyd (laboratory medicine and pathology); Donna R. Fontana (microbiology); Thomas S. Hays (genetics and cell biology); Georgiana May (plant biology); Mary E. Porter (cell biology and neuroanatomy); Ann E. Rougvie (genetics and cell biology); Jeffrey A. Simon (biochemistry); Robert T. Tranquillo (chemical engineering and materials science); H. Joseph Yost (cell biology and neuroanatomy)

Other: Mary J. Ahrens; Shari R. Baldinger; Beth A. Henderson-Conrad; Bonnie S. LeRoy; Carol J. Ludowese

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—The program provides students with scientific training in the basic life sciences, with emphasis on the molecular basis of genetics, development, and cell biology. Areas of specialization in the program are cell biology, developmental biology, genetics, and human genetics. Special institutes in human genetics, plant molecular genetics, and biological process technology provide opportunities for graduate study, as does a specialty in genetic counseling.

Prerequisites for Admission—The program is sufficiently flexible to accommodate students with a wide range of backgrounds. Students with bachelor's degrees in any of the biological, chemical, or physical sciences are encouraged to apply. Recommended academic preparation includes one year each of calculus, organic chemistry, and physics, and background in basic biology including biochemistry and genetics. Physical chemistry is recommended for students with interests in the molecular aspects of genetics. Research

experience is highly desirable. For students of demonstrated ability, background deficiencies can be made up during the first year of graduate study.

Special Application Requirements—

Applicants should submit three letters of recommendation from persons familiar with their academic and research capabilities; scores from the General (Aptitude) Test and the Subject (Advanced) Test (in biology or chemistry) of the Graduate Record Examination; and a statement of interests, goals, and research experience. Recommended date for receipt of completed applications is January 15. Graduate studies typically begin in summer session or fall term.

Master's Degree Requirements—The average length of time required to obtain a master's degree is two years. Students are admitted to the M.S. program only under exceptional circumstances (e.g., if, for personal reasons, they can be in the area for only two years) or if they are accepted into the genetic counseling specialization; in both cases, applicants must also be competitive for admission at the Ph.D. level.

Doctoral Degree Requirements—There are no specific course credit requirements. The Ph.D. program is designed by the student and the adviser to meet individual interests and goals. Advanced courses in genetics, molecular biology, cell biology, and biochemistry are required, in addition to special courses, topical seminar courses, laboratory research rotations, thesis research, department seminars, and journal clubs.

Language Requirements—None.

Applicants are urged to obtain a working knowledge of at least one language before enrollment.

Minor Requirements for Students

Majoring in Other Fields—Proposed minor courses typically include the genetics core series (GCB 8131 and 8132) and advanced cell biology courses (GCB 8148 and 8149) appropriate to the student's field of specialization.

For Further Information and Applications—

Inquiries about admission and financial support should be directed to the director of graduate admissions, Molecular, Cellular, Developmental Biology and Genetics, University of Minnesota, 250 Biological Sciences Center, 1445 Gortner Avenue, St. Paul, MN 55108 (612/624-7470; fax 612/625-5754; e-mail mcdbg@molbio.cbs.umn.edu). Inquiries about graduate program activities, courses, and research opportunities should be directed to the director of graduate studies at the same address and phone number.

MCDG 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

MCDG 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

MCDG 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Genetics and Cell Biology (GCB)

5015s. HISTOLOGY: CELL AND TISSUE ORGANIZATION. (5 cr; prereq Biol 5004 or #) Cunningham

Structure and function of vertebrate tissues and organs. Lectures combine electron microscopy, light microscopy, physiology, and cell biology of higher animals. Labs concentrate on light microscopy of mammalian tissues.

5024w. THE GENETICS OF DEVELOPMENT. (4 cr; prereq Biol 5003 or #) R Herman
Introduction to current concepts of and experimental approaches to the genetic basis of morphogenesis and metazoan development. Emphasis on organisms amenable to genetic analysis, including some prokaryotes and single-cell eucaryotes, a nematode and *Drosophila*.

5030s. LABORATORY: GENETICS. (2 cr; prereq 3022 or 5022 or BioC 5333 or Biol 5003)
Investigative approaches to analysis of genetic problems. Focus on a given organism or related group of organisms may differ quarterly.

5034w. INTERMEDIATE MOLECULAR GENETICS. (4 cr; prereq Biol 5003, 5004, advanced bioscience undergrad or non-bioscience grad student) Hackett
Molecular genetics of prokaryotes and eucaryotes, concentrating on characterization and regulation of gene expression; techniques used to study gene expression.

5035f. INTERMEDIATE CELL BIOLOGY. (4 cr; prereq Biol 5004 or #) Brooker
Selected scientific papers illustrating new concepts and experimental approaches to basic questions of cell organization and function. Membranes, secretion, endocytosis, the cytoskeleton, and the nucleus.

5061s. DEVELOPMENTAL BIOLOGY. (4 cr; prereq Biol 3011 or Biol 3111, Biol 5004) Kerr
Animal embryology; morphogenesis and cellular differentiation with emphasis on vertebrates and pattern formation. Control mechanisms of development.

5073s. ADVANCED HUMAN GENETICS. (4 cr; prereq 5034 or #) King
Application of molecular, biochemical, chromosomal, and population genetics to human variation and disease. Abnormal chromosome number and structure; abnormal enzyme, structural protein, receptor and transport; analysis of inheritance patterns; behavioral genetics; and genetic basis of common disease.

5114f. GENERAL PHYSIOLOGY. (3 cr; prereq Biol 3011 or Biol 3111, Biol 5001 or BioC 3021 or BioC 5331, Phys 1109 or Phys 1253 or Phys 1295) Goldstein
Quantitative approach to the study of cell function with emphasis on application of physical and chemical principles. Transport, electrical activity of cell membranes, cell contractility.

5134w. ENDOCRINOLOGY. (4 cr; prereq Biol 3011 or Biol 3111, Biol 5001 or BioC 3021 or BioC 5331 or #) W Herman
Survey of structure and function of invertebrate and vertebrate endocrine systems.

5605f. CELL BIOLOGY LABORATORY. (2 cr; prereq Biol 5004 or ¶5004 or #) Blumenfeld
Experimental approaches to cell structure, function, and replication, including microscopy, autoradiography, cell fractionation, and molecular and chemical analyses.

5970. DIRECTED STUDIES. (Cr ar; prereq #, Δ)
Individual study of selected topics or problems with emphasis on selected readings and use of scientific literature.

5990. DIRECTED RESEARCH. (Cr ar; prereq #, Δ)
Lab or field investigation of selected areas of research.

8060. CURRENT TOPICS. (2 cr [may be repeated for cr]; offered when feasible)

8131f. ADVANCED GENETICS I. (4 cr; prereq 3022 or Biol 5003, Biol 5001 or BioC 5751 or #) Lefebvre
Comparative organization of genetic material in prokaryotic and eukaryotic organisms. Mutation, complementation, and recombination as operational criteria for genetic analysis.

8132w. ADVANCED GENETICS II. (4 cr) Hackett
Action of the gene in molecular, cellular, and organismal development. Mechanisms of information transfer and regulation of these processes in various biological systems; emphasis on examining original research.

8148w. ADVANCED CELL BIOLOGY I. (4 cr, \$CBN 8148; prereq Biol 5004 or #) Iwani
Eucaryotic systems with emphasis on structure, function, and chemistry of cell organelles; also selected specialized cells. Membranes and secretion, including membrane methodologies, structure, function, synthesis, and turnover; cell surfaces, protein synthesis, glycosylation, membrane fusion, lysosomes, endocytosis, role of peroxisomes, and detoxification by endoplasmic reticulum.

8149s. ADVANCED CELL BIOLOGY II. (4 cr; prereq Biol 5003, Biol 5004) Hays, Silflow
Eucaryotic systems with emphasis on structure, function, and chemistry of cell organelles; also selected specialized cells. Motility and cell nucleus. Roles of microtubules and microfilaments in cell locomotion, shape changes, cytokinesis, ciliary beating, and organelle redistribution; cell cycle, chromosomal structure, replication and mitosis; compartmentalization and autonomy of mitochondria and chloroplasts.

8213f. ADVANCED MOLECULAR BIOLOGY I. (4 cr, \$BioC 8213, \$MdBc 8213; prereq BioC/MdBc 8002 or GCB 8132 or #)
Lectures, readings, and discussions. DNA replication, recombination and gene conversion, regulation of gene expression in prokaryotes, regulation of gene expression in eucaryotes, chromatin structure and transcription, organellar gene expression.

8214w. ADVANCED MOLECULAR BIOLOGY II. (4 cr, \$BioC 8214, \$MdBc 8214; prereq BioC/MdBc 8002 or GCB 8132 or #)
Lectures, readings, and discussions. RNA splicing, RNA stability, initiation and control of translation, animal viruses, gene families, transposable elements, somatic recombination, yeast molecular biology, oncogenes.

8900f,w,s. SEMINAR. (1 cr [may be repeated for cr]; S-N only)

8910f,w,s. JOURNAL CLUBS. (1 cr; prereq Δ; S-N only)
Critical evaluation of selected current literature.

8912. GENETIC COUNSELING IN PRACTICE. (4 cr; prereq admission to genetic counseling emphasis within genetics master's program or #) Leroy
Practical genetic counseling, communicating genetics and medical information to the family. Helping families with decision making.

8913. PSYCHOSOCIAL ISSUES IN GENETIC COUNSELING. (3 cr; prereq admission to genetic counseling emphasis within genetics master's program or #)
Interviewing skills, supportive counseling, case study analysis.

8914. ETHICAL AND LEGAL ISSUES IN GENETIC COUNSELING. (3 cr; prereq admission to genetic counseling emphasis within genetics master's program or #)
Professional ethics and concerns with new technologies.

8950. PRACTICUM: TEACHING IN GENETICS. (1 cr; prereq Δ; S-N only)
Supervised experience in classroom, laboratory, and/or recitation instruction in genetics courses; development of skills in effective use of instructional materials, tests, and measurement.

8960. PRACTICUM: TEACHING IN CELL AND DEVELOPMENTAL BIOLOGY. (1 cr; prereq Δ; S-N only)
Supervised experience in classroom, laboratory, and/or recitation instruction in cell and developmental biology courses; development of skills in effective use of instructional materials, tests, and measurement.

Graduate Programs

8970f,w,s,su. DIRECTED STUDIES. (Cr ar; prereq #, Δ) Staff

Content determined by interests of individual in consultation with instructor; independent, nonlaboratory study.

8990f,w,s,su. RESEARCH. (Cr ar; prereq #) Staff

CBN 5103. HUMAN HISTOLOGY. (3-8 cr [7 cr for med/dent fr]; prereq regis med/dent fr, Anat grad student or grad student with #) Sorenson, staff
Microscopic structure, cytochemical and functional aspects of cells, tissues, and organs.

CBN 8135. BIOLOGICAL ELECTRON MICROSCOPY: TECHNICS. (1-5 cr; prereq #; offered alt yrs) Erlandsen
Introduction to principles and technics of electron microscopy. Laboratory emphasis on acquisition of skills in tissue preparation, photography, use of electron microscope and ancillary equipment.

CBN 8136. BIOLOGICAL ELECTRON MICROSCOPY: TECHNICS. (1-5 cr; prereq #; offered alt yrs) Erlandsen
Specialized ultrastructural technics and their application to biologic problems. Laboratory emphasis on high resolution microscopy and use of scanning electron microscope.

CBN 8137. BIOLOGICAL ELECTRON MICROSCOPY: INTERPRETATION. (1-5 cr; prereq 5103, 8135-8136, and #; hrs ar; offered alt yrs) Erlandsen
Structure and function of cell organelles. Individual projects using advanced technics for both transmission and scanning electron microscopy.

CBN 8166. SEMINAR: PANCREATIC ISLET BIOLOGY. (3 cr; prereq #; offered alt yrs) Bauer, staff
Structure, development, physiology, and cell biology of pancreatic islets of Langerhans. Primary sources: original publications supplemented by recent reviews.

CBN 8210. DEVELOPMENTAL NEUROBIOLOGY. (3 cr; prereq 5111, Phsl 5112 or #; offered alt yrs) McLoon
Nervous system development. General mechanisms and experimental approaches.

Other Courses of Interest

Agro 8230. CYTOGENETICS

BioC 5025. LABORATORY IN BIOCHEMISTRY

Biol 5003. GENETICS.

Biol 5004. CELL BIOLOGY

Biol 5125. RECOMBINANT DNA LABORATORY

Biol 5951. SOCIAL USES OF BIOLOGY

CBN 8223. NEUROBIOLOGY OF ENDOCRINE REGULATION

EEB 5044. EVOLUTION

MicB 5218. IMMUNOLOGY

MicB 5321. PHYSIOLOGY OF BACTERIA

MicB 5424. BIOLOGY OF VIRUSES

MicB 8112. MICROBIAL GENETICS

MicB 8125. MICROBIAL ECOLOGY AND DEVELOPMENT

MicB 8421. VIROLOGY AND TUMOR BIOLOGY

NSc 5460. NEUROCHEMICAL COMMUNICATION

OPat 8012. HUMAN AND MEDICAL CYTOGENETICS

OPat 8300. HUMAN DEVELOPMENT GENETICS I

Path 8108. PATHOBIOLOGY I

Path 8109. PATHOBIOLOGY II

Path 8110. PATHOBIOLOGY III

Path 8130. CELL BIOLOGY OF THE EXTRACELLULAR MATRIX

Museum Studies (MSt)

Professor: Joanne B. Eicher (design, housing, and apparel); Robert J. Poor (art history); Janet D. Spector (anthropology); Peter S. Wells (ancient studies); Gayle Graham Yates (American studies)

Associate Professor: Margaret K. DiBlasio (curriculum and instruction); Kerry J. Freedman (curriculum and instruction)

Adjunct Associate Professor: Gordon R. Murdock (Bell Museum of Natural History), *director of graduate studies*

Assistant Professor: Lyndel I. King (University Art Museum)

Adjunct Assistant Professor: Louis B. Casagrande (design, housing, and apparel); Michael P. Conforti (art history); Robert Jacobsen (art history); George Keyes (art history)

Course of Study—Minor in museum studies, applicable to master's (M.A. and M.S.) and doctoral programs.

Curriculum—The museum studies minor offers a structured graduate curriculum for students interested in museums. It provides students from a variety of disciplines with an introduction to the issues involved in museum practices (e.g., educational, curatorial, administrative, and conservation). The curriculum can include seminars, directed readings, and internships.

Prerequisites for Admission—Admission to the museum studies graduate minor is contingent upon prior admission to a master's or doctoral degree-granting program within the Graduate School. It is anticipated that no more than 15 students will be admitted to this minor each year.

Minor Requirements—Master's students must take a total of 9 credits for the minor, doctoral students a total of 18 credits; for both master's and doctoral students, 4 of these required credits are for the introduction to museum studies core seminar.

Language Requirements—None specific to the minor program.

For Further Information, Applications, and List of Courses—Contact the Museum Studies Minor, University of Minnesota, 300 Bell Museum, 10 Church Street S.E., Minneapolis, MN 55455 (612/624-4112).

8010. MUSEUM HISTORY AND PHILOSOPHY.

(4 cr; prereq #)

Historical and philosophical roots of museum development from Renaissance to modern-day museums and historical societies.

8012. MUSEUM PRACTICES: CURATORIAL AND EDUCATION DEPARTMENTS IN MUSEUMS. (3 cr; prereq 8010 or #; offered alt yrs)

Practical aspects of museum work. Responsibilities and issues. Larger context of the museum in which these departments operate.

8013. MUSEUM PRACTICES: TECHNICAL AND ADMINISTRATIVE DEPARTMENTS. (3 cr; prereq 8010 or #; offered alt yrs)

Practical aspects of work of technical and administrative departments in contemporary museums: standards, practices, and larger museum context in which these departments function. Collections management, security, funding, boards, public relations, installation, budgeting.

8016. INTERNSHIP. (1-6 cr per qtr; prereq 8010, permission of MSt director of graduate studies after agreement between student and internship supervisor)

Music

Regents' Professor: Dominick Argento

Professor: Everett L. Sutton, *director*; John E. Anderson¹; David B. Baldwin¹; Alexander Braginsky¹; Margo Garrett¹; Paul A. Haack; James A. Hepokoski; Donna Cardamone Jackson; Craig J. Kirchoff; Thomas S. Lancaster; Richard Leppert; Glenda Maurice¹; Sally O'Reilly¹; Tanya Remenikova¹; Judith L. Zaimont

Associate Professor: David A. Grayson, *director of graduate studies*; Lydia Artymiw¹; Thomas J. Ashworth (on leave 1994-95); Dean W. Billmeyer¹; Robert L. Borg; Michael Cherlin; David A. Damschroder; Charles E. Furman; Jean Herzberg; Alan L. Kagan; Young-Nam Kim¹; Alex Lubet; Claire W. McCoy; Ronald C. McCurdy; Duncan R. McNab¹; Stephen W. Schultz; Rebecca P. Shockley; D. Clifton Ware, Jr.¹; Lawrence Weller¹

Assistant Professor: Eric A. Becher; Mark P. Bjork; Corey B. Konkol; Fernando A. Meza; Paul M. A. Shaw; John Tartaglia²

Affiliated Faculty: Kendall A. Betts²; Julia Bogorad²; Gary A. Bordner³; Christopher Brown³; Jane G. Burris; James L. Clute²; Marvin D. Dahlgren²; Richard Dirlam; David W. Eagle; Elaine K. Eagle; Jorja Fleezanis²; Kathryn Greenbank³; Burt T. H. Hara²; Ruben G. Haugen; Robert W. Jamieson²; David B. Kamminga²; Barbara G. Kierig; Merilee I. Klemp; Rosalind L. Laskin; Manuel Laureano²; James P. McGuire; Frances G. Miller; John W. Miller, Jr.²; Kathy S. Romey; Elizabeth Starr; Ross Tolbert²; Charles Ullery³; Jeffrey W. Van; Herbert E. Winslow³

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—Music: M.A. (Plan A and Plan B), M.A. (Plan B only), M.M., D.M.A., and Ph.D.; Music Education: M.A. (Plan B only).

Curriculum—For the *master of arts (M.A.) degree (Plan A and Plan B) in music* (Graduate School application code 0580), emphases are offered in musicology and ethnomusicology. For the *master of arts (M.A.) degree (Plan B only) in music* (Graduate School application code 0580), emphases are offered in theory and composition. For the *master of arts (M.A.) degree (Plan B only) in music education* (Graduate School application code 0584), emphases are offered in music education and music therapy. For the *master of music (M.M.) degree*, emphases are offered in piano, harpsichord, organ, voice, violin, viola, cello, double bass, flute, oboe, clarinet, saxophone, bassoon, French horn, trumpet, trombone, euphonium, tuba, percussion, harp, guitar, piano pedagogy, accompanying and coaching, orchestral conducting, wind ensemble and band conducting, choral conducting, and church music (choral and organ concentrations). For the *doctor of musical arts (D.M.A.) degree*, emphases are offered in piano, organ, voice, violin, viola, cello, clarinet, woodwinds, trumpet, trombone, guitar, accompanying and

¹ *Advising role restricted to master's and D.M.A. students.*

² *Minnesota Orchestra*

³ *St. Paul Chamber Orchestra*

Graduate Programs

coaching, and orchestral conducting. For the *doctor of philosophy (Ph.D.) degree*, emphases are offered in musicology, ethnomusicology, theory, composition, and music education/music therapy.

Prerequisites for Admission—Applicants to the M.A., M.M., Ph.D., and D.M.A. programs must hold a bachelor's degree or its equivalent with a major emphasis in one of the following areas of music: musicology and/or ethnomusicology, theory and/or composition, performance, or music education and/or music therapy.

Special Application Requirements—Three letters of recommendation. In addition, applicants to emphases in musicology/ethnomusicology, theory, or composition must submit scores for the Graduate Record Examination (GRE) General Test and music Subject Test. For music education and music therapy, only the GRE General Test scores are required. Applicants whose primary language is not English must score a minimum of 500 on the TOEFL test for admission and 550 for exemption from further English study (ESL).

The various degree programs also require the following additional application materials:

Degree Objective	Additional Materials
Theory (M.A., Ph.D.)	Original papers (tonal and post-tonal analysis)
Composition (M.A., Ph.D.)	Original scores
Musicology/ Ethnomusicology (M.A., Ph.D.)	Original paper(s)
Music Education/ Music Therapy (M.A.)	None
Music Education/ Music Therapy (Ph.D.)	Original paper(s)
Accompanying/Coaching (M.M., D.M.A.)	Audition/Repertoire list
Choral Conducting (M.M.)	Audition/Interview
Church Music (M.M.)	Audition/Interview
Orchestral Conducting	Audition/Interview (M.M., D.M.A.)
Wind Ensemble/ Band Conducting (M.M.)	Audition/Interview
Piano Pedagogy (M.M.)	Audition/Interview
Performance (M.M., D.M.A.)	Audition Repertoire list

For the M.M. and D.M.A. programs in performance, applicants living more than 200 miles from Minneapolis may submit a tape in lieu of a live audition. In the case of admission based on a taped recording, the appropriate level of study, including the possibility of remedial work, is determined by a live audition before registration. For the M.M. and D.M.A. in accompanying and coaching, a preliminary (audio) tape screening is required. For the M.M. and D.M.A. in orchestral conducting and the M.M. in wind ensemble/band conducting, a preliminary tape screening is required in both audio and video formats.

Although students may be admitted any quarter, opportunities for financial assistance are maximized by applying before January 15 for fall admission. Applicants to the musicology/ethnomusicology, theory, and composition emphases maximize their chances for admission by completing their applications before March 1 for fall admission.

Diagnostic Tests—Music Theory and Music History Placement Tests are administered to all entering students. All graduate students in music must demonstrate proficiency in the material found in the undergraduate music theory and ear training sequences, including twentieth-century music theory and ear training. Similarly, they must demonstrate proficiency in music history from the Middle Ages to the present. Students in musicology and ethnomusicology degree programs must take an additional discipline-specific diagnostic examination at the onset of their study; during the first year, a piano proficiency test is administered for the musicology specialization and a transcription test for ethnomusicology. An audition is required for registration in all applied music courses.

Degree Requirements—Program descriptions may be obtained from the School of Music graduate studies office.

Language Requirements—For the M.M. degree and for the M.A. and Ph.D. degrees in music education, none. For the M.A. degree

in music, a reading knowledge of French, German, or Italian is required. For the Ph.D. degree and the D.M.A. degrees in accompanying/coaching and orchestral conducting, two languages chosen from French, German, or Italian are required (German is required of theory and orchestral conducting majors). Substitution may be made with the approval of the relevant division when a different language is needed for an individual research project. For the Ph.D. degrees in theory and composition, one language may be replaced by a special research technique or collateral field of knowledge. For D.M.A. degree programs other than those named above, language requirements are at the discretion of the adviser according to the nature of the degree plan.

For Further Information and

Applications—Contact the School of Music, University of Minnesota, 100B Ferguson Hall, 2106 4th Street South, Minneapolis, MN 55455 (612/624-0071; fax 612/626-2200).

Music Applied (MusA)

Graduate courses in applied music are classified according to seven modes: elective, principal, major, secondary

required, secondary elective, principal beyond requirement, and major beyond requirement. Students may not register for a course in applied music until they have passed the required applied entrance audition. The audition committee determines the mode(s) for which a student may register. Students should consult the School of Music, 100 Ferguson Hall, regarding the audition as well as the mode and level of music appropriate for fulfilling specific requirements for their degree programs. All scholarship students and all M.M. students enrolled in principal- or major-level lessons are required to register concurrently for a large ensemble. This requirement does not pertain to keyboard or guitar majors.

Applied music courses in the various modes offered at the graduate level are listed below. Credits and prerequisites for all MusA courses are:

MusA 5101 to 5123

(2 cr; prereq audition, Δ)

MusA 8201 to 8223; 8401 to 8723

(2 or 4 cr [max 12 cr]; prereq music major, Δ)

MusA 8301 to 8324

(2 or 4 cr [max 16 cr for MM; max 48 cr for DMA]; prereq audition, Δ)

<i>Instrument</i>	<i>Elective</i>	<i>Principal</i>	<i>Major</i>	<i>Secondary Required</i>	<i>Secondary Elective</i>	<i>Principal Beyond Requirement</i>	<i>Major Beyond Requirement</i>
Piano	5101	8201	8301	8401	8501	8601	8701
Harpsichord	5102	8202	8302	8402	8502	8602	8702
Organ	5103	8203	8303	8403	8503	8603	8703
Voice	5104	8204	8304	8404	8504	8604	8704
Violin	5105	8205	8305	8405	8505	8605	8705
Viola	5106	8206	8306	8406	8506	8606	8706
Cello	5107	8207	8307	8407	8507	8607	8707
Double Bass	5108	8208	8308	8408	8508	8608	8708
Flute	5109	8209	8309	8409	8509	8609	8709
Oboe	5111	8211	8311	8411	8511	8611	8711
Clarinet	5112	8212	8312	8412	8512	8612	8712
Saxophone	5113	8213	8313	8413	8513	8613	8713
Bassoon	5114	8214	8314	8414	8514	8614	8714
French Horn	5115	8215	8315	8415	8515	8615	8715
Trumpet	5116	8216	8316	8416	8516	8616	8716
Trombone	5117	8217	8317	8417	8517	8617	8717
Baritone	5118	8218	8318	8418	8518	8618	8718
Tuba	5119	8219	8319	8419	8519	8619	8719
Percussion	5121	8221	8321	8421	8521	8621	8721
Harp	5122	8222	8322	8422	8522	8622	8722
Guitar	5123	8223	8323	8423	8523	8623	8723
Accompanying/Coaching			8324				

Graduate Programs

Mus 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Mus 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Mus 8888. THESIS CREDITS: DOCTORAL. (36 cr required for PhD, 6 cr required for DMA)

Mus 8999. RECITAL CREDITS: DOCTORAL. (6 cr [max 12 cr per qtr]; prereq DMA student)
Registration for recital credits coincides with performance of DMA recital, for total of 30 credits (5 recitals).

Music (Mus)

Vocal/Choral/Opera Studies

(See also Music Applied section above and *Ensembles*)

5150. BODY AWARENESS IN ACTIVITY: THE ALEXANDER TECHNIQUE FOR MUSICIANS. (2 cr; prereq music major or #; CEE only)
Introduction to Alexander Technique with specific applications to music performance. Emphasis on body/mind awareness to promote technical ease and freedom.

5260. WORKSHOP: SACRED CHORAL REPERTOIRE. (2 cr)

Sacred choral literature of all periods covering church year and festive occasions. Special lectures and topics with guest faculty.

5261. WORKSHOP: BUILDING THE SACRED MUSIC LIBRARY. (1 cr)

Systematic and thorough building of a library of sacred choral music.

5370. VOCAL PEDAGOGY PRACTICUM. (1 cr per qtr [max 3 cr]; prereq sr or grad student, #) Ware
Application of principles and techniques for group or individual adult instruction at beginning, intermediate, and advanced levels. Observation of faculty while teaching students.

5371f, 5372w, 5373s. DICTION FOR SINGERS. (2 cr per qtr; prereq 12 cr of 1204 or #)
Principles and techniques of singing in English, Italian, German, and French. International Phonetic Association alphabet used. 5371: English and Italian. 5372: German. 5373: French.

5374. TEXT AND LANGUAGE: A SINGER'S TOOLS FOR INTERPRETATION. (2 cr; prereq #)
Maurice

Specific meanings, properties, and inflections of words as used by singers for artistic interpretation; role of musical setting in defining meaning. Performance required.

5375. THE VOCAL MECHANISM. (2-3 cr; prereq sr or grad student, #) Ware
Mental and physical preparations for singing. Voice production basics of singing and speaking: respiration, phonation, registration, resonance, articulation. Anatomy and physiology of vocal mechanism. Efficient, healthy voice methods and techniques. Optional 1 credit research project.

5376. VOCAL PERFORMANCE. (2-3 cr; prereq sr or grad student, #) Ware

Analysis and interpretation of art songs. Performance skills, styles, methods, and techniques; recital programming; career opportunities; pedagogical application of subject matter to art song performance. Optional 1 credit research project.

5377. VOCAL PEDAGOGY. (2-3 cr; prereq sr or grad student, 5375, #) Ware

Historical survey of voice pedagogues and comparative teaching methodology. Learning theory; general teaching methods and techniques; teaching child, adolescent, and aging voice; teaching pedagogy classes, individuals, and group voice. Optional 1 credit research project.

5378. VOCAL CONFERENCE/WORKSHOP. (1-2 cr; prereq sr or grad student, #) Ware

Specific theme for each conference or workshop. Anatomy and physiology of vocal mechanism; scientific research and applications; vocal methods and techniques; voice use and care.

5384, 5385. CHORAL CONDUCTING. (4 cr per qtr; prereq #; offered alt yrs) Lancaster
Choral conducting technique, rehearsal procedures, choral tone, performance practice.

5741, 5742. VOCAL LITERATURE. (4 cr per qtr; prereq 12 cr in 1104 or 1204 or 1304 or #; offered alt yrs)
Vocal literature of major and minor composers from 16th century to present; structure, style, and performance practice.

8399f,w,s. PERFORMANCE: CHORAL CONDUCTING. (4 cr; prereq 5384, 5385, #) Lancaster
Preparation and performance of a choral conducting recital, with supporting paper.

8537. SCORE STUDY (CHORAL). (4 cr; prereq grad student, #) Lancaster
Analysis of various choral scores ranging from Renaissance era through 20th century. Reading of choral and choral/orchestral scores at piano, including scores employing C clefs and transposing instruments.

8754. CHORAL LITERATURE: RENAISSANCE THROUGH BAROQUE ERAS. (4 cr; prereq grad student, #) Lancaster
Sacred and secular choral works of Renaissance and baroque eras.

8755. CHORAL LITERATURE: CLASSICAL ERA THROUGH THE 20TH CENTURY. (4 cr; prereq grad student, #) Lancaster
Sacred and secular choral works of classical era through 20th century.

Keyboard Studies

(See also Music Applied section above and *Ensembles*)

5150. BODY AWARENESS IN ACTIVITY: THE ALEXANDER TECHNIQUE FOR MUSICIANS. (2 cr; prereq music major or #; CEE only)
See Vocal/Choral/Opera Studies for description.

5310. PIANO PEDAGOGY PRACTICUM. (1 cr per qtr [max 3 cr]; prereq ¶5351-5352-5353 or ¶5354-5355-5356 or #) Shockley

Application of principles and techniques for group or individual instruction at elementary, early intermediate, and late intermediate levels in directed teaching setting.

5351f-5352w-5353s. PIANO PEDAGOGY. (2 cr per qtr; prereq 12 cr in MusA 1201 or MusA 1301 or #; offered alt yrs) Shockley

Demonstration and discussion of teaching techniques, methods, and materials for group and individual instruction at elementary, early intermediate, and late intermediate levels.

5354f-5355w-5356s. ADVANCED PIANO PEDAGOGY. (2 cr per qtr; prereq grad piano major or 5353 or #; offered alt yrs) Shockley

Demonstration and discussion of teaching techniques, methods, and materials for group and individual instruction at intermediate and early advanced levels.

5411. INSTRUMENTAL ACCOMPANYING SKILLS AND REPERTOIRE. (2 cr; prereq accompanying major) Garrett

Performance class in accompanying skills particular to orchestral reductions and "non-sonata" instrumental accompanying. Repertoire to include, but not be limited to, classical and romantic string concerti and "encore" pieces.

5421, 5422, 5423. VOCAL ACCOMPANYING SKILLS AND REPERTOIRE. (2 cr per qtr; prereq French and German and Italian diction, accompanying or graduate vocal major) Garrett

Performance class (*Lieder, mélodie*, opera) with emphasis on coaching techniques and performance skills of pianists and singers.

5744f, 5745w, 5746s. PIANO LITERATURE. (2 cr per qtr; prereq 12 cr of MusA 1201 or 1301 or #; offered alt yrs) McNab

Literature for piano from late Baroque period to mid-20th century.

5747, 5748, 5749. ORGAN LITERATURE. (2 cr per qtr; prereq 3606, 3532 or #) Billmeyer
Organ literature from 14th century to present. Influence of organ design from various periods and national schools on literature, performance.

8401, 8402, 8403. SONATA SEMINAR. (2 cr per qtr; prereq accompanying major; strings and winds by audition, #) Garrett

Performance class in standard Baroque, Classical, and Romantic sonatas for piano and violin, cello, viola, flute, clarinet, or oboe.

8421, 8422, 8423. ADVANCED VOCAL ACCOMPANYING SKILLS AND REPERTOIRE.

(2 cr per qtr; prereq French and German and Italian diction, accompanying major or DMA vocal major; MM vocal major by audition only) Garrett
Advanced performance class (*Lieder, mélodie*, opera) with emphasis on coaching techniques and performance skills of pianists and singers.

Instrumental Studies

(See also Music Applied section above and *Ensembles*)

5016. TRUMPET PEDAGOGY. (2 cr; prereq 12 cr lower div trumpet lessons) Baldwin
Principles. Discussion of literature, history, method, and current teaching aids.

5150. BODY AWARENESS IN ACTIVITY: THE ALEXANDER TECHNIQUE FOR MUSICIANS. (2 cr; prereq music major or #; CEE only)
See Vocal/Choral/Opera Studies for description.

5321-5322-5323. SUZUKI VIOLIN PEDAGOGY. (2 cr per qtr; prereq undergrad or grad string major with violin as principal performing instrument or #) Bjork
Intensive examination of philosophy and teaching techniques of Japanese pedagogue Shinichi Suzuki and their application in Western culture. Discussion, playing experience, and observation of children's lessons in MacPhail Center Suzuki Program.

5324-5325-5326. ADVANCED SUZUKI VIOLIN PEDAGOGY. (2 cr per qtr; prereq 5323 or equiv, audition; offered when feasible) Bjork

5350. ORCHESTRAL REPERTOIRE. (1 cr)
Performance problems in standard orchestral repertoire: style and interpretation.

5361f-5362w-5363s. VIOLIN PEDAGOGY I. (2 cr per qtr; prereq 12 cr in 1205 or 1206 or 1305 or 1306 or #)
Private teaching of violin students at beginning, intermediate, and advanced levels. Discussion and demonstrations of pedagogical techniques.

5364, 5365. CELLO PEDAGOGY. (2 cr; prereq 12 cr applied cello or MuEd 3501 or #; offered when feasible) Remenikova

5366. GUITAR PEDAGOGY. (2 cr; prereq guitar principal or major or #) Van
Teaching techniques, including historical survey of methods and etudes from late 18th century to present; variety of content and approach.

5387. INSTRUMENTAL CONDUCTING. (4 cr; prereq #)
Basic conducting techniques; role of conductor.

5388. ADVANCED INSTRUMENTAL CONDUCTING. (4 cr; prereq 5387 or #)
Score study, instrumentation, performing practices.

5389. CONDUCTING WIND LITERATURE. (3 cr; prereq music grad student with undergrad conducting exper or equiv or #; offered when feasible)

5391. HISTORY AND ACOUSTICS OF SINGLE REED INSTRUMENTS. (2 cr; prereq upper div standing in major instrument or #) Anderson
Clarinet and saxophone history and literature, mechanical design and development, acoustics, modern schools of performance.

Graduate Programs

5392, 5393. WOODWIND LITERATURE AND PEDAGOGY I AND II. (3 cr per qtr; prereq upper div standing in major instrument or grad student or #) Anderson

5392: Major teaching methods for the five woodwind instruments, including solos and ensembles used primarily for pedagogical reasons. 5393: Major solo and chamber literature for the five woodwind instruments.

5564. BAND ARRANGING. (4 cr; prereq 3532, 5563 or MuEd 3516 or #) Schultz

Scoring techniques for wind and percussion instruments. Scoring for band. Creative arrangements for marching or concert band.

5731-5732-5733. PERCUSSION LITERATURE I-II-III. (2 cr per qtr; prereq upper div undergrad or grad perc major or #) Meza

Study, analysis, and performance. 5731: Orchestral/band repertoire for snare drum and percussion accessories; solo literature for percussion instruments. 5732: Orchestral/band repertoire for mallet instruments; literature for percussion ensemble. 5733: Orchestral/band repertoire for timpani; chamber music for mixed ensembles of percussion and non-percussion instruments.

5971. MUSIC TRANSCRIPTION FOR WINDS. (2 cr; prereq 3532) Baldwin

Transcription of three works with score and parts copied in ink. Principles of music manuscript and examination of examples of transcription.

8380. ORCHESTRAL CONDUCTING. (4-5 cr; prereq #; required for orchestral conducting majors)

Orchestral conducting techniques, including work with diverse orchestral, operatic, choral, and dance repertoires of differing styles and periods; 17th century to present.

8391-8392. ADVANCED CONDUCTING. (4 cr per qtr; prereq #)

Application of conducting techniques to music from 16th century to contemporary times through analysis of stylistic and technical characteristics of each historical period.

Jazz Studies

(See also *Ensembles*)

5300. JAZZ RHYTHM SECTION TECHNIQUES.

(1 cr per qtr; prereq jazz studies major or #) McCurdy
Study and function of instruments in jazz rhythm section. Bass line construction, voicings for piano and guitar, style patterns for percussion.

5331. JAZZ IMPROVISATION IV. (2 cr; prereq 3331, 3332, 3333 or audition) McCurdy

Analysis of and improvisation on advanced tunes from post-bop literature (ballads, Latin, swing, rock); application of harmony beyond seventh chords, quartal harmonies; development of knowledge of American standards.

5332. JAZZ IMPROVISATION V. (2 cr; prereq 5331 or audition) McCurdy

Analysis of and improvisation on advanced tunes from post-bop literature; application of advanced harmony; development of ability to execute in faster tempos; transposition and transcriptions.

5333. JAZZ IMPROVISATION VI. (2 cr; prereq 3331, 3332, 3333 or audition) McCurdy

Analysis of and improvisation on advanced tunes from post-bop literature; application of advanced harmony; development of ability to execute 5/4, 7/4, and other multi-metered tunes, ballads, and transcribed solos.

5336. JAZZ ARRANGING I. (2 cr; prereq 3532 or #) McCurdy

Beginning techniques for arranging for chamber jazz ensemble; vocal and instrumental.

5337. JAZZ ARRANGING II. (2 cr; prereq 3532, 5336 or #) McCurdy

Intermediate and advanced techniques for arranging for chamber jazz ensemble; vocal and instrumental.

5341. JAZZ PEDAGOGY. (2 cr; prereq 3532)

McCurdy
Published and unpublished jazz improvisation methods and materials. Rehearsal techniques for big band, combo, and vocal jazz ensemble.

5342. JAZZ THEORY. (2 cr; prereq 3532 or #)

McCurdy
Beginning techniques for basic chord construction, extended chords, and nomenclature in jazz idiom.

Ensembles

5290. JAZZ SINGERS. (1 cr per qtr; prereq #)

McCurdy
Sight reading, study, and performance of representative vocal jazz literature.

5330. CONCERTO GROSSO ENSEMBLE. (1 cr; prereq #) Kim

Study and performance of string orchestra and small chamber orchestra literature.

5340f,w,s. JAZZ ENSEMBLE. (1 cr per qtr [max 6 cr]; prereq audition, #) McCurdy

A 20-member performing organization covering significant jazz compositions and arrangements written specifically for this medium.

5360. WOODWIND ENSEMBLE. (1 cr per qtr; prereq audition) Anderson

Practice and performance of chamber music for combinations of woodwind instruments in small groups (3 or more players) and in large homogenous instrumental choirs.

5380. BRASS CHOIR. (1 cr per qtr; prereq #) Baldwin

Practice and performance of representative brass ensemble literature from antiphonal music of Giovanni Gabrieli to works of 20th century.

5390. PERCUSSION ENSEMBLE. (1 cr; prereq #)

Practice and performance of standard and contemporary compositions for percussion ensembles in various combinations.

5410f,w,s. UNIVERSITY WIND BANDS. (1 cr per qtr; prereq audition, #)

Wind ensemble and symphony bands perform standard and contemporary literature; concerts and tour appearances. Players from all colleges may participate.

5420f, w.s. ORCHESTRA. (1 cr per qtr; prereq audition, #)

Symphony orchestra performs standard repertoire and major works with chorus; concerts and tour appearances. Players from all colleges may participate.

5430f, w.s. CHORUS. (1 cr per qtr; prereq audition, #)
Sec. 1—Women's Chorus: Performance of concert music for women's voices, 16th-20th centuries. Sec. 2—Men's Chorus: Performance of concert music for men's voices, 16th-20th centuries. Sec. 3—Concert Choir: Performance of concert music for mixed ensemble, 16th-20th centuries. Sec. 4—Choral Union: Large oratorio chorus that performs major works for chorus with orchestra. Sec. 5—Conducting Class Ensemble: Participation in laboratory ensemble for choral conducting class.

5440f, w.s. ENSEMBLE. (1 cr per qtr; prereq #)
Performance of chamber music: duos (sonatas), trios, quartets, quintets, and other ensemble combinations for instruments and/or voices.

5450f, w.s. COLLEGIUM MUSICUM. (1 cr per qtr; prereq #)
Small ensemble of singers and instrumentalists study and perform early music.

5460f, w.s. NEW MUSIC ENSEMBLE. (1 cr per qtr; prereq #)
Practice and performance of recent music for various combinations of vocal and instrumental ensembles.

5470f, w.s. OPERA WORKSHOP AND ENSEMBLE. (1 cr per qtr; prereq ability to sing arias satisfactorily by audition, #) Sutton
Preparation and performance of operatic arias, choruses, and scenes. Participation in fully staged or workshop productions of music-theatre repertoire.

5480. OPERA THEATRE. (2 cr; prereq advanced ability to sing arias satisfactorily by audition, #) Sutton
Preparation and performance of fully-staged operatic production. Major involvement in singing, acting, and technical aspects of opera.

5490f, w.s. CHAMBER SINGERS. (1 cr per qtr; prereq audition, #) Lancaster
Mixed chorus of 24 voices. Performances each quarter.

Topics and Directed Studies

5950. TOPICS IN MUSIC. (1-5 cr [exact cr and prereq designated for each offering])
For topics, see current *Class Schedule*.

5970. DIRECTED STUDIES. (1-5 cr; prereq #, Δ, CLA approval)
Guided individual reading or study.

8950. TOPICS IN MUSIC. (1-5 cr)
For topics, see current *Class Schedule*.

8990. SPECIAL PROBLEMS. (2-12 cr; prereq Δ)

Music Theory and Composition

5521f-5522w-5523s. ADVANCED KEYBOARD HARMONY. (2 cr per qtr; prereq 3532, sr or grad student) Billmeyer

Diatonic and chromatic harmony at the piano. Realization of figured basses of the 17th and 18th centuries. Performance of choral, orchestral, and chamber music of 17th-20th centuries from open score using all clefs.

5532. ANALYSIS OF 20TH-CENTURY MUSIC. (3 cr; prereq 3532)
Introduction to analysis of 20th-century music.

5533. MUSIC SINCE 1945. (4 cr; prereq 3532 or #)
Procedures and techniques of music composed since 1945.

5541f. COUNTERPOINT. (4 cr; prereq 3531, 3511 or equiv) Lubet
Practice writing in polyphonic styles of Renaissance and Baroque.

5550. COMPOSITION. (2 cr per qtr [max 12 cr]; prereq 3532 or equiv, 3553 or grad student, #) Argento, Lubet, Zaimont
Original work in various forms.

5561f-5562w-5563s. ORCHESTRATION. (2 cr per qtr; prereq 3532) Argento, Zaimont
Scoring instruments for ensemble combinations and full orchestra.

5571. SCHENKERIAN ANALYSIS FOR PERFORMERS. (4 cr; prereq 3531; offered alt yrs) Damschroder
Theory and analysis of tonal music using principles developed by Heinrich Schenker. Basic concepts and notation, and their application to excerpts and short pieces from 18th and 19th centuries.

5572. CHROMATICISM IN LATE-TONAL MUSIC. (4 cr; prereq 3534; offered alt yrs) Damschroder
Exploration of late-tonal chromatic practice through analysis of selected repertoire, completion of written exercises (figured bass, harmonization of melodies, model composition), ear training, and keyboard drill.

5791. ELECTRONIC MUSIC: HISTORY, LITERATURE, PRINCIPLES. (4 cr)
History of technological developments that made electronic music possible; composers and compositions that reflect maturation of craft and connection with prevailing aesthetic values; equipment, principles, and techniques used in production.

5793. ANALOG SYNTHESIS AND RECORDING TECHNIQUES. (2 cr; prereq 5791 or ¶5791)
Studio work with stereo and quadraphonic tape recorders and selected microphones directed toward development of recording skills (e.g., splicing, dubbing, preparation of tape loops, and synchronization of recording on discrete channels); exploration of analog synthesis equipment and its compositional possibilities and techniques.

Graduate Programs

5795. DIGITAL MUSIC SYNTHESIS AND PROCESSING TECHNIQUES. (2 cr; prereq 5793)

Studio work with digital synthesizers and processors, recording equipment, and computers (using variety of software) to develop skills in using digital equipment for composition, teaching, and performance.

5796. COMPUTER APPLICATIONS IN MUSIC: FOR USE BY COMPOSERS, PERFORMERS, AND SCHOLARS. (4 cr; prereq music major or #)

Using PCs for research, composition, and performance of electro-acoustic compositions requiring computers. Use of modem, graphics, score preparation, MIDI interfacing, word processing.

5797. MUSIC AND TEXT: SEMINAR ON THE INTERRELATIONS OF TEXT AND MUSIC. (4 cr; prereq 3531, 3532) Cherlin

Interrelations of poetic imagery, form, metrics, and sonic characteristics with aspects of musical form, including repertory from 18th through 20th centuries.

8540. ELECTRONIC COMPOSITION. (3 cr per qtr [max 12 cr]; prereq composition major, 5550 or 8550, 5795 or equiv or #)

Music composition including use of computers and MIDI equipment.

8550. COMPOSITION. (3 cr per qtr [max 18 cr]; prereq completion of undergrad major sequence in music theory and composition, #) Argento, Lubet, Zaimont

8555. MUSIC THEORY PEDAGOGY. (4 cr; prereq undergrad degree in music or #) Lubet

Comparative study of different approaches to teaching music theory; available literature (harmony, ear-training/sightsinging, counterpoint, composition, orchestration, form and analysis texts and anthologies); specific pedagogical problems.

8560. READINGS IN MUSIC THEORY. (4 cr; prereq #)

Seminars on major theoretical text or group of interrelated texts.

8565. TEXT SETTING. (4 cr; prereq major in composition or choral conducting or voice or accompanying or music educ, #) Zaimont

Text setting techniques for many mediums (from jingle to art song to choral settings) through analysis of repertoire and original compositions. Emphasizes sense and sound features of language in general, nature of specific text, and special considerations in writing for voice.

8570. SEMINAR IN COMPOSITION. (4 cr per qtr [max 12 cr]; prereq grad student, #)

Aesthetic and technological influences on compositional attitudes and techniques; notation, electronic synthesis, new and expanded instrumental resources, and multimedia composition (e.g., stage and film).

8571. COMPOSERS' LABORATORY I. (1 cr; prereq 8570) Zaimont

Current compositional styles focusing on works by class members. Project involving composing to specification for possible radio/TV/theatre/dance/film use.

8572. COMPOSERS' LABORATORY II. (1 cr; prereq 8570, 8571) Zaimont

Analytical/critical project based on research into current factors influencing criticism in arts/music journalism. Current compositional styles focusing on works by class members.

8575. WOMEN COMPOSERS. (4 cr; prereq #) Zaimont

Contributions by women composers to development of European-American art music, primarily from the 17th through 20th centuries. Historical and current issues affecting women's access to professional music sphere. Music analysis, listening list, research and performance components.

8580. TOPICS IN TONAL ANALYSIS. (4 cr; prereq #) Zaimont

Seminars on major composition or group of interrelated compositions from tonal period.

8581-8582. SCHENKERIAN THEORY AND ANALYSIS I AND II. (4 cr per qtr; prereq 3534 or #) Damschroder

Critical reading of major treatises by Heinrich Schenker, including *Harmony*, *Counterpoint*, and *Free Composition*. Application of his method to representative repertoire from 18th and 19th centuries. Contrapuntal writing modeled after presentation in *Counterpoint*.

8590. TOPICS IN 20TH-CENTURY ANALYSIS.

(4 cr; prereq #)

Seminars on major composition or group of interrelated compositions from 20th century.

8861. HISTORY OF MUSIC THEORY: 1550-1750.

(4 cr; prereq #) Damschroder

Speculative and practical musical theories of late Renaissance and Baroque eras, including monody, tuning systems, figured bass, chords and their inversions, rhetoric, counterpoint, and acoustics.

8862. HISTORY OF MUSIC THEORY: 1750-1935.

(4 cr; prereq #) Damschroder

Speculative and practical musical theories of Classical through Early Modern eras, including harmony, counterpoint and fugue, melody, form, rhythm, acoustics, and pedagogical works.

8863. SEMINAR: THEORIES AND CONCEPTS IN POST-TONAL MUSIC. (4 cr; prereq completion of 3-yr undergrad theory program or equiv) Cherlin

Discussion of post-tonal music theories (as conceived by composers and theorists) and views of such music for which theories have not been articulated, using appropriate writings and scores.

Musicology and Ethnomusicology

5182. BAROQUE PERFORMANCE PRACTICE.

(4 cr; prereq sr or grad student, 3606, 3532 or #)

Ornamentation, phrasing, articulation, and improvisation in music of period 1550-1759. Instruction books of period; analysis of performance of baroque music in baroque style.

5644. STUDIES IN 20TH-CENTURY AMERICAN

MUSIC. (4 cr; prereq 3606, 5532 or #) Hepokoski
Competing concepts of musical style and purpose in 20th-century America: stylistic and cultural bases of both "art" and "popular" music and their (often uneasy) interrelationships. Typical areas include Ives, Copeland, 1920s jazz, Broadway, and popular song.

5645. EIGHTEENTH-CENTURY EUROPEAN

MUSIC. (4 cr; prereq 3606 or equiv [12 undergrad cr in mus hist], 3534 or equiv, # for undergrads)
Survey of vocal and instrumental genres (opera and church, orchestral, chamber, and keyboard music) as they developed from High Baroque through Classical era.

5646. NINETEENTH-CENTURY EUROPEAN

MUSIC. (4 cr; prereq 3606 or equiv [12 undergrad cr in mus hist], 3534 or equiv, # for undergrads) Grayson, Hepokoski
Survey of major composers, issues, and problems in history of 19th-century European music: transformations of sonata and symphony, "absolute" and "program" music, opera and "music drama," aesthetic conceptions of music, structural and harmonic innovations.

5647. TWENTIETH-CENTURY EUROPEAN/

AMERICAN MUSIC. (4 cr; 3606 or equiv, 12 undergrad cr in mus hist, 5532 or equiv, # for undergrads) Jackson
Survey of major composers, issues, and problems in history of 20th-century European/American music: principal trends and artistic movements, new musical aesthetics, transformations of 19th-century genres, new methods of organization.

5666. STRAVINSKY. (4 cr; prereq 12 cr music history, 5532) Jackson

Changing styles and aesthetic principles of Stravinsky as seen in representative compositions and writings on music; contributions to artistic life in Europe and America (particularly ballet).

5667. CHAMBER MUSIC OF BEETHOVEN. (4 cr; prereq 3606, 3532; offered when feasible)**5757, 5758. HISTORY OF THE SYMPHONY.** (4 cr per qtr; prereq 3606, 3532; offered when feasible)**5804. FOLK AND TRADITIONAL MUSIC: CROSS-CULTURAL SURVEY.** (4 cr; offered when feasible) Kagan**5810. ASIAN MUSIC IN PERFORMANCE.** (2 cr; prereq #) Kagan

Development of vocal and/or instrumental skills through applied training and lecture demonstrations.

5811. TRADITIONAL INDIAN MUSIC: THE SACRED AND THE PROFANE. (4 cr) Kagan

Vedic chant and regional folk music. Musical analysis and associations with belief systems, social institutions, history and aesthetic expression. Music theory of India, notational systems, tonal and rhythmic materials and classifications, musical forms and performance practices.

5841. RESOURCES FOR MUSIC RESEARCH. (2 cr;

prereq 3606 or #) Probst
Introduction to use of basic bibliographies and indexes, reference works, periodicals and historical editions; techniques for preparing an annotated bibliography.

5863. MUSICAL INSTRUMENTS OF THE WORLD.

(4 cr; offered when feasible) Kagan

5864. AMERICAN FIDDLE TRADITIONS. (4 cr;

prereq #) Kagan
Repertoire and performance practice of American fiddle music; rural and urban contexts; social, stylistic, and regional history. Training in performance is optional.

8631f. MUSIC IN MEDIEVAL EUROPE. (4 cr; prereq

3606; offered alt yrs) Jackson
Medieval styles from 9th through 13th centuries: chant and liturgy, lyric song forms, polyphonic genres. Analysis and criticism, performance traditions in socio-cultural contexts.

8632w. MUSIC OF THE ARS NOVA AND EARLY RENAISSANCE. (4 cr; prereq 3606; offered alt yrs)

Jackson
History of music from Machaut through Josquin: secular song, mass and motet. Analysis and criticism, performance traditions in sociocultural contexts.

8661. SEMINAR: EDITING LASSO'S MUSIC FOR

PERFORMANCE. (4 cr; prereq undergrad degree in music) Jackson
Preparation of scores from primary sources of vocal and instrumental music (partbooks and tablatures); performance traditions in sociocultural contexts.

8840. SEMINAR IN MUSICOLOGY. (4 cr) Staff

Topics differ with each offering; readings, research strategies, and methods.

8843. CURRENT ISSUES IN HISTORICAL-CRITICAL PRACTICE. (4 cr; prereq grad student in music or #) Hepokoski

Key issues, controversies, and problems in the humanities; their implications for advanced work in musicology.

8844f. SEMINAR: ADVANCED RESEARCH IN HISTORICAL MUSICOLOGY. (4 cr; prereq

undergrad degree in music) Jackson
Reference and research materials, including computer applications and databases. Historical methods and historiography. Research strategies, documentation, and writing (criticism and narrative).

8845w. ADVANCED RESEARCH IN CURRENT MUSICOLOGY. (4 cr; prereq undergrad degree in

music) Hepokoski
Readings and topics in recent scholarly and analytical work.

8847. SEMINAR: NOTATION OF POLYPHONIC MUSIC. (4 cr; prereq undergrad degree in music; offered

alt yrs) Jackson
White mensural notation of 15th and 16th centuries. Transcribing and editing for historically informed performance from primary sources.

Graduate Programs

8864. RESEARCH IN ETHNOMUSICOLOGY. (4 cr; prereq 5861 or #) Kagan
Methods and techniques of fieldwork, eliciting and collecting. Practicum in field research with Minnesota ethnic and Indian music. Theories of transcription and actual transcription of materials collected. Description of musical compositions and analyses. Advanced readings in ethnomusicology.

Music Education (MuEd)

5111. RESEARCH IN MUSIC EDUCATION: BIBLIOGRAPHY. (3 cr) Schultz
Sources, materials, and techniques.

5112. RESEARCH IN MUSIC EDUCATION: TECHNIQUES. (3 cr) Furman, Haack
Methods and techniques employed in investigating and reporting of music education problems; review of significant research.

5115. RESEARCH IN MUSIC EDUCATION: MEASUREMENT. (3 cr; prereq #) McCoy
Current status of music testing; principles; survey of evaluative, accountability, and testing materials in music.

5211. PHILOSOPHIES OF MUSIC EDUCATION. (3 cr; offered alt yrs) Borg, Haack
Analysis and interpretation of philosophies in music and education; objectives, trends, curriculum, evaluation.

5214. PSYCHOLOGICAL FOUNDATIONS. (3 cr; prereq #; offered alt yrs) Furman
Analysis and interpretation of psychologies of music and education as applied to the teaching of music.

5217. HISTORICAL FOUNDATIONS OF MUSIC EDUCATION. (3 cr; prereq #; offered alt yrs) Furman
Analysis and interpretation of important elements in modern music teaching derived from the past.

5313. INFLUENCE OF MUSIC ON YOUTH BEHAVIOR. (3 cr) Haack
How music functions to influence human behavior; effects of commercial styles on children and youth. Particularly appropriate for teachers and parents.

5606. MOVEMENT-BASED METHODS FOR MUSIC EDUCATION. (3 cr; prereq music or music educ major or #) McCoy
Participation in movement activities; Dalcroze philosophy and techniques; applications of movement to music education; examination of research.

5611. TECHNIQUES AND MATERIALS: MUSIC AND RELATED ARTS. (3 cr; prereq #) Haack
Teaching music to reflect the major developments of Western culture.

5613. TEACHING MUSIC LITERATURE. (3 cr; prereq #; offered alt yrs) Borg, Haack
Principles, methods, and materials for teaching music history (appreciation) in grades K-12.

5615. TEACHING MUSIC READING. (3 cr; prereq #; offered alt yrs) Borg
Objectives; materials, research, teaching procedures, evaluation; class and individual projects; emphasis on general music class approach.

5621. SUPERVISION AND ADMINISTRATION OF SCHOOL MUSIC. (3 cr; prereq #; offered alt yrs) Borg
Analysis and evaluation of instructional, supervisory, and administrative techniques; readings, new trends.

5633. TECHNIQUES AND MATERIALS: CHORAL ENSEMBLES. (3 cr; prereq #) McCoy
Empirical research and literature on voice development in individual, class, and choral work; individual surveys of performance practices and organization of school vocal groups; selection of vocal music.

5643. TECHNIQUES AND MATERIALS: WOODWINDS. (3 cr; prereq #; offered when feasible) Schultz

5645. TECHNIQUES AND MATERIALS: BRASS. (3 cr; prereq #; offered when feasible) Haack

5647. TECHNIQUES AND MATERIALS: PERCUSSION. (3 cr; prereq #; offered alt yrs) Meza
Contemporary approaches to teaching in elementary, junior high, and senior high school; emphasis on performing techniques; playing of teaching materials, solo and ensemble repertoire.

5655. NEW DIMENSIONS IN MUSIC EDUCATION. (3 cr; offered when feasible) Haack

5666. MICROCOMPUTERS IN THE MUSIC CLASSROOM. (3 cr) Schultz
Using the microcomputer to enhance instruction; materials for theory, ear training, composition, electronic music; developing a database for music libraries, instrument inventories, budgets.

5667. COMPUTER-BASED MUSIC INSTRUCTION. (3 cr; prereq 5666 or #) Schultz
Design, development, and implementation of computer applications for the music classroom, emphasizing HyperCard environment with interactive audio, video, and MIDI.

5668. COMPUTERIZED MUSIC NOTATION. (3 cr) Schultz
Fundamentals of music notation and printing using Macintosh computer, MIDI keyboards, and Finale software. Preparation of instrumental and vocal scores, part extraction, and page layout.

5669. CONDUCTING THE MUSICAL SHOW. (3 cr; offered when feasible) Schultz

5750. WORKSHOP: MUSIC EDUCATION. (1-12 cr [max 12 cr])
Selected topics in music education. Each offering focuses on a single topic.

5801. INFLUENCE OF MUSIC ON BEHAVIOR. (4 cr; prereq mus therapy major or grad student with mus therapy emphasis or #) Furman
Methods and principles of behavioral sciences related to practice of music therapy.

5802. PSYCHOLOGY OF MUSIC II. (4 cr, §3802; prereq 3801) Haack

Elements of music and their psychological effects, music ability and its measurement, and research methods applied in psychology of music studies.

5804. MUSIC IN THERAPY. (3 cr; grad student in music educ or music therapy or #) Furman

Principles and methods related to public school, hospital, and other community mental health and education settings; observation and laboratory sessions.

5821. HISTORY OF MUSIC THERAPY. (3 cr; offered when feasible) Furman

5831. MUSIC FOR EXCEPTIONAL CHILDREN.

(3 cr; prereq #; offered alt yrs) Furman

Trends; methods and materials for a functional program of singing, playing, rhythm, listening, and creative activities for mentally and physically handicapped and gifted pupils.

5970. INDEPENDENT STUDY. (1-4 cr; prereq music educ/therapy or grad student, #, Δ)

Independent study project organized by the student in consultation with the appropriate instructor.

8281. MUSIC EDUCATION SEMINAR:

PHILOSOPHICAL ISSUES. (3 cr; prereq MA in music or music educ or #)

Survey and analysis of issues in philosophical foundations of music education.

8282. MUSIC EDUCATION SEMINAR:

HISTORICAL ISSUES. (3 cr; prereq MA in music or music educ or #)

Survey and analysis of issues in historical foundations of music education.

8283. MUSIC EDUCATION SEMINAR:

PSYCHOLOGICAL ISSUES. (3 cr; prereq MA in music or music educ or #)

Survey and analysis of issues in psychological foundations of music education.

8700. SEMINAR: ADVANCED TOPICS IN MUSIC EDUCATION/THERAPY. (1-4 cr; prereq #)

Issues and problems in music education/therapy theory, research, and practice.

8880. MASTER'S RESEARCH PROJECT. (1-8 cr; prereq 5112 or #)

Individual Plan B projects.

8990. RESEARCH PROBLEMS. (1-12 cr; prereq knowledge of elementary statistics, Δ)

Individual projects.

Music Education

See Music.

Neuroscience (NSc)

Professor: Alice A. Larson (veterinary biology), *director of graduate studies;* Alvin J. Beitz (veterinary biology); Gary Birnbaum (neurology); Dwight A. Burkhardt (psychology); Marilyn E. Carroll (psychiatry); Bianca Conti-Fine (biochemistry); Timothy J. Ebner (neurosurgery); Robert P. Elde (cell biology and neuroanatomy); Esam E. El-Fakahany (psychiatry); Apostolos P. Georgopoulos (physiology); Glenn J. Giesler, Jr. (cell biology and neuroanatomy); Boyd K. Hartman (psychiatry); William G. Iacono (psychology); William R. Kennedy (neurology); James F. Koerner (biochemistry); Nancy M. Lee (pharmacology); Gordon E. Legge (psychology); Paul C. Letourneau (cell biology and neuroanatomy); Allen S. Levine (food science and nutrition); Horace H. Loh (pharmacology); Charles F. Louis (veterinary biology); Walter C. Low (neurosurgery); Steven C. McLoon (cell biology and neuroanatomy); Robert F. Miller (physiology); Charles A. Nelson (child development); David A. Nelson (otolaryngology); Eric A. Newman (physiology); Jack H. Oppenheimer (medicine); Harry T. Orr (laboratory medicine and pathology); J. Bruce Overmier (psychology); Richard E. Phillips (ecology, evolution, and behavior); Richard E. Poppele (physiology); Richard W. Price (neurology); Richard L. Purple (physiology); David A. Rottenberg (neurology); Virginia S. Seybold (cell biology and neuroanatomy); Burt Sharp (medicine); John F. Soechting (physiology); Sheldon B. Sparber (pharmacology); Akira E. Takemori (pharmacology); David D. Thomas (biochemistry); Kamij Ugurbil (biochemistry); Neal F. Viemeister (psychology); George L. Wilcox (pharmacology)

Associate Professor: John H. Anderson (otolaryngology); W. Dale Branton (physiology); David R. Brown (veterinary biology); Howard B. Clark (laboratory medicine and pathology); William C. Engeland (surgery); Jurgen F. Fohlmeister (physiology); Kenneth M. Hargreaves (restorative sciences); Costantino Iadecola (neurology); Keith C. Kajander (oral biology); Daniel J. Kersten (psychology); Ping-Yee Law (pharmacology); Patrick W. Mantyh (psychiatry); Karen A. Mesce (entomology); John W. Osborn (animal science); Winfried A. Raabe (neurology); Peter A. Santi (otolaryngology); John J. Sidtis (neurology); Peter W. Sorensen (fisheries and wildlife)

Assistant Professor: James Ashe (neurology); Paul F. Chapman (psychology); Patricia L. Faris (psychiatry); Martha Flanders (physiology); Kevin D. Fox (physiology); William H. Frey II (psychiatry); Christopher M. Gomez (neurology); Christopher N. Honda (cell biology and neuroanatomy); Karen K. Hsiao (neurology); Jose V. Pardo (psychiatry); Margaret E. Ross (neurology); Donald A. Simone (psychiatry); Richard L. Sutton (neurosurgery); Stanley A. Thayer (pharmacology)

Research Associate: Jon Gottesman (physiology); Linda K. McLoon (ophthalmology); Martin W. Wessendorf (cell biology and neuroanatomy)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Graduate Programs

Degree Offered—Ph.D.

Curriculum—Neuroscience is a relatively new field of scientific inquiry. The objects of this inquiry—the brain and nervous systems—are sufficiently complex and unique among biological systems as to require analytical approaches that cross the traditional boundaries of anatomy, behavioral biology, biochemistry, cell biology, genetics, pharmacology, physiology, and psychology. In some instances, neuroscientific inquiry also encompasses the disciplines of computer science, information processing, engineering, physics, and mathematics.

The neuroscience curriculum for the Ph.D. begins in the summer session with the intensive laboratory course in cellular and molecular neurobiology (5550), held at the Lake Itasca Biological Station at the headwaters of the Mississippi River in northern Minnesota. The core curriculum continues through the academic year at the Twin Cities campus with a series of five courses: Neurochemical Communication (5460), Systems Neuroscience (CBN 5111, PhsI 5112, and NSc 5480), Behavioral Neuroscience (5660), and Developmental Neurobiology (8210). While taking these courses, students explore research opportunities in the laboratories of the faculty and thereby select a thesis adviser. Elective courses and a minor or supporting program are selected through consultation between the student and the adviser. Students with sufficient background and previous course experience may apply for waiver of appropriate requirements. Because thesis research is expected to include statistical analysis of data, a course in statistics (such as Stat 5021) is required. Proficiency in at least one computer programming language is highly recommended.

Prerequisites for Admission—Applicants to the Ph.D. program must have a bachelor's degree or its foreign equivalent from a recognized college or university. Undergraduate coursework should include

instruction in several of the following disciplines: mathematics, physics, chemistry, biology, psychology, and neuroscience.

Special Application Requirements—

Applicants are required to take the Graduate Record Examination General Test. The Subject Test appropriate to their field of emphasis is optional.

Degree Requirements—The written preliminary examination is administered to students before the start of the second year. Upon completion of most of the elective and minor courses, students take the preliminary oral examination. The final oral examination is a defense of the research presented in the thesis.

Language Requirements—None, although a reading knowledge of a foreign language relevant to the student's major field of interest is highly recommended.

Minor Requirements for Students

Majoring in Other Fields—The program for an individual student is developed by consultation between the student and the director of graduate studies for neuroscience. Students are required to take at least three core courses in three of four areas: function, structure, neurochemistry, and behavior. In addition, students are required to take elective courses in one area, for a total minimum of 18 credits (including the core courses).

For Further Information and

Applications—Contact the Neuroscience Program, University of Minnesota, 295 Animal Science/Veterinary Medicine, 1988 Fitch Avenue, St. Paul, MN 55108 (612/625-1715).

NSc 8666. DOCTORAL PRE-THESIS CREDITS.
(max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

NSc 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Required Courses

5460f. NEUROCHEMICAL COMMUNICATION.

(4 cr, §MdBc 5460, §VB 5460; prereq biochem)

Koerner, Wilcox, staff

Electrophysiology and biochemistry of neuronal signaling and its manipulation by pharmacological agents, in context of historical findings and current research techniques. Information about most systems (e.g., autonomic and central nervous systems) in context of specific transmitter systems wherever practical.

5480. INVERTEBRATE NEUROBIOLOGY.

(2 cr, §Ent 5480) Mesce

Cellular bases of invertebrate behavior. Functional organization of nervous systems common to invertebrates and vertebrates. Sensory, motor, and central integrative systems, neuromodulation, learning, and neurogenetics.

5550. ITASCA CELL AND MOLECULAR NEUROBIOLOGY LABORATORY.

(6 cr; prereq NSc grad student or Δ)

Intensive laboratory introduction to cellular and molecular aspects of research techniques in contemporary neurobiology; held at Itasca Biological Station. Electrophysiological investigations of neuronal properties, neuropharmacological assays of transmitter action, and immunohistochemical studies in experimental preparations.

5660s. BEHAVIORAL NEUROSCIENCE.

(4 cr; prereq NSc major or minor or #) Chapman, Phillips
Introduction to animal behavior from neuroscience perspective. Neural mechanisms for orientation and migration, rhythms, sleep, reproduction, motivated behaviors, perception, learning and memory, communication, and behavioral disorders.

8210s. DEVELOPMENTAL NEUROBIOLOGY.

(3 cr, §CBN 8210; prereq CBN 5111, Phsl 5112 or #)

Letourneau, McLoon

Nervous system development. General mechanism and experimental approaches.

8333. LAB NEUROSCIENCE.

(Cr ar; prereq NSc grad student or Δ) Miller

CBN 5111. HUMAN NEUROSCIENCE A.

(4 cr; prereq regis med fr or grad student, #; 5111-Phsl 5112†)

Ebner
Structure and function of nervous system, including organs of special sense.

Phsl 5112. HUMAN NEUROSCIENCE B.

(3 cr; prereq regis med fr or grad student; CBN 5111-Phsl 5112†)

Ebner

Elective Courses

5031. PERCEPTION.

(4 cr, §Psy 5031; prereq Psy 3051 or Psy 3031 or #) Legge
Data and principles of visual perception: color vision, pattern vision, object recognition, abnormal vision, and physiological optics.

5034. PSYCHOBIOLOGY OF VISION.

(4 cr, §Psy 5034; prereq Psy 3031 [except for grads] or #) Burkhardt
Analysis of properties and biological bases of sensory perception in humans and animals. Color vision, visual sensitivity and adaptation, and nerve cell circuits of eye and brain.

5037. PSYCHOLOGY OF HEARING.

(4 cr, §Psy 5037; prereq 3031 or #)
Biological and physical aspects of hearing; auditory psychophysics; theories and models of hearing; perception of complex sounds, including music and speech; clinical and other applications.

5100. INTRODUCTORY NEUROBIOLOGY

LABORATORY AT ITASCA. (3 cr; prereq upper div student in biological or physical sciences, intro biol and chem, #)

Concepts in cellular neurosciences in laboratory environment. Basis of membrane properties, including ionic and molecular mechanisms of resting, action, and synaptic potentials. State-of-the-art equipment and contemporary techniques used to examine experimental evidence.

5102. VETERINARY NEUROBIOLOGY.

(3 cr, §VB 5102; prereq #) Beitz

Structural and functional organization of central nervous system of domestic animals.

5201. COMPUTATIONAL NEUROSCIENCE I: MEMBRANES AND CHANNELS.

(5 cr, §Phsl 5201; prereq Phsl 5112 or equiv) Fohlmeister
Comprehensive examination of membrane and ion channels using UNIX work stations to simulate their properties. Hodgkin-Huxley model, nonlinear dynamic systems, voltage and ligand gated ion channels, impulse propagation.

5202. COMPUTATIONAL NEUROSCIENCE II: CELLS AND CIRCUITS.

(5 cr; prereq understanding of UNIX, Phsl 5201 or equiv) Miller
Comprehensive investigation of computational properties of single neurons and locally connected cell networks. Linear cable theory; compartmental modeling of single neuron properties; spatio-temporal interactions between synaptic inputs and neuronal dendritic trees; computational properties of passive and active dendritic spines and spine clusters; quantitative interpretation of whole-cell voltage-clamp data; and dynamics of locally connected cell networks.

5203. COMPUTATIONAL NEUROSCIENCE III:

NEURAL SYSTEMS AND INFORMATION PROCESSING. (5 cr, §Phsl 5203; prereq 5202 or equiv)

Poppele, Soechting

Quantitative examination of information processing by networks of neurons based on experimental data and theoretical models. Neural codes, neural network models and information processing, neural control systems, computational maps.

Graduate Programs

5323. MECHANISMS OF ANIMAL BEHAVIOR.

(5 cr, §EEB 5323; prereq Biol 3011 or 1 qtr animal physiology) Phillips
Survey of animal behavior mechanisms; organization and functions. Analysis of behavior sequences, motor coordination, fixed action patterns, sensory systems, release mechanisms, mechanisms of animal communication, orientation behavior, feedback mechanisms and control, behavior of small neural networks. Laboratory included.

5400. VETERINARY PHARMACOLOGY.

(3 cr, §VB 5400; prereq VB 5310 or equiv or #) Larson
General principles of drug action, disposition, and use, focusing on drug action in central and peripheral nervous systems. Pharmacology of autonomic drugs, local anesthetics, parenteral general anesthetics, tranquilizing agents, analeptics, anticonvulsants, and neuromuscular blockers.

5444. MUSCLE CONTRACTION.

(3 cr, §MdBc 5444, §Phsl 5444, §VB 5444; prereq undergrad biochem or physiology courses or #) Donaldson, Louis, Poppele, Thomas
Introduction to physiology, biochemical regulation, and physical chemistry of muscle contraction.

5462. NEUROSCIENCE PRINCIPLES OF DRUG ABUSE.

(2 cr; prereq #; offered alt yrs) Law, Wilcox
Current research on drugs of abuse: their mechanisms of action, characteristics shared by various agents, and cellular and neural systems affected by them.

8026. NEURO-IMMUNE INTERACTIONS.

(3 cr, §PNI 8026, §Psy 8026, §VMic 8026; prereq 5111 or equiv, MicB 5218 or equiv) Sharp
Regulatory systems (neuroendocrine, cytokine, and autonomic nervous systems) linking brain and immune systems in a brain-immune axis. Functional effects of bidirectional brain-immune regulation.

8031. SEMINAR: VISUAL PERCEPTION.

(3 cr, §Psy 8031; prereq Psy 5031 or #) Legge
Physiological, psychophysical, and cognitive determinants of visual perception.

8037. PSYCHOPHYSICS AND AUDITION.

(3 cr, §Psy 8037; prereq #) Viemeister
Modern and classical psychophysics. Psychophysical and physiological correlates of audition. Theories of hearing.

8124. RECENT ADVANCES IN

CHEMORECEPTION SCIENCE.

(1 cr; prereq #) Sorensen
Interdisciplinary and comparative seminar. Receptor function, signal transduction, coding, central pathways, animal behavior, and psychophysics.

8136. EXPERIMENTAL COMPARATIVE

VETERINARY NEUROLOGY.

(3 cr, §VB 8136; prereq VB 8135 or #) Beitz, Fletcher
Principles, methods, and laboratory exercises in investigating central nervous system of domestic animals.

8207. SEMINAR: PSYCHOPHARMACOLOGY. (3 cr on completion of 3 qtrs, §Phsl 8207; prereq #) Sparber
Topics on behavioral aspects of drug action.

8216. SELECTED TOPICS: NEUROPHYSIOLOGY.

(Cr ar, §Phsl 8216; prereq CBN 5111, Phsl 5112 or equiv or #) Poppele, Soechting, staff
Advanced seminar.

8218. PHYSIOLOGY OF VISUAL SYSTEMS.

(3 cr; prereq #; offered alt yrs) Purple
Seminar. Emphasis on vertebrate visual system, including receptor transduction, retinal structure and physiology, and central visual processes. Conceptual emphasis on visual system as information-reception and information-processing system.

8221. NEUROBIOLOGY OF PAIN AND

ANALGESIA. (3 cr, §CBN 8221; prereq #; offered in alt sequence with 8222 and 8223) Giesler
Neural systems underlying pain perception, production of analgesia.

8222. CENTRAL REGULATION OF AUTONOMIC

FUNCTION. (3 cr, §CBN 8222; prereq #; offered in alt sequence with 8221 and 8223) Osborn
Morphology and physiology of autonomic ganglia and enteric nervous system, neuronal circuitry underlying central regulation of pupil, exocrine glands, cardiovascular system, respiratory system, and pelvic viscera.

8247. PHYSIOLOGY OF HEARING.

(3 cr, §Otol 8247; prereq #)
Structure and function of mammalian auditory systems. Cochlear anatomy; basilar membrane mechanics, cochlear potentials, and the anatomy and neurophysiology of auditor nerve and nuclei.

8248. READINGS IN AUDITORY PHYSIOLOGY.

(1-3 cr, §Otol 8248; prereq #)
Current research on biophysics and physiology of auditory system; topics selected for each student. Preparation and discussion of written reviews.

8324. READINGS IN NEUROBIOLOGY.

(1 cr per qtr, §NSu 8324; prereq Phsl 8104 or #) Staff
Survey of major topics in neurobiology.

8325. DEVELOPMENTAL

NEUROPSYCHOBIOLOGY. (3 cr, §CPsy 8325; students taking course to fulfill core reqs for PhD in CPsy must take it A-F) Gunnar, C Nelson
Research and theory on human brain and endocrine activity and their relations with behavioral development. Memory development, stress and coping in children, development of sex differences.

8400. NEUROBIOLOGY OF DISEASE.

(2 cr; prereq 5111 or CBN 5111, 5112 or Phsl 5112, 5460 or #) Ross
Major neurological diseases; pathogenic mechanisms of neurologic disease; potential applications of advances in basic neuroscience to human disease.

Neurosurgery (NSu)

Professor: Roberto C. Heros, *head*; Timothy J. Ebner; Donald L. Erickson; Stephen J. Haines; Walter C. Low; Robert E. Maxwell; Setti S. Rengachary; Gaylan L. Rockswold

Assistant Professor: Walter A. Hall

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S.Nsurg. (Plan A only) and Ph.D.Nsurg.

Curriculum—Specialized study is available in neurosurgical science as a clinical discipline, with research focused on basic neurobiology and clinical trials of new modalities of therapy.

Prerequisites for Admission—Applicants for either degree must hold an M.D. degree from an approved medical school and have at least one year of experience in an approved program of general surgery or fundamental clinical skills.

Special Application Requirements—Applicants must send the following to the Department of Neurosurgery: transcripts of undergraduate and medical school education; at least three letters of recommendation from persons well acquainted with their academic work and professional experience; National Board scores; and a statement of personal academic and professional goals and experience. Final selection is made through the national Neurological Surgery Matching Program.

Master's Degree Requirements—At least six academic years are required, including the following minimums: 36 months in clinical neurosurgery (including 12 months in a senior capacity), 6 months in neuropathology and clinical neurology, and at least 12 months in research. The minor must be in a basic nonclinical neuroscience discipline. A thesis on basic or clinical research is required. Also required are final written and oral examinations. Additionally, the candidate must pass the American Board of Neurological Surgery's primary examination.

Doctoral Degree Requirements—There are no specific credit requirements beyond the master's except that the minor or supporting program in a nonclinical neuroscience discipline must carry at least 18-24 credits and that the thesis should be based on research in a basic nonclinical neuroscience discipline. A supporting program in lieu of the minor is acceptable. A preliminary oral and final written and oral examinations are required.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Neurosurgery, University of Minnesota Hospitals, Box 96 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/624-6666).

NSu 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

NSu 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

NSu 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

8305. NEUROSURGICAL DIAGNOSIS. (4 cr) Heros, staff

The neurosurgical fellow assists in instruction of clinical clerks and interns, and studies problems in diagnosis at University and affiliated hospitals.

8308. NEUROSURGICAL PROBLEMS AND MANAGEMENT. (4 cr) Heros, staff

The neurosurgical fellow acts as house surgeon at University and affiliated hospitals.

8311. OPERATIVE NEUROSURGERY. (4 cr) Heros, staff

The neurosurgical fellow acts as first assistant at operations in University and affiliated hospitals, and later may be permitted to operate.

8316. NEUROSURGICAL RESEARCH. (6 cr) Ebner, Heros, Low, staff

Problems in experimental or clinical neurosurgical sciences.

8318. NEURORADIOLOGICAL CONFERENCE.

(1 cr) Heros, staff

Review of X-rays and case histories on neurosurgical service.

8320. NEUROSURGICAL CONFERENCE. (2 cr)

Haines, Heros, staff

In-depth review of selected topics in basic or clinical neurosurgery.

Graduate Programs

8324. READINGS IN NEUROBIOLOGY. (2 cr; prereq Phsl 8104, consent of Medical School) Ebner, Low
Survey of major topics in neurobiology. Specific papers in each area serve as basis for discussion.

8330. NEUROSURGERY LITERATURE SEMINAR.
(2 cr) Heros, staff
Review and discussion of current literature relating to neurosurgery and the neurosciences.

Nursing (Nurs)

Professor: Sandra R. Edwardson, *dean*; A. Marilyn Sime, *director of graduate studies*; Sheila A. Corcoran-Perry; Mark E. Nesbit; Margaret A. Newman; Muriel B. Ryden; Mariah Snyder; Patricia S. Tomlinson

Associate Professor: Margaret J. Bull; Patricia Crisham; Sara S. Dehart; Laura J. Duckett; Ellen C. Egan; Bernadine M. Feldman; Cynthia R. Gross; LaVohn Josten; Barbara J. Leonard; Betty Lou Lia-Hoagberg; Ruth D. Lindquist; Marilee A. Miller

Assistant Professor: Karen Alaniz; Melissa D. Avery; Donna Z. Bliss; Linda H. Beringer; Derryl E. Block; Kenneth R. Burns; Marilyn R. Gustafson; Helen E. Hansen; Mary Jo Kreitzer; Kathleen Krichbaum; Marsha Lewis; Carol Pederson; Janice Post-White; Kathleen Soderger

Adjunct Assistant Professor: Barbara Vellenga

Associate Clinical Specialist: Cathleen C. Johnson

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Emphases in the M.S. program include preparation as a nurse educator, nurse manager, or advanced clinical practitioner in psychiatric mental health nursing, child and family nursing, community health nursing in long-term care, medical-surgical nursing, gerontology nursing, oncology nursing, and public health nursing; or practitioner preparation as a nurse midwife, pediatric nurse practitioner, gerontological nurse practitioner, and family nurse practitioner. The Ph.D. program prepares creative and productive scholars in nursing. Students can gain a depth of knowledge and experience in the development and modification of health-related behaviors; human responses to environmental and life process events disruptive to health; phenomenon of health; organization and system of delivery of

nursing knowledge; and organization and system of delivery of nursing care. An individualized program and independent research are planned by the student and adviser.

Prerequisites for Admission—In the M.S. program, a bachelor's degree with a major in nursing or evidence of ability in health promotion, community health nursing, leadership/management, teaching/counseling, and systematic investigation, as well as licensure as a registered nurse, are required. For the Ph.D. program, a master's degree with a strong background in the physical and/or behavioral sciences or a bachelor's degree with an exceptionally strong background are required.

Special Application Requirements—For the M.S. degree, Graduate Record Examination (GRE) General Test scores, three letters of reference, and a goal statement are required. For the Ph.D. degree, GRE General Test scores, two letters of reference, and a statement of goals, objectives, and research interest are required. The application deadlines for the M.S. program are December 15 for spring, summer, or fall quarter admission; April 15 for summer, fall, or winter quarter admission; and October 25 for winter, spring, or summer admission. The application deadline for the Ph.D. program is January 25 for fall quarter admission.

Master's Degree Requirements—The Plan A program is individually planned with a faculty adviser and must include a course in nursing research methodology. The Plan B program must include 32 credits in the major distributed in specific categories; required are Nurs 8010, Nurs 8011, and Nurs 8014 (3 credits each) and 4 credits of 8050 for the Plan B project. For more information, see the School of Nursing publication *Graduate Study in Nursing*. A final oral examination is required for both plans.

Graduate students admitted as of fall 1990 must be registered in the Graduate School each quarter they work with advisers on research projects.

Doctoral Degree Requirements—Students plan with their advisers individualized programs of study and independent research subject to approval by a faculty committee. A total of 18 credits in a minor field is required.

Graduate students admitted as of fall 1990 must be registered in the Graduate School each quarter they work with advisers on research projects.

Language Requirement—None.

For Further Information and Applications—Contact the School of Nursing, University of Minnesota, 6-101 Health Sciences Unit F, 308 Harvard Street S.E., Minneapolis, MN 55455 (612/624-3108; fax 612/626-2359).

Nurs 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Nurs 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Nurs 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Theoretical and Ethical Foundations of the Discipline

5711. SPIRITUALITY AND NURSING PRACTICE. (2-3 cr; prereq Nurs sr or RN [for undergrad cr] or RN with baccalaureate degree [for grad cr]) Gustafson
Concept of spirituality as integral to the whole person. Spiritual nursing care interventions within context of nursing process.

5738. TRANSCULTURAL NURSING: THEORIES AND ISSUES. (2-3 cr; prereq cultural anthropology course, Nurs grad student or RN or #) Gustafson
Cultural factors that influence theories, issues, and nursing care practice in diverse cultures and subcultures. Emphasis on nursing within international systems of health care and nursing practices related to health-illness systems in United States and worldwide.

5902. NURSING AND THE POLITICS OF HEALTH. (3 cr; prereq grad student, #; offered when feasible) Josten, Lia-Hoagberg

5960. ADVANCED PUBLIC HEALTH NURSING. (3 cr; prereq 8010 or 8010, Nurs grad student or nurse grad student in another field) Lia-Hoagberg
Developing conceptual frameworks for advanced practice. National health priorities and assessment strategies.

8010. STRUCTURE OF THE DISCIPLINE OF NURSING. (3 cr; prereq Nurs grad student or #) Block, Egan, Sime, Sodergren, Vellenga
Exploring purposes, characteristics, and kinds of structures with emphasis on theories, models, and conceptual frameworks.

8011. MORAL AND ETHICAL POSITIONS IN NURSING. (3 cr; prereq Nurs grad student or #) Block, Corcoran-Perry, Crisham
Influence of moral and ethical positions on behavior and decision making in nursing. Emphasis on bases for positions taken, such as selected moral and ethical theory, rights and responsibilities, and conflict.

8012. CONCEPTUAL FRAMEWORK FOR NURSING PRACTICE. (3 cr; prereq 8010, Nurs grad student or #) Egan, Sodergren
Exploration and reconceptualization of assumptions, values, and beliefs underlying learner's view of nursing and nursing practice. Analysis of structure of a nursing conceptual framework and development of personal framework. Concept of intervention model and systematic process that underlies development of such a model.

8110. THEORETICAL FOUNDATIONS OF THE DISCIPLINE. (4 cr; prereq 8012 or equiv, knowledge of philosophy of science, Nurs grad student or #) Sime
Analysis of knowledge systems and relevant research; identification of boundaries of knowledge and projection of needs for further knowledge development and testing.

8111. MORAL AND ETHICAL DEVELOPMENT IN NURSING SCIENCE. (4 cr; prereq 8011 or equiv, Nurs grad student or #) Crisham
Interaction between research and theory in moral judgment and behavior, applied ethics, and nursing.

8220, 8221. SEMINAR: DEVELOPING NURSING KNOWLEDGE I, II. (1 cr; prereq Nurs PhD student or #; Nurs grad majors must take both courses)
Critique of selected philosophical perspectives and research methodologies.

8800. PHENOMENON OF HEALTH. (3 cr; prereq Nurs grad student or #) Newman
Examination of assumptions and scientific perspectives of differing views of health; articulation and evaluation of holistic view of person-environment and health.

8802. PHENOMENON OF HEALTH II. (3 cr; prereq 8800, #) Newman
Philosophical, theoretical, and methodological implications of nursing paradigm that incorporates transformative view of health as evolving pattern of the whole. Emphasis on integration of theory with appropriate methods of inquiry.

8900. THEORETICAL FOUNDATIONS OF HEALTH-RELATED BEHAVIORS. (3 cr; prereq #) Snyder
Research and theory in development and modification of health-related behaviors and human responses to events disruptive to health. Formulation of hypotheses for nursing research.

Methodological Foundations of the Discipline

5720. WRITTEN COMMUNICATION SKILLS FOR HEALTH PROFESSIONALS. (3 cr; prereq knowledge of medical terminology) Schoenfelt

Students critique each other's work for organization, style, clarity of presentation, conciseness, accuracy, transitions, consistency, and writing mechanics. Examination of journal articles, work of professional authors, and writing guidelines.

5820. DECISION MAKING IN HEALTH CARE. (3 cr; prereq grad student in health-related major)

Corcoran-Perry
Comparison of conceptual models of decision making. Developing plans for assessing, evaluating, teaching, and assisting others (health professionals, patients, and families) in making decisions about health care.

5966. PUBLIC HEALTH PROGRAM PLANNING AND GRANT WRITING. (4 cr, §PubH 5731; prereq public health admin or Nurs grad student or #)

Planning health promotion and disease prevention programs using PRECEDE-PROCEED model as framework; writing grants to fund these programs.

8014. RESEARCH IN NURSING. (3 cr; prereq inferential statistics) Block, Bull, DeHart, Duckett, Feldman, Vellenga

Exploring research process and research methodologies appropriate to nursing. Analysis of research reports.

8020. EVALUATING QUALITY IN COMMUNITY HEALTH/LONG-TERM CARE. (3 cr; prereq statistics course including inferential statistics, 8014 or equiv research course, Nurs grad student or #) Bull

Models and measurement related to evaluating quality in community health/long-term care. Distinguishing characteristics of long-term care from those of acute care.

8050. PROBLEMS IN NURSING. (1-9 cr; prereq #)

Individual study of a problem.

8051. SPECIAL TOPICS IN NURSING RESEARCH. (1-9 cr)

Seminar and/or individual study in nursing research.

8062. QUALITATIVE RESEARCH IN NURSING AND HEALTH CARE. (3-4 cr; prereq 8010 or 8014 or equiv or #) Bull

Characteristics of qualitative research methods such as ethnography, phenomenology, and grounded theory. Data collection, analysis, and applications in health care.

8064. RESEARCH ON DECISION MAKING IN HEALTH CARE. (4 cr; prereq one grad-level research course) Corcoran-Perry

Analysis of selected conceptual models of decision making and critique of related studies. Formulation of research proposal to investigate decision making about health care by health-care professionals, patients, and/or families.

8114. ADVANCED NURSING RESEARCH. (4 cr; prereq 8014 or equiv, advanced inferential and non-parametric statistics, computer science, Nurs grad student or #) Sime

Testing and validating methods of study unique to nursing science.

8120. CONCEPTUAL AND METHODOLOGICAL ISSUES IN THE STUDY OF FAMILY HEALTH. (3 cr; prereq 5920, 8114 or equiv or #) Tomlinson

Formulating research designs for studying family health.

8210. THEORY DEVELOPMENT IN NURSING. (3 cr; prereq 8110, #) Egan

Examining strategies for theory development; synthesis of theoretical formulations in nursing using a selected strategy.

Nursing Knowledge Underlying Clinical and Functional Specialization

Clinical Specialization

5634. WOMEN'S ISSUES: A HEALTH PERSPECTIVE. (3 cr; prereq upper div or grad student or #) Ringdahl

Multidisciplinary analysis of sexual and reproductive health, victimization, poverty, work, nutrition, physical activity, and mental health, emphasizing health promotion.

5640. COMMON RESPONSE PATTERNS TO ILLNESS. (3 cr; prereq #; offered when feasible) Snyder

5642. BEHAVIORAL PROBLEMS IN PERSONS WITH DEMENTIA. (2 cr; prereq grad student or upper div student with knowledge of research process, #) Ryden

Nature of aggression, agitation, and wandering in persons with dementia; theoretical perspectives for understanding such problems. Research studies about behavioral problems; relationship between knowledge about behavioral problems and clinical management.

5650. THERAPEUTIC TOUCH: PRACTICE AND RESEARCH. (2 cr; prereq Nurs student, #) Egan, Sodergren

Therapeutic touch as a healing modality. Explanations of its effects. Students learn and evaluate its practice. Analysis of research literature.

5680. THEORY AND PRACTICE OF OCCUPATIONAL HEALTH. (3 cr, §PubH 5167)

Introduction to major concepts and issues in occupational health and safety. Students identify conceptual framework for working with aggregate populations of workers.

5780. MULTIDISCIPLINARY PERSPECTIVES ON AGING. (4 cr, §AdEd 5440, §CPsy 5305, §HSU 5009, §PA 5414, §Phar 5009, §PubH 5737, §Soc 5960, §SW 5024)

Sociological, biological, and psychological aspects of aging, death, and bereavement; issues and problems of older adults in the United States; human services and their delivery systems (health, nutrition, long-term care, education); public policy and legislation; environment and housing; retirement.

5782. THE ELDERLY: A HIGH RISK**POPULATION.** (3 cr, §PubH 5517, §PubH 5736;

prereq PubH or grad student)

Characteristics of people over 65 that place them at high risk for disability, institutionalization, and death. Health maintenance, rehabilitation, and alternatives to institutionalization.

5810. HEALTH ASSESSMENT FOR ADVANCED**NURSING PRACTICE.** (3 cr; prereq Nurs grad student, #)

Health assessment skills; identifies variations across the life span. Performance and documentation of comprehensive, systematic, and integrated history and physical examination, while interpreting both normal and abnormal findings.

5834. PRIMARY CARE: REPRODUCTIVE**HEALTH.** (4 cr; prereq Nurs grad student, ¶5835, ¶8030, concurrent with or completed course in health assessment and reproductive physiology, #)

Explores theory, research, management of selected reproductive health concerns to provide basis for advanced nursing practice and nurse-midwifery.

5835. PRIMARY CARE PRACTICUM:**REPRODUCTIVE HEALTH.** (3 cr; prereq Nurs grad student, ¶5834, #)

Application of standardized techniques to establish client-centered database focused on reproductive health. Implementation and evaluation of health care plans that include reproductive and sexuality counseling, family planning interventions, education, screening, and referral.

5881. THE BIOLOGY OF CANCER. (3 cr, §GCB

3008; prereq Biol 1009) McKinnell

Biological aspects of etiology, phylogeny, and cellular processes involved in neoplasia. Growth and differentiation of normal and cancer cells. History of cancer research.

5882. PRACTICUM IN ENVIRONMENTAL AND**OCCUPATIONAL HEALTH.** (1-6 cr, §PubH 5154;

prereq environ health major or Nurs grad student)

Students work with organizations with environmental and occupational health concerns, under joint supervision of faculty adviser and organization's staff.

5883. ISSUES IN ENVIRONMENTAL AND**OCCUPATIONAL HEALTH.** (2 cr, §PubH 5155;

prereq PubH or grad student or #)

The field, current issues, and principles and methods of environmental and occupational health protection. Independent field visits to observe, review, and analyze environmental/occupational health programs.

5884. EMPLOYEE HEALTH SERVICES AND**COST CONTAINMENT.** (3 cr, §PubH 5166; prereq

occ hltl nurs or Nurs grad student)

Trends in corporate health cost containment; implications regarding planning and financing of health care for employees and families. Associated role development of occupational health nurse specialists.

5885. THEORY AND PRACTICE OF**OCCUPATIONAL HEALTH: FIELD EXPERIENCE.** (1 cr, §PubH 5168; prereq 5680, PubH

5167)

Arranged field experience and seminar course.

Application of occupational health and safety concepts within conceptual framework of occupational health. Builds on theories explored in Nurs 5680/PubH 5167.

5886. FIELD PROBLEMS IN OCCUPATIONAL**HEALTH.** (3 cr, §PubH 5218; prereq PubH 5211 or

Nurs grad student or #)

Guided evaluation of potential occupational health problems; recommendations and design criteria for correction, if correction is needed.

5917. HEALTH CARE FOR CHILDREN AND**YOUTH WITH SPECIAL HEALTH CARE NEEDS.**

(4 cr; prereq #)

Growth and development, pathophysiology, specific conditions, and a wholistic, family-centered, community-based, culturally competent, coordinated approach to assessment and intervention.

5918. HEALTH CARE FOR CHILDREN AND**YOUTH WITH SPECIAL HEALTH CARE NEEDS****PRACTICUM.** (5 cr; prereq 5917 or ¶5917, 5925, #)

Clinical course emphasizing assessment and management of acute and chronic conditions; wholistic, family-centered, community-based, culturally competent, coordinated approach.

5920. CONCEPTUALIZATION OF FAMILY**HEALTH.** (3 cr; prereq Nurs grad student, 8010 or #)

Tomlinson

Theoretical framework that serves as foundation for family nursing practice.

5923. PRIMARY CARE PRACTICUM: HEALTH**ASSESSMENT AND CARE OF WELL INFANTS,****CHILDREN, AND ADOLESCENTS.** (4 cr; prereq

Nurs grad student, 5810, ¶5924, #)

Clinical course for beginning PNP and FNP student.

5924. PRIMARY CARE: NURSING ASSESSMENT**AND HEALTH PROMOTION FROM INFANCY****THROUGH ADOLESCENCE.** (4-5 cr; prereq Nurs

grad student, 5810, ¶5923, #)

Age-specific, family-centered prevention and health promotion services. Instruments and processes incorporated as means for establishing database. Emphasizes diagnostic reasoning and primary-care advanced-practice interventions.

5925. PRIMARY CARE PRACTICUM: COMMON**HEALTH PROBLEMS OF INFANTS, CHILDREN,****AND ADOLESCENTS.** (4 cr; prereq Nurs grad student,

5923, 5924, ¶5926, #)

Advanced clinical course. Assessment of minor acute and chronic illnesses and their impact on the individual and family, health care management, evaluation strategies, and follow-up care.

Graduate Programs

5926. PRIMARY CARE: COMMON ACUTE AND CHRONIC CONDITIONS EXPERIENCED BY INFANTS, CHILDREN, AND ADOLESCENTS. (4 cr; prereq Nurs grad student, 5923, 5924, ¶5925, #)
Differentiation of health problems, interdisciplinary consultation and referral, and independent and collaborative health care management.

5927. PRIMARY CARE: ASSESSMENT AND MANAGEMENT OF FAMILIES EXPERIENCING STRESS. (4 cr; prereq Nurs grad student, #)
Assessing and analyzing impact of minor acute, chronic illness and disruptive behavior on families. Behavioral intervention models, incorporating variety of cultural values, beliefs, and behaviors.

5928. PRIMARY CARE: PHARMACOTHERAPEUTICS. (3 cr; prereq Nurs grad student, #)
Pharmacokinetics, pharmacoepidemiology, therapeutic dosages for various age groups, client patterns of drug use, prescriptive privileges, and prescription writing for advanced-practice nurses.

5932. PRIMARY CARE: ASSESSMENT AND MANAGEMENT OF ADULT AND ELDERLY HEALTH. (5 cr; prereq Nurs grad student, 5810, ¶5933, #)
Advanced-practice course. Data-based primary care management of common acute and chronic conditions. Clinical reasoning, independent and collaborative practice health care plans.

5933. PRIMARY CARE PRACTICUM: ADULT AND ELDERLY HEALTH. (5 cr; prereq Nurs grad student, 5810, ¶5932, #)
Application of advanced-practice comprehensive health histories and physical assessments in formulating client-centered databases; development and implementation of care plans and follow-up evaluation of primary care.

5940. NURSING ASSESSMENT OF THE ELDERLY. (2 cr; prereq basic course in health-history taking and physical assessment, #) Burns, Camillo
Taking gerontological health histories and performing physical assessment. Emphasis on theoretically and empirically based variations of normal, common health disruptions; interpretation and classification of data.

5941. CARE OF THE ELDERLY I: PHYSIOLOGICAL CONCEPTS. (2 cr; prereq #) Snyder
Functional patterns related to physiological aspects of aging; research-based interventions used to maintain or restore optimal functioning of elderly.

5942. NURSING CARE OF THE ELDERLY I. (4 cr; prereq Nurs grad student, 1 assessment of elderly course) Camillo, Snyder
Managing health care of elderly; testing nursing interventions for maintaining and restoring health. Focuses on persons with physiological concerns.

5943. CARE OF THE ELDERLY II: PSYCHOSOCIAL CONCEPTS. (2 cr; prereq Nurs grad student, knowledge of adult human development across life span or #) DeHart, Ryden
Psychosocial assessment and research-based interventions for elderly clients; emphasizes promotion of health and supportive care.

5944. NURSING CARE OF THE ELDERLY II (4 cr; prereq 5940, Nurs grad student, #) Camillo, DeHart
Managing health care of elderly clients; testing nursing interventions for maintaining and restoring health. Focus on persons whose presenting concerns are primarily psychosocial.

5945. NURSING CARE OF THE ELDERLY: ASSESSMENT AND MANAGEMENT. (4 cr; prereq 5940) Burns, Camillo
Database management of common acute and chronic conditions and physiological, psychosocial, and pharmacological interventions. Family and community resources incorporated into nursing care interventions. Protocols of care analyzed and developed. Methods of evaluating interventions.

5947. PHARMACOTHERAPEUTICS FOR THE ELDERLY. (2 cr; prereq basic pharmacology course, grad student or #) Camillo, DeHart
Issues related to prescriptive practice and other regulations. Case-based protocols for specific acute and chronic illnesses with emphasis on pharmacokinetics and pharmacodynamics.

8021. COMMUNITY HEALTH NURSING IN LONG-TERM CARE. (3 cr; prereq 8010, Nurs grad student or #) Bull
Systematic inquiry into nature of long-term care and community health nursing for families with adult members who have self-care limitations.

8022. CLINICAL INVESTIGATION IN COMMUNITY HEALTH NURSING IN LONG-TERM CARE. (5-6 cr; prereq ¶5330, ¶8011, ¶8021, #) Bull
Systematic inquiry and clinical investigation of nursing care problems for communities with families who have adult members with self-care limitations. Students design, implement, and evaluate interventions for selected populations.

8030. NURSING INTERVENTION MODELS. (4-8 cr [8 cr must be completed before cr is granted]; prereq 8011 or ¶8011, 8012, #) Alaniz, Avery, Bliss, Leonard, Lindquist, Tomlinson
Developing, providing, and evaluating nursing intervention with a specified client population. Students register for a section that focuses on a desired population.

8040. PUBLIC HEALTH INTERVENTIONS ACROSS THE LIFE SPAN. (3 cr; prereq 5609 or ¶5609, 8011 or ¶8011, PubH 5330 or ¶PubH 5330 or #) Bearger
Synthesis of life-cycle developmental approach and public health perspective with nursing and behavior change conceptual theories to develop intervention models that effectively address priority public health problems across the life span.

8042. COMMUNITY-BASED PUBLIC HEALTH NURSING INTERVENTIONS. (3 cr; prereq Nurs grad student or nurse grad student in another field, 5960 or #) Lia-Hoagberg

Systematic inquiry into community-based intervention models that integrate nursing knowledge, clinical research, and public health knowledge. Emphasizes community organization and social change models and development of community-based nursing intervention models for practice.

8060. ADVANCED CLINICAL NURSING. (3-9 cr; prereq #; offered when feasible)

8313. CARE OF THE CHILDBEARING FAMILY IN RISK. (4-6 cr; prereq physiology, #) Avery, Rossi
Problems encountered during perinatal period with emphasis on nursing care of mothers with medical complications.

8314. NURSE-MIDWIFERY MANAGEMENT DURING CHILDBEARING. (9-10 cr; prereq #) Avery, Rossi

For students wanting to complete requirements for nurse-midwifery certification. Emphasis on labor and delivery management with opportunity to improve skills throughout childbearing period.

8400. NURSING INTERVENTIONS FOR ADULT POPULATIONS. (3 cr; prereq 8014 or equiv, 8012, #; offered when feasible) Burns

8421. PSYCHIATRIC-MENTAL HEALTH NURSING: GROUP DYNAMICS AND LEADERSHIP SKILLS. (3 cr; prereq 8030, #) Vellenga

Group dynamics and process with emphasis on development of leadership skills. Integration and application of mental health concepts, clinical practice in group therapy.

8422. PSYCHIATRIC-MENTAL HEALTH NURSING: FAMILY DYNAMICS AND THERAPY. (3 cr; prereq 8030, #) Vellenga

Family dynamics, development, and communication patterns. Relationship of selected family to community using concepts from systems theory. Clinical practice in family therapy.

8431. CHILDBEARING-CHILDREARING FAMILY NURSING: THEORETICAL FORMULATIONS. (4-6 cr; prereq 8030, #) Pederson

Maintenance, promotion, improvement, and restoration of health in the childbearing-childrearing family unit. Theoretical concepts related to women, children and families, and family development.

8450. INVESTIGATIONS OF STRESS AND COPING FROM A NURSING PERSPECTIVE. (3 cr; prereq grad in nursing or psychology or behavioral medicine, 8014 or equiv, #; offered when feasible) Snyder

Functional Specialization

8451. TEACHING-LEARNING PROCESS IN NURSING. (4 cr; prereq 8030, ¶course in learning theory, Nurs grad student or #) Gustafson

Use of theories of learning to develop an intervention model for teaching nursing. Testing the intervention model in simulated situations.

8701. NURSING ADMINISTRATION I. (6 cr; prereq #) Hansen

Intensive study of role of nursing administrator by application of major concepts in organization and management theories and nursing process to nursing administration. Emphasis on planning for and organizing nursing administration and assembling resources to carry out plans. Experiences planned to meet individual needs and to maximize previous experience and knowledge.

Nursing Role Development

5660. BASIC MANAGEMENT IN LONG-TERM CARE FACILITIES. (1-4 cr; prereq current RN licensure, RN with baccalaureate degree for grad cr) Krichbaum

Provides critical basis for practice of nursing management. Emphasis on analysis of management theory and its relevance to current practice. Theories of management, organization, regulation, and organization behavior.

5946. PROFESSIONAL ISSUES IN ADVANCED GERONTOLOGICAL NURSING PRACTICE ROLES. (2 cr; prereq 6 cr gerontological nursing focus or #) Feldman

Professional and policy issues, including reimbursement, certification, professional relationships, standards of care, legislation and regulation as they pertain to nurse practitioners, professional practice, the health care system, and care of older adults.

5948. ADVANCED-PRACTICE ROLES. (6-8 cr; prereq Nurs grad student) Snyder
Advanced-practice roles within nursing care and health care delivery systems.

5963. NURSING LEADERSHIP FOR A CHANGING WORLD. (3 cr; prereq Nurs grad student or nurse grad student in another field or #) Josten
Visioning, change, organizational culture, power, negotiation, team building, forecasting, and personal growth analyzed to strengthen leadership skills for the future. Concepts within variety of nursing leadership roles (educator, manager, clinical specialist, consultant).

5964. PUBLIC HEALTH NURSING LEADERSHIP PRACTICUM. (4 cr; prereq 5960, 5963 or ¶5963, 8010, 8040, #) Josten
Developing knowledge of and skills for specific leadership role within the field. Leadership and role theory.

Graduate Programs

5965. SPECIAL PROBLEMS OF MANAGEMENT OF COMMUNITY-BASED NURSING SERVICES.

(3 cr; prereq 8010 or ¶8010, 8011 or ¶8011, 8014 or ¶8014, clinical courses in student's area of study or #) Josten

Management problems common to community-based nonprofit or public nursing services. Developing skill in management problem solving to address such problems as working with a governing board, nonprofit budgeting, and missed appointments.

8063. NURSING CONSULTATION. (3 cr; offered when feasible)

8315. NURSE-MIDWIFERY MANAGEMENT: INTRAPARTAL AND POSTPARTAL. (8-10 cr; prereq 8314) Avery, Rossi

Theory and clinical experience in management and care of the laboring woman/couple through the six-week restorative period. Early care of the newborn is an integrated component.

8425. PSYCHIATRIC-MENTAL HEALTH NURSING: ROLE DEVELOPMENT. (6 cr; prereq #) Vellenga

Theoretical and clinical components of modalities of psychiatric-mental health nursing intervention. Opportunity to clarify understanding of interdisciplinary roles and relationships in community mental health setting. Concepts from systems theory related to organizational structure of mental health facilities and community.

8455. THE NURSE EDUCATOR IN HIGHER EDUCATION. (6 cr; prereq 8451, §course in educational measurement, #) Gustafson

Analysis of roles and responsibilities of nurse educator in higher education. Data for analysis obtained through review of relevant literature and testing of roles in an academic setting.

8600. HEALTH CARE INSTITUTIONS AND NURSING LEADERSHIP. (3 cr; prereq Nurs grad student or #)

Nature of experiencing and its modes; a person's relatedness to others and responsibility to the human community; characteristics of American society and their demonstration in health care institutions.

8702. NURSING ADMINISTRATION II. (6 cr; prereq 8701, #) Hansen

Intensive study of role of nursing administrator by application of major concepts in organization and management theory and nursing process to nursing administration. Emphasis on making operational and evaluating nursing administration goals.

Special Topics Courses

5609. SPECIAL EDUCATIONAL EXPERIENCES IN NURSING. (1-6 cr; prereq Δ)

Planned to meet individual student needs.

5620. INDEPENDENT STUDY IN NURSING TOPICS. (1-9 cr; prereq #)

Elective course planned to meet individual student needs.

5799. SELF-DIRECTED STUDY AS A MEANS OF ACCOMPLISHING NURSING ELECTIVES. (Cr ar; prereq #)

For students with a specific interest or wanting specific experience not provided in regularly offered courses. Student writes objectives and makes formal contract with instructor that specifies credits, types of experiences, and method of evaluation.

8001. SPECIAL EDUCATIONAL EXPERIENCES IN NURSING. (Cr ar; prereq #)

Various learning experiences planned to meet individual needs.

8009. SPECIAL TOPICS IN NURSING. (Cr ar; prereq #)

8509. SPECIAL TOPICS IN NURSING EDUCATION. (Cr ar; prereq #)

8609. SPECIAL TOPICS IN NURSING SUPERVISION. (Cr ar; prereq #)

Nutrition (Nutr)

Professor: Joanne L. Slavin (food science and nutrition), *director of graduate studies;* Paul B. Addis (food science and nutrition); C. Eugene Allen (animal science); Judith E. Brown (epidemiology); Francis F. Busta (food science and nutrition); Frank B. Cerra (surgery); Agnes S. Csallany (food science and nutrition); William R. Dayton (animal science); Mary E. Dempsey (biochemistry); Richard D. Goodrich (animal science); John H. Himes (epidemiology); Ralph T. Holman (*emeritus:* food science and nutrition); Theodore P. Labuza (food science and nutrition); Arthur S. Leon (kinesiology and leisure studies); Allen S. Levine (food science and nutrition); Jay C. Meiske (animal science); Donald E. Otterby (animal science); James E. Pettigrew (animal science); John D. Potter (epidemiology); Dennis A. Savaiano (food science and nutrition); Marshall D. Stern (animal science); Paul E. Waibel (animal science)

Associate Professor: Elaine Asp (food science and nutrition); Linda J. Brady (food science and nutrition); Margot P. Cleary (Hormel Institute); Mary T. Story (epidemiology); Sally Weisdorf (pediatric gastroenterology)

Assistant Professor: Roderick A. Barke (surgery); Paul S. Brady (food science and nutrition); I. Marilyn Buzzard (epidemiology); Patricia J. Elmer (epidemiology); Daniel D. Gallaher (food science and nutrition); Mary C. Gannon (food science and nutrition); Craig A. Hassel (food science and nutrition); Darlene G. Kelly (food science and nutrition); Mindy S. Kurzer (food science and nutrition); Lawrence H. Kushi (epidemiology); Marla M. Reicks (food science and nutrition); Patricia L. Splett (epidemiology)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Three subspecialty areas are offered in the doctoral degree program: human nutrition, nutritional biochemistry, and public health nutrition. Thesis work can be conducted in the laboratory, clinic, or field, locally or internationally.

Prerequisites for Admission—A strong foundation in the biological and physical sciences is required. This background includes college mathematics through calculus, physics, the equivalent of one year of general and one year of organic chemistry, general biology, biochemistry, physiology, and two additional courses in the biological sciences. If there is evidence that the applicant has a good background in the sciences, some of the prerequisites can be met after admission.

Applicants interested in the M.S. degree with clinical emphasis must offer as prerequisites courses in general biology, human nutrition, microbiology, college algebra, one year each of general and organic chemistry, 20 or more quarter credits in food science and nutrition, and a dietetic internship or equivalent.

Applicants to the Ph.D. program who have completed the M.S. degree with a clinical emphasis must have completed the requirements described in the first paragraph above under Prerequisites for Admission.

Special Application Requirements—Graduate Record Examination scores and three letters of recommendation evaluating the applicant's scholarship must be submitted. At least two letters should be from professorial-rank faculty.

Master's Degree Requirements—Students must develop and demonstrate general competence in nutrition, including knowledge of basic biochemistry, physiology, food chemistry, and statistics. In addition, students must develop a minor or coherent related field program in a discipline(s) closely allied to nutrition—e.g., biochemistry, cell biology, epidemiology, food science, microbiology, or physiology. An oral final examination is required for both plans.

Doctoral Degree Requirements—Programs are designed by the student and adviser to develop appropriate skills in research and scholarship. A more comprehensive knowledge is required in the subject matter listed above for the master's program. Core requirements include FScN courses 5622, 5623, 5624, 8101 (twice), and two 8xxx courses; and one course in biochemistry. Students complete a minor consisting of an individual subject (e.g., biochemistry) or a supporting program consisting of a cluster of subjects (e.g., biochemistry, physiology, and statistics).

Language Requirements—None, unless specified by an adviser.

Minor Requirements for Students Majoring in Other Fields—General competence in nutrition.

For Further Information and Applications—Contact the Nutrition Graduate Program, Department of Food Science and Nutrition, University of Minnesota, 1334 Eckles Avenue, St. Paul, MN 55108 (612/624-1290).

Note—The following courses are commonly selected for major and minor programs; other courses are also available.

Nutr 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Nutr 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Nutr 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

FScN 5612. EXPERIMENTAL NUTRITION. (2 cr; prereq 3612, ¶Biol 5001) Gallaher
Use and evaluation of methods and interpretation of results from clinical nutrition measures.

FScN 5622. MACRONUTRIENT METABOLISM. (4 cr; prereq 3612, Biol 5001, Phsl 3051) Brady
Physiological function and metabolic fate of carbohydrates, lipids, and proteins and their involvement in fulfilling energy needs for maintenance, growth, and work.

FScN 5623. VITAMIN AND MINERAL BIOCHEMISTRY. (4 cr; prereq 3612, Biol 5001, Phsl 3051) Gallaher
Nutritional/biochemical and physiological function of essential vitamins and minerals in humans and experimental animal models.

Graduate Programs

FScN 5624. HUMAN PROTEIN AND ENERGY UTILIZATION. (4 cr; prereq 5622, 5623) Kurzer
Regulation of human protein and energy use, interactions, adaptations; critical evaluations of methods of determining requirements; technical and ethical problems in human experimentation and determination of recommended levels of intake.

FScN 5643. WORLD FOOD PROBLEMS. (3 cr, §AgEc 5790, §Agro 5200, §CAPS 5280; prereq sr or grad student; limited enrollment) Breene, Busta, Savaiano

Multidisciplinary approach to social, economic, and technical problems of feeding world's growing population. Principles from social and economic sciences and from plant, animal, and food sciences for application to world food problems.

FScN 8101. RESEARCH SEMINAR. (1 cr; prereq #; S-N only) Staff

Discussion with faculty member(s) on research progress within the group, or review and discussion of current research literature related to food science and nutrition.

FScN 8313. TOPICS IN LIPID CHEMISTRY. (2 cr; prereq 5110 or 5622 or #; offered alt yrs) Csallany
Current evaluation of research relevant to lipid chemistry and biochemistry in animal and plant tissues, biological fluids, and food systems, emphasizing oxygen, free radicals, superoxide, singlet oxygen, autoxidation, oxidative deteriorations, antioxidants, and protective enzyme systems.

FScN 8603. ADVANCED TOPICS IN NUTRITION.

(1-4 cr; prereq #)

Review of recent research or presentation of special topics.

FScN 8621. INDEPENDENT STUDY: NUTRITION.

(1-9 cr; prereq #) Staff

Independent study and written reports in nutrition.

Nutr 8745. SEMINAR. (1 cr [may be repeated for cr];

prereq #) Staff

Current topics in human nutrition.

Nutr 8990. GRADUATE RESEARCH. (2-5 cr; prereq #) Staff

Research in various areas in nutrition represented by staff interests.

PubH 5330. EPIDEMIOLOGY I. (4 cr; prereq public hlth or pharmacy or med school or nursing or dentistry or grad student or #) Luepker, Sellers

Basic epidemiologic principles applicable to infectious and noninfectious disease; host-agent-environment complex; factors underlying spread of infectious disease; lab applications of statistical and epidemiologic methods.

PubH 5386. PUBLIC HEALTH ASPECTS OF CARDIOVASCULAR DISEASES. (3 cr; prereq 5330, 5450 or equiv) Elmer

Evaluating population studies and trials on cardiovascular diseases; modifiable risk factors for coronary heart disease; preventing other types of heart disease.

PubH 5387. CANCER EPIDEMIOLOGY. (3 cr; prereq 5330, 5340 or #) Potter, Robison
Epidemiologic aspects of cancer, including theories of carcinogenesis, incidence, site specific risk factors, and issues of cancer control and prevention.

PubH 5902. MATERNAL AND INFANT NUTRITION. (3 cr; prereq 3xxx nutrition course or equiv or #) Brown

Nutritional needs of childbearing women and infants, how to meet these through programs and services.

PubH 5914. NUTRITION INTERVENTION. (3 cr; prereq nutrition course or #) Jeffery, Kushi
Selecting appropriate nutrition intervention strategies for health programs, applying them to specific target audiences, and evaluating their usefulness in relation to program objectives.

PubH 5932. NUTRITION: ADULTS AND THE ELDERLY. (3 cr; prereq 3xxx nutrition course or equiv or #) Krinke

Review of current literature and research on nutrient needs and factors affecting nutritional status of adults and the elderly.

Obstetrics and Gynecology (Obst)

Professor: Benjamin S. Leung, *director of graduate studies;* Takashi Okagaki; Leo B. Twiggs

Assistant Professor: Doris C. Brooker; Jon L. Pryor

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.S.Obs. & Gyn. (Plan A only).

Curriculum—Joint programs, particularly with the basic sciences, are acceptable on approval.

Prerequisites for Admission—Applicants must hold an M.D. degree from an approved medical school.

Master's Degree Requirements—A minimum of 45 credits is required, 20 of which must be taken in courses relating to aspects of human reproduction. The remainder of the credits can be taken in nonclinical courses or independent study relating to research. By the end of the program, students must demonstrate an understanding of epidemiology and a working knowledge of biometry and the use of computers in biomedical research. Students must develop skill in designing studies and doing critiques for rigorous

review of research reports. Students electing the Plan A format must write a thesis that is publishable in a refereed journal. A final oral comprehensive examination is required.

Language Requirements—None.

For Further Information and

Applications—Contact the Department of Obstetrics and Gynecology, University of Minnesota Medical School, Box 395 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/626-3111; fax 612/626-0665).

Obst 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

8201-8202-8203-8204. ADVANCED OBSTETRICS AND GYNECOLOGY I. (Cr ar; required of 1st-yr fellows)

Includes service in the University of Minnesota-affiliated hospitals (University, Metropolitan Medical Center, and Hennepin County Medical Center) with ample experience in diagnosis, care, and treatment (operative and nonoperative) of patients.

8205-8206-8207-8208. ADVANCED OBSTETRICS AND GYNECOLOGY II. (Cr ar; required of 2nd-yr fellows)

Similar to Obst 8201-8202-8203-8204 but more advanced, both in clinical and research aspects of the subjects; adapted to increased training and experience of fellows.

8209-8210-8211-8212. ADVANCED OBSTETRICS AND GYNECOLOGY III. (Cr ar; required of 3rd-yr fellows)

Similar to Obst 8205-8206-8207-8208 but more advanced.

8213-8214-8215-8216. ADVANCED OBSTETRICS AND GYNECOLOGY IV. (Cr ar; prereq 8212)

8217-8218-8219-8221. SEMINAR IN OBSTETRICS AND GYNECOLOGY. (Cr ar; prereq 8216)

8222-8223. GYNECOLOGICAL ONCOLOGY. (Cr ar; prereq 8221)

8224. GYNECOLOGICAL ENDOCRINOLOGY I. (Cr ar; prereq 8223)

8225. GYNECOLOGICAL ENDOCRINOLOGY II. (Cr ar; prereq 8224)

8226. OBSTETRICAL PHYSIOLOGY AND ANESTHESIOLOGY. (Cr ar; prereq 8225)

8227. PRECEPTORSHIP IN CLINICAL PRACTICE. (Cr ar; prereq 8226)

8228. SELECTED ASPECTS OF RADIATION THERAPY. (Cr ar; prereq 8227)

8229. SELECTED ASPECTS OF MEDICAL ONCOLOGY. (Cr ar; prereq 8228)

8230. RESEARCH IN REPRODUCTION. (Cr ar; prereq 8229)

8240. HUMAN GAMETES AND FERTILIZATION. (4 cr; prereq 8224, 8225 or #, Phsl 8110, Phsl 8111, GCB 5013 or AnSc 5322) Hensleigh, Leung
Origin, migration, multiplication of germ cells; differentiation of the gonad; control of meiotic cycle; oogenesis, ovulation, and ovum; spermatogenesis and spermatozoa; gamete transport, fertilization, pre-implantation embryo; implantation; manipulation of development. Emphasis on current research.

8241. HUMAN GAMETES AND FERTILIZATION LABORATORY. (3 cr; prereq 8240 or ¶8240) Hensleigh, Leung

Culture of human gametes and embryos; semen analysis; sperm preparation for IVF; ovulation and superovulation; ova harvest; insemination and fertilization; embryonic development *in vitro*; embryo transfer; embryo cryopreservation; micromanipulation, including separation of blastomeres, injection of sperm, and zona drilling.

Oral Biology (OBio)

Professor: Quenton T. Smith, *director of graduate studies* (oral science); William H. Douglas (oral science); Gregory R. Germaine (oral science); Mark C. Herzberg (preventive science); William F. Liljemark (diagnostic/surgical science); Charles F. Schachtele (oral science); Burton L. Shapiro (oral science)

Associate Professor: Ralph DeLong (restorative sciences); Kenneth M. Hargreaves (restorative sciences); Robert H. Ophaug (oral science); Joel D. Rudney (oral science); Larry F. Wolff (preventive science)

Assistant Professor: David K. Ann (pharmacology); Pamela R. Erickson (preventive science); Keith C. Kajander (oral science); Ambika Mathur (oral science)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Students are provided with a broad understanding of the orofacial region, its development (including aging), structure, function, and pathology. More specialized areas of interest, such as salivary glands and secretions, development of oral structures, mineral metabolism and nutrition, pulp biology, oral microbial ecology and physiology, mechanisms of microbial infection and immunity, and development and evaluation of dental materials are emphasized in advanced coursework and research. Individual programs are planned

Graduate Programs

according to the student's specific areas of interest and may include courses from other disciplines as part of the major. A minor in a related nonclinical discipline is also required.

Prerequisites for Admission—Programs are designed for individuals who have completed requirements for graduation with high standing from dental or medical schools and desire to undertake advanced studies in oral biology. In some cases individuals who have not yet obtained the D.D.S. (D.M.D.) or M.D. degree, but who have demonstrated exceptional potential for graduate study, may be admitted for a combined program.

Individuals with a bachelor's or master's degree who can demonstrate an appropriate background and an interest in oral biology are considered for admission.

Special Application Requirements—

Applicants must submit three letters of recommendation from persons familiar with their academic and research experience and a statement describing how training in oral biology will help them attain their professional objectives. Students may enter the program in any quarter, but fall quarter is recommended.

Master's Degree Requirements—The M.S. degree program generally requires two years or more. For Plan A (with thesis), the student must complete a minimum of 20 credits in the major, including the survey course in oral biology (8010), 4 credits of oral biology topics courses, and participate each quarter in the student seminar. Students must also complete a minor in a related nonclinical discipline (minimum 9 credits). Plan B does not include a research thesis, but involves additional coursework (minimum 44 credits, including a minor of at least 9 credits) and three papers, at least one of which includes a laboratory study. Students must maintain a cumulative grade point average (GPA) of at least 3.00 in both the major and minor. Only grades of A or B are acceptable in the core courses designated above. A final oral examination is required for both plans.

Doctoral Degree Requirements—

Coursework for the Ph.D. degree is selected to give the student a broad background in oral biology plus advanced coursework more directly related to the student's research interests. Though there are no minimum credit requirements for the Ph.D. degree, all students register for the survey oral biology course (8010) and 8 credits of oral biology topics courses and participate each quarter in the student seminar. Most students are also expected to take 10 credits of cell biology, 7 credits of biochemistry, and a course (3 to 5 credits) in statistics, biometry, or epidemiology to complete a core curriculum of 35-37 credits. A minor in a relevant nonclinical discipline is required. A cumulative GPA of at least 3.00 in both the major and minor is required. Only grades of A or B are acceptable in the core courses designated above. The preliminary written examination is taken before the end of the second year in residence. It consists of two research proposals, one representing the student's anticipated thesis research, and the other on a topic assigned by the graduate faculty. The preliminary oral examination consists primarily of a defense of the two proposals described above. Students must present a research seminar (which is attended by the final examination committee) no later than six months before defense of the thesis.

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—A minor in oral biology consists of 9 credits for the M.S. degree and 20 credits for the Ph.D. degree. The minor must include OBio 8010, at least two advanced courses in oral biology, and other coursework in consultation with the director of graduate studies.

For Further Information and

Applications—Contact the Oral Biology Graduate Program, University of Minnesota, 17-252 Moos Health Sciences Tower, 515 Delaware Street S.E., Minneapolis, MN 55455 (612/624-9123).

OBio 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

OBio 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

OBio 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5001f. METHODS IN RESEARCH AND WRITING. (2 cr; prereq grad student) Kajander
Process of scientific inquiry and reporting. Critical literature review and proposal writing.

8001. RESEARCH IN ORAL BIOLOGY. (Cr ar) Staff

8002. TUTORIAL IN ORAL BIOLOGY. (Cr ar [2 hrs per wk=1 cr; may be repeated for cr]) Staff
Quarter-long apprenticeship with faculty members to familiarize students with faculty research interests.

8010w. ORAL BIOLOGY. (3 cr; prereq dental specialist and/or oral research trainee) Staff
Oral aspects of inflammation, wound healing, and immunology; plaque composition, formation, and metabolism; saliva glands, composition, and function; biochemistry of connective and mineralized tissues; neurobiology and pathophysiology of orofacial pain and sensations.

8021, 8022, 8023, 8024. TOPICS IN ORAL BIOLOGY. (1-3 cr per qtr [may be repeated for cr]; prereq #) Staff
Individual courses address specialized topic relevant to biology of orofacial region. Specific offerings for at least the next two years are listed below.

8021f. SALIVARY GLANDS AND SECRETIONS. (2 cr; offered even yrs) Germaine, Herzberg, Rudney, Shapiro, Smith
Structure, development, and evolution of salivary glands; mechanisms and control of secretion of electrolytes and macromolecules; structure and function of mucins, antimicrobial and mineral binding proteins, and exocrinopathy of salivary glands.

8021f. ORAL MICROBIOLOGY. (1-2 cr; offered odd yrs) Liljemark, Schachtele, Wolff
Lectures, assigned readings, and discussions on acquisition, distribution, and interactions of oral flora; mechanisms of dental plaque formation; etiology of dental caries and periodontal diseases; other oral bacterial infections; microbiology in dental specialty areas.

8022w. MOLECULAR MECHANISMS OF CELLULAR AND MICROBIAL ADHESION. (2 cr; offered even yrs) Germaine, Herzberg, Liljemark, guest lecturers
Biochemical basis of adhesion phenomena, focusing on cells of immune system, development and tissue formation, and bacterial colonization of the human.

8022w. PHYSICAL BIOLOGY OF THE ORAL CAVITY. (1-2 cr; offered odd yrs) DeLong, Douglas, Sakaguchi

Structure and function of human masticatory system discussed from biophysical point of view. Mandibular form, movement, and infrastructure of hard tissues as related to occlusal wear and masticatory efficiency; role of saliva and salivary pellicle in reduction of interocclusal friction. Physical methods (artificial mouth), computational methods of stimulation, digitization and graphic representation of anatomical surfaces, and methods of clinical measurements.

8023s. THE SECRETORY IMMUNE SYSTEM. (1-2 cr; offered odd yrs) Mathur
Lectures and discussions of secretory immunoglobulin A system. Origin, structure, and synthesis of sIgA; induction and biological activity of sIgA; role of sIgA in oral health.

8024su. GENETICS OF ORAL DISEASES. (2 cr; offered SS1 of even yrs) Shapiro
Principles of medical genetics with emphasis on oral diseases. Twins, chromosomes, recombinant DNA, major gene traits, genes in populations, chromosomal abnormalities, complex traits, facial clefts, dental caries, periodontal diseases.

8024su. BIOLOGY OF THE CHEMICAL SENSES. (1-2 cr; offered SS1 of odd yrs) Rudney, staff
Review of topical areas in biology of taste and smell. Histology, physiology, receptor recognition of tastant and odorant molecules, clinical measurement, and pathobiology.

8030f,w,s. SEMINAR. (1 cr [may be repeated for cr]) Staff
Faculty and student discussion of current topics in oral biology.

8101, 8102, 8103. TOPICS IN CARIOLOGY. (1-2 cr; prereq #) Ophaug, staff
Different topics or subject areas each quarter, announced in advance. Includes etiology, pathogenesis, diagnosis, epidemiology, contributing factors, and prevention of dental caries.

Additional major coursework may be drawn from basic medical sciences and other areas appropriate to the individual program.

Otolaryngology (Otol)

Professor: George L. Adams, head; Frank M. Lassman (emeritus), director of graduate studies; Arndt J. Duvall, III; S. K. Juhn; Robert H. Maisel; Robert H. Margolis; David A. Nelson

Clinical Professor: Michael M. Paparella

Associate Professor: John H. Anderson; Lawrence R. Boies, Jr.; Peter A. Hilger; Eric Javel; Samuel C. Levine; Peter A. Santi

Clinical Associate Professor: Marcos V. Goycoolea; Stephen L. Liston

Graduate Programs

Assistant Professor: Kathleen A. Daly; Markus Gapany; George S. Goding, Jr.; David B. Hom; Lisa L. Hunter; John A. Ness; Edward H. Szachowicz II

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S., M.S.Otol. (Plan A only) and Ph.D.Otol.

Curriculum—The graduate degree programs prepare students in both clinical and experimental aspects of otolaryngology. Rotations at the University Hospitals, Minneapolis Veterans Administration Medical Center, St. Paul-Ramsey Medical Center, and Hennepin County Medical Center provide a wide range of material for clinical education and surgical experience. Opportunities for independent research are provided by the research laboratories of audiology, auditory electrophysiology, auditory neurophysiology, biochemistry, electronmicroscopy, electrophysiology, histochemistry, morphometry, psychoacoustics, temporal bone pathology, tumor immunology, skin-flap physiology, laryngeal physiology, mandibular bone physiology, microvascular tissue transfer, and vestibular physiology. Graduates of the program have careers in teaching, research, and the professional practice of otolaryngology.

Prerequisites for Admission—Applicants must hold an M.D. degree from an approved medical school.

Degree Requirements—All graduate students in the program spend one year in general surgery and four years in otolaryngology. During the last four years, each fellow is required to spend six months in basic research directed toward preparation of an acceptable thesis for a master's or doctoral degree. Most Ph.D. candidates require time beyond the four years to complete their research.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Otolaryngology, University of Minnesota,

Box 396 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/625-3200).

Otol 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Otol 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Otol 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5101f. INTRODUCTION TO THE BASIC SCIENCES IN OTOLARYNGOLOGY I: EAR. (3 cr; prereq #) Anderson, Daly, Duvall, Javel, Juhn, Lassman, Liston, Margolis, Santi
Acoustics and psychoacoustics, temporal bone anatomy, external and middle ear mechanisms, cochlear physiology, auditory neurophysiology, ear embryology, ear biochemistry, fine structures, vestibular mechanisms and measurement.

5102s. INTRODUCTION TO THE BASIC SCIENCES IN OTOLARYNGOLOGY II: HEAD AND NECK. (3 cr; prereq #) Adams, Gapany, Goding, Hilger, Hom, Liston, Santi, Szachowicz
Laryngeal anatomy and physiology, nasal anatomy and physiology, immune biology, embryology of head and neck.

5970. DIRECTED STUDIES. (Cr ar [may be repeated for cr]; prereq #) Staff
Directed readings and preparation of reports on selected topics.

8230. CLINICAL OTORHINOLARYNGOLOGY. (6 cr) Adams, Boies, Duvall, Gapany, Goding, Hilger, Hom, Levine, Maisel, Ness, Szachowicz
Diagnostic and management instruction and experience in all phases of clinical otorhinolaryngology. Both inpatient and outpatient services are provided at University of Minnesota Hospitals, St. Paul-Ramsey Medical Center, Veterans Administration Medical Center, and Hennepin County Medical Center.

8231. SURGERY OF THE EAR, NOSE, AND THROAT. (4 cr) Adams, Boies, Duvall, Gapany, Goding, Hilger, Hom, Levine, Maisel, Ness, Szachowicz
Surgical training and experience with a broad scope of surgical problems encountered in otorhinolaryngology provided at University of Minnesota Hospitals, St. Paul-Ramsey Medical Center, Veterans Administration Medical Center, and Hennepin County Medical Center.

8232. MAXILLOFACIAL SURGERY. (1 cr) Adams, Boies, Duvall, Hilger, Maisel, Ness, Szachowicz
Basic science principles and management principles of maxillofacial diseases. Problems of maxillofacial trauma. Experience with these problems in the hospitals of the training program, especially the county hospitals.

8233. PLASTIC AND RECONSTRUCTIVE SURGERY OF THE HEAD AND NECK. (1 cr) Adams, Boies, Duvall, Hilger, Hom, Maisel, Szachowicz
Teaching and practical training for otolaryngologic cosmetic surgery with emphasis on rhinoplasty and otoplasty.

8234. ANATOMY OF THE HEAD AND NECK AND TEMPORAL BONE DISSECTION. (2 cr) Levine
Head and neck anatomy is studied from cadaver material through programmed learning. Temporal bones are dissected to learn anatomy and to practice all otologic surgical procedures.

8235. ROENTGENOLOGY OF THE HEAD AND NECK. (2 cr) Staff
Experience in X-ray diagnostic procedures for otolaryngologic problems.

8236. PHARMACOLOGY IN OTOLARYNGOLOGY. (2 cr) Staff
General principles of pharmacology as they relate to otolaryngology.

8237. ENDOSCOPY. (2 cr) Adams, Duvall, Goding, Maisel
Instruction, didactic and practical, in laryngoscopy, esophagoscopy, bronchoscopy, and mediastinoscopy. General management principles emphasized.

8238. PATHOLOGY OF THE EAR, NOSE, AND THROAT. (2 cr) Adams, Duvall, Goding, Maisel
Gross pathology and histopathology of diseases of the ear, nose, throat, and related regions.

8239. OTONEUROLOGY. (2 cr) Anderson, Levine
Instruction and experience in diagnosis and management of otoneurologic problems including training in electronystagmographic analysis of vestibular function.

8240. ALLERGY. (2 cr) Staff
Concepts and management of otolaryngologic allergy.

8241. TUMOR CLINIC. (1 cr) Adams, Duvall, Gapany, Goding, Maisel
Clinical head and neck oncology including consideration of etiology, treatment (both surgical and nonsurgical), and other principles of management.

8242. AUDIOLOGY AND SPEECH PATHOLOGY. (2 cr) Margolis, staff
Fundamentals of audiology and speech pathology. Measurement and description of disorders of hearing, speech, and language in children and adults. Peripheral vs. central differential diagnostic signs. Hearing aids. Special educational management of children and adults. Community resources.

8243. INTRODUCTION TO RESEARCH METHODOLOGY. (2 cr) Daly, staff
Basic introduction to such topics as statistical methods, experimental design, and execution of otolaryngologic research. Required for all 1st-year otolaryngology residents.

8244. SEMINAR: CURRENT LITERATURE. (1 cr) Adams, Gapany
Presentation and discussion of selected articles required for all residents.

8245. MASTER'S THESIS RESEARCH. (Cr ar) Staff

8246. PH.D. THESIS RESEARCH. (Cr ar) Staff

8247f. PHYSIOLOGY OF HEARING. (3 cr, §NSc 8247; prereq #; offered alt yrs) Staff
Basic functional mechanisms of the auditory system, peripheral and central.

8248. READINGS IN AUDITORY PHYSIOLOGY. (1-3 cr; prereq #) Staff
Current research on biophysics and physiology of auditory system; specific topics selected for each student. Written reviews prepared and discussed.

8249. SEMINAR: CURRENT TOPICS IN COCHLEAR ANATOMY. (1 cr; prereq #) Santi
Review of current research papers concerning cochlear anatomy and pathology.

8250. ADVANCED BIOCHEMISTRY OF THE AUDITORY SYSTEM. (2 cr; prereq MdBc 5100, MdBc 5101 or equiv or #) Juhn
Review of recent progress in biochemical aspects of auditory end organs.

8262. ADVANCED CLINICAL AUDIOLOGY. (3 cr; prereq Otol grad major, 8242 or #) Margolis
Comprehensive reading and practicum experience in auditory evaluation of patients. Assumes basic knowledge of clinical audiology. Each session devoted to aspect of auditory evaluation or aural rehabilitation, including behavioral audiometry, electrophysiologic evaluation, hearing aid selection, and cochlear implants.

Parasitology

See Veterinary Pathobiology under Veterinary Medicine.

Pathobiology (Path)

Regents' Professor: Alfred Michael; James G. White

Professor: Leo T. Furcht, *head*; Khalil Ahmed; Miguel M. Azar; Henry H. Balfour, Jr.; Richard D. Brunning; Agustin P. Dalmasso; Richard D. Estensen; Leonard Greenberg; Erhard Haus; Robert P. Hebbel; Harry S. Jacob; Arthur G. Johnson¹; John Kersey; Tucker W. LeBien; Catherine Limas; Philip B. McGlave; Matthew F. Mescher; Theodore R. Oegema, Jr.; Harry T. Orr; Gundu Rao; Stephen Rich; Andreas Rosenberg; Burton L. Shapiro; Michael W. Steffes; Daniel Vallera; Brian G. Van Ness; Lee W. Wattenberg

Associate Professor: James B. McCarthy, *director of graduate studies*; Diane Arthur; Peter B. Bitterman; Bruce R. Blazar; Aristidis S. Charonis; Douglas J. Christie; Lynda B. Ellis; Vincent F. Garry; Betsy A. Hirsch; Marc K. Jenkins; Danuta Malejka-Giganti; R. Scott McIvor; Miriam Segall; Yoji Shimizu; Keith M. Skubitz; Michael Y. Tsai; Effie C. Tsilibary; Gregory M. Vercellotti; Carol L. Wells; Michael J. Wilson; Walid Yasmineh

Assistant Professor: Timothy W. Behrens; Frederick T. Boyd; Alejo Erice; Gregg B. Fields; William B. Gleason; Jeffrey P. Houchins; Bruce R. Lester; Ambika Mathur; Daniel L. Mooradian; Christopher A. Pennell; Amy P. Skubitz; Catherine M. Verfaillie; Elizabeth A. Wayner

¹ University of Minnesota, Duluth

Graduate Programs

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—Ph.D.

Curriculum—The program is administered in the Department of Laboratory Medicine and Pathology. It is for qualified postbaccalaureate students who seek careers as independent investigators in biomedical research. The program emphasizes the use of contemporary methods in cellular and molecular biology to address questions related to human disease.

Prerequisites for Admission—A bachelor's degree in an area of science and one course in biochemistry and histology are required. A course in microbiology is highly recommended but not required.

Special Application Requirements—

Applicants must forward to the Department of Laboratory Medicine and Pathology three letters of recommendation, scores from the General (Aptitude) Test of the Graduate Record Examination (GRE), and a brief statement of intent including reasons for seeking a degree in pathobiology, career objectives, and areas of special interest. Scores from the new GRE biochemistry, cell and molecular biology test are highly recommended. A minimum score of 600 on the Test of English as a Foreign Language (TOEFL) is required of applicants whose native language is not English. Students are admitted fall quarter only, except under unusual circumstances. Applications, especially those that request financial aid, should be received by January 15.

Degree Requirements—Students are expected to maintain at least a B average in the program. The preliminary written examination must be passed at the end of the first year of coursework; the preliminary oral examination must be passed after approximately two to three years in the program.

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—Minor programs must be approved by the director of graduate studies in pathobiology. Path 8108, 8109, 8110, and nine additional credits in pathobiology are required for the minor.

For Further Information and

Applications—Contact the Pathobiology Program, Department of Laboratory Medicine and Pathology, University of Minnesota, Box 609 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/625-9171).

Path 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Path 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5109. SEMINAR: SELECTED TOPICS IN PATHOBIOLOGY. (1 cr; prereq #; intended for Path grad students; A-F for students presenting seminars, S-N for all others)
Current thesis topics and other aspects of pathobiology.

5110. SEMINAR: PATHOLOGY. (1 cr; prereq #) Staff Department research seminar series.

5115. BASIC TRANSMISSION ELECTRON MICROSCOPY. (4 cr; prereq Path grad student, #)
Introduction to principles of basic electron microscopy. Lab emphasis on sample preparation, microscope use, image interpretation, photographic techniques.

5141. PROBLEMS IN EXPERIMENTAL AND CLINICAL CHRONOBIOLOGY. (Cr and hrs ar)
Halberg

8108f-8109w-8110s†. PATHOBIOLOGY I-II-III. (3 cr; prereq MdBc 5100, 5101 [or ¶MdBc 5100, 5101], CBN 5103, 5104 [or ¶CBN 5103, 5104] or #) McCarthy (8108), Orr (8109), LeBien (8110), staff
In-depth examination of cell injury and death, cell adhesion/growth, cell cycle and aging, platelets and coagulation, immunology/immunopathology, carcinogenesis, molecular genetics and inborn errors of metabolism, inflammation and mechanisms of pathogenesis, cell biology, and biochemistry.

8120. CELL CYCLE CONTROL. (2 cr; prereq 8108 or CDB 8149 or #; offered alt yrs) Boyd
Students report on current research. Cell cycle checkpoints and DNA damage, cyclins, growth factor modulation of cell cycle, and transcription factors.

8122w. BASIC SCIENCE OF CANCER. (1 cr; prereq MdBc 5100 or equiv) Wattenberg
Causes of cancer and mechanisms by which neoplasia is produced.

8130. CELL BIOLOGY OF THE EXTRACELLULAR MATRIX. (3 cr; prereq MdBc 5100-5101 or equiv, 8108-8109-8110 or #; offered alt yrs) McCarthy
Classification of extracellular matrices and structural nature of components within them; cell adhesion and spreading on extracellular matrix; extracellular matrix in certain normal and pathologic conditions.

8135w. BIOCHEMICAL ASPECTS OF NORMAL AND ABNORMAL CELL GROWTH. (3 cr; prereq #) Ahmed
Current studies on biochemical mechanisms in model systems relating to gene action, cell cycle, physiological, and pathological cell growth.

8201. RESEARCH. (Cr and hrs ar; grads with necessary preliminary training may elect research, either as majors or minors in pathobiology) McCarthy, staff

8216. FRONTIERS OF IMMUNOLOGY I: MOLECULAR IMMUNOLOGY. (3 cr, §Micro 8216; prereq Biol 5001 or equiv) Jemmerson, Orr
Molecular basis of immunological recognition: B and T cells; immunoglobulin and T-cell receptor genes and mechanisms of expression; antigen processing and presentation; signal transduction in lymphokines, MHC gene products, and components of complement.

8217. FRONTIERS OF IMMUNOLOGY II: CELLULAR IMMUNOLOGY. (3 cr, §Micro 8217; prereq Biol 5001 or equiv or #) Jenkins
Overview of B-cell/T-cell interactions, major histocompatibility complex, cell surface markers, B-cell development and responses, negative regulatory mechanisms, T-cell responses, PMNs, and macrophages.

8218. FRONTIERS OF IMMUNOLOGY III: CLINICAL IMMUNOLOGY. (4 cr, §Micro 8218; prereq 8216, 8217) Gray
Antibody-mediated hypersensitivity, cellular hypersensitivity, auto-immunity, transplantation, tumor immunology, immunocytology, immune deficiencies.

8263. PATHOPHYSIOLOGY OF ENVIRONMENTAL DISEASE. (3 cr; prereq PubH 8261 or #) Garry
General mechanisms of environmentally induced tissue injury; compensatory mechanisms and repair processes; acute and chronic pathophysiology; tissue specificity of toxic agents; mutagenesis; teratogenesis.

8275. NORMAL AND ABNORMAL LYMPHOCYTE DIFFERENTIATION. (2 cr; prereq 8109, MicB 5218, #) LeBien
Analysis of historical and contemporary papers. How developmental perturbations can lead to immunodeficiency or leukemia. Students present papers.

8300. CURRENT TOPICS IN MEDICAL GENETICS. (2 cr; prereq # or Δ) Hirsch, Orr
Current developments in medical genetics and concepts of pathogenesis of genetic diseases.

8335. MAMMALIAN GENE TRANSFER AND EXPRESSION. (3 cr; prereq #) McIvor
Techniques, concepts, and application of gene transfer to mammalian physiology, pathology, and genetics; gene regulation, gene mapping, genetically engineered biologicals, transgenic animals, prospects for human gene therapy.

Pharmaceutics (Phm)

Professor: Yueh-Erh Rahman, head; David J. W. Grant; Edward G. Rippie; Ronald J. Sawchuk

Adjunct Professor: Gilbert S. Banker; Michael Pikal; Aldo Rescigno

Associate Professor: Raj G. Suryanarayanan, director of graduate studies; Timothy S. Wiedmann; Cheryl L. Zimmerman

Adjunct Associate Professor: Walid M. Awni; Keith K. Chan

Assistant Professor: Pei-Fan Bai

Adjunct Assistant Professor: George A. Agyilirah; Robert K. Schultz

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A only) and Ph.D.

Curriculum—Emphases are available in physical pharmacy, biopharmaceutics and pharmacokinetics. Coursework in supporting fields typically include chemistry, chemical engineering, mechanical engineering, physiology, biochemistry, cell biology, biometry, and pharmacology.

Prerequisites for Admission—A degree from a recognized college of pharmacy and an exceptional scholastic record are required. However, individuals from other academic fields (such as chemistry, engineering, biochemistry, and biology) may be admitted if their undergraduate coursework satisfies the prerequisites for graduate coursework in pharmaceutics. The degree program adviser may recommend additional background pharmacy coursework for such individuals.

Special Application Requirements—For applicants to both the M.S. and Ph.D. programs, recent Graduate Record Examination scores, a statement of career goals, and three letters of recommendation

Graduate Programs

are required. Fall quarter admission is preferred; under exceptional circumstances other quarters may be considered.

Master's Degree Requirements—Required components of the program include advanced courses in pharmaceuticals and chemistry. A complete list of degree program requirements may be obtained from the director of graduate studies. An oral final examination is required.

Doctoral Degree Requirements—Required components of the program include advanced courses in pharmaceuticals, chemistry, mathematics, statistics, and pharmacology. A complete list of degree program requirements may be obtained from the director of graduate studies.

Language Requirements—For the master's degree, none. For the doctoral degree, one foreign language or a collateral field of knowledge chosen with the consent of the director of graduate studies is required. The choice of option must have the approval of the major adviser.

For Further Information and Applications—Contact the Department of Pharmaceuticals, College of Pharmacy, University of Minnesota, 9-177 Health Sciences Unit F, 308 Harvard Street S.E., Minneapolis, MN 55455 (612/624-5151; fax 612/624-2974).

Phm 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Phm 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Phm 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

8100.* SEMINAR: PHARMACEUTICS. (1 cr; required of majors in pharmaceuticals) Staff

8101. READINGS IN PHARMACEUTICS. (1 cr) Staff
Current literature.

8105. PHARMACOKINETICS RESEARCH SEMINAR. (2 cr; prereq Phm grad specializing in pharmacokinetics) Sawchuk, Zimmerman
Advanced topics in animal and human pharmacokinetics.

8200.* RESEARCH PROBLEMS. (Cr ar) Staff
Experimental investigation of problems in pharmaceuticals.

8410. STABILIZATION OF PHARMACEUTICALS. (3 cr; prereq survey course in physical chem and in organic chem) Wiedmann
Application of physicochemical principles (e.g., chemical kinetics) to elucidate and minimize stability problems in pharmaceutical systems.

8420. MODELING APPROACHES IN PHARMACOKINETICS. (3 cr; prereq Phmc 5680, Math 3211 or #; offered alt yrs) Sawchuk
Application of compartmental, noncompartmental, and physiological model analyses to study of absorption, distribution, metabolism, and excretion of drugs.

8425. ADVANCED TOPICS IN PHARMACOKINETICS. (3 cr; prereq 8420; offered alt yrs) Zimmerman
Nonlinear pharmacokinetics (concentration- and time-dependent), drug metabolite kinetics, kinetics of pharmacological response, population kinetics.

8430. DRUG TRANSPORT AND ABSORPTION. (3 cr; prereq 5630, survey course in physical chem and in differential equations; offered alt yrs) Bai
Macroscopic and microscopic drug transport across biological and polymeric membranes.

8440. PHYSICAL PHARMACY. (4 cr; prereq Phmc 5680, survey course in physical chem or #; 4 hrs per wk; offered alt yrs) Rippie
Application of physical-chemical relationships between drugs and their formulations for optimization of bioavailability.

8441. SOLID-STATE PROPERTIES OF DRUGS. (3 cr; prereq Phmc 5680, survey course in physical chem or #; offered alt yrs) Suryanarayanan
Physical and physicochemical properties of drugs in solid state as related to drug delivery.

8442. PHYSICAL PHARMACY LABORATORY. (1 cr; prereq Phmc 5680, 8441, and a survey course in physical chem or #; offered alt yrs) Rippie
Lab experimentation dealing with application of physical and chemical information to dosage form design.

8450. INDUSTRIAL PHARMACY. (3 cr; prereq Phmc 5605 or equiv or #; offered alt yrs) Schultz
Design, manufacture, and evaluation of modern pharmaceutical dosage forms, including drug regulatory considerations. Preformulation studies, oral liquid and solid pharmaceutical dosage forms, optimization and drug regulatory affairs.

8460. SOLUBILITY BEHAVIOR OF DRUGS AND OTHER ORGANIC COMPOUNDS. (4 cr; prereq survey course in physical chem or #; offered alt yrs) Grant
Thermodynamics and kinetics of solubility and partitioning. Intermolecular interactions in pure state and in solution. Measurement and prediction of solubility and partitioning behavior. Functional group contributions. Molecular complexation and ion-pairing in solution.

8470. BIOLOGICAL APPROACHES TO DRUG TARGETING. (3 cr; prereq biochem survey course; offered alt yrs) Rahman

Concept of drug targeting. Characteristics of site-specific drug delivery systems. Biological, drug-related, and carrier-related factors. Therapeutic applications and critical evaluation of major drug carrier systems.

Phmc 5680. PHARMACOKINETICS. (3 cr; prereq 5620, Math 1221) Zimmerman

Kinetics of drug absorption, distribution, metabolism, and excretion in humans. Bioavailability, the plateau principle and effect of patient variability on dosing regimens.

Phmc 5696. PARENTERAL DOSAGE FORMS. (3 cr; prereq 5650, 5651) Staff

Theoretical and practical considerations in design, formulation, and evaluation.

Phmc 5999. SPECIAL PROBLEMS. (Cr ar; prereq #) Staff

Research in physical pharmacy, biopharmaceutics, or pharmacokinetics.

Pharmacology (Phcl)

Professor: Horace H. Loh, *head*; Timothy F. Walseth, *director of graduate studies*; Bianca M. Conti-Fine; Richard M. Eisenberg¹; Robert P. Elde; Patrick E. Hanna; Jordan L. Holtzman; Donald B. Hunninghake; Nancy M. Lee; Philip S. Portoghese; Michael A. Raftery; Alan R. Sinaiko; Norman E. Sladek; Sheldon B. Sparber; Fatih M. Uckun; George L. Wilcox; Ben G. Zimmerman

Associate Professor: Jean F. Regal¹, *associate director of graduate studies, Duluth*; Earl W. Dunham; Kenneth M. Hargreaves; Edward T. Knych¹; Ping-Yee Law; Rita B. Messing; Robert F. O'Dea; Paul R. Pentel; Aloysius J. Quebbemann; Virginia S. Seybold; George J. Trachte¹; Kendall B. Wallace¹; Wellington G. Wood III

Assistant Professor: David K. Ann; Frank H. Burton; Colin R. Campbell; Leonard Lichtblau; Louise M. Nutter; Sundaram Ramakrishnan; Daniel P. Romero; Paul J. Sammak; Stanley A. Thayer; Li-Na Wei

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A only) at Duluth (and under special circumstances at Twin Cities) and Ph.D.²

Curriculum—Courses and research provide opportunities for training in biochemical, physiological, and behavioral pharmacology and toxicology. For qualified students,

training in clinical pharmacology is available through the Division of Clinical Pharmacology.

Prerequisites for Admission—Applicants should be well grounded in the chemical and biological sciences and mathematics.

Special Application Requirements—At least three letters of recommendation from former instructors or employers and scores from the General (Aptitude) Test of the Graduate Record Examination are required.

Master's Degree Requirements—A complete list of degree program requirements may be obtained from the director of graduate studies. An oral final examination is required.

Doctoral Degree Requirements—Students must complete Phcl 5111 (or an acceptable alternative), 8110, 8111, 8112, 8204, and 8888. Prerequisite courses include physiology and biochemistry. Additional requirements are courses in statistics, calculus, microbiology, and any others that may be specified by the major adviser.

Language Requirements—None.

Minor and Supporting Program Requirements for Students Majoring in Other Fields—Students must complete 18 credits of coursework. At least 15 credits must be completed in Phcl 5111 or the equivalent, 8110, 8111, 8112, and 8204. The remaining credits can be completed in other advanced pharmacology courses.

For Further Information and Applications—Contact the Department of Pharmacology, University of Minnesota, 3-249 Millard Hall, 435 Delaware Street S.E., Minneapolis, MN 55455 (612/625-9997).

Phcl 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Phcl 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Phcl 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

¹ University of Minnesota, Duluth

² For information on the M.S. degree program offered in conjunction with the University of Minnesota, Duluth, please contact the associate director of graduate studies on the Duluth campus.

Graduate Programs

5110. PHARMACOLOGY. (2 cr; prereq regis med or #) Hunninghake, staff
Lectures and small groups on general principles of pharmacology and major classes of drugs.

5111f,w†. PHARMACOLOGY. (3 cr fall, 4 cr wtr; prereq 5110 or #) Hunninghake, staff
Continuation of 5110.

5462. NEUROSCIENCE PRINCIPLES OF DRUG ABUSE. (2 cr; prereq #; offered alt yrs) Law, Wilcox
Current research on drugs of abuse; their mechanisms of action, characteristics shared by various agents, and cellular and neural systems affected by them.

8110f. ADVANCED PHARMACOLOGY I. (2 cr; prereq biochem and physiol bkgnd, 5111 or ¶5110 or #) Loh
Supplement to 5110. Contemporary research concepts and experimental approaches in different areas of investigative pharmacology. Emphasis on mechanisms of action of drugs on systems (whole animal), organ, and cellular levels.

8111w. ADVANCED PHARMACOLOGY II. (3 cr; prereq biochem and physiol bkgnd, 5111 or ¶5111 or #) Loh, staff
Supplement to 5111. Contemporary research concepts and experimental approaches in different areas of investigative pharmacology. Emphasis on mechanisms of action of drugs on cellular and molecular levels.

8112s. ADVANCED PHARMACOLOGY III. (3 cr; prereq biochem and physiol bkgnd, 5111 or #) Loh, staff
Supplement to 5111. Contemporary research concepts and experimental approaches in different areas of investigative pharmacology. Emphasis on mechanisms of action of drugs on cellular and molecular levels.

8204. SEMINAR: SELECTED TOPICS IN PHARMACOLOGY. (3 cr on completion of 3 qtrs; prereq 5111 or #) Walseth, staff

8207. SEMINAR: PSYCHOPHARMACOLOGY. (1 cr; prereq #) Sparber, staff
Selected topics on behavioral aspects of drug action.

8208s. NEUROPSYCHOPHARMACOLOGY. (3 cr, §NSc 8208; prereq 5111, Psy 5018, Psy 5062 or #; offered alt yrs) Sparber, staff
Lectures on methodologies currently used to study relationships between drugs and biochemical, behavioral, and neurophysiological consequences. Discussions of functional biogenic amine, peptidergic, and other pathways; how specific manipulations result in altered neuronal function and behavior; and theories of feedback mechanisms, induction, and inhibition. Theories of tolerance to and/or dependence on stimulants, hallucinogens, depressants, and opiates.

8214s. TOXICOLOGY. (2 cr; prereq MdBc 5101 or #) Holtzman, Loh
Lectures on biochemical and molecular mechanisms of action by which drugs and other chemicals adversely alter human health.

8216s. IMMUNOPHARMACOLOGY. (2 cr; prereq MicB 5216 or equiv or #; offered alt yrs) Regal
Purported mediators of inflammatory process with reference to their actions on components of immune system and physiological response. Models for development of drugs useful in inflammatory disease as well as mechanisms of drugs currently in use. Lectures, assigned readings, discussion.

8217f. PROBLEMS IN INVESTIGATIVE PHARMACOLOGY. (2 cr; prereq #) Loh, staff
Contemporary research problems, investigative approaches and methodologies in experimental pharmacology. Related to cardiovascular, renal, endocrine, and autonomic pharmacology; neuropharmacology; psychopharmacology; chemotherapy; toxicology; and molecular pharmacology.

8219s. ADVANCED TOXICOLOGY. (1 cr; prereq 8214 or #; offered alt yrs) Holtzman, staff
Lectures on the biochemical mechanisms of intoxication by selected compounds.

8261. MOLECULAR TOXICOLOGY. (3 cr; prereq 5262, Biol 5001, ¶PubH 8261, #) Holtzman, staff
Toxic actions and mechanisms of environmental chemicals at molecular level; emphasis on current research in selective toxicity.

8269. TOXICOLOGY SEMINAR. (1 cr; prereq 8261, ¶PubH 8269, #) Holtzman, staff
Evaluation of toxicological studies. Students present data from literature or their own research.

Philosophy (Phil)

Professor: William H. Hanson, *chair*; Norman O. Dahl, *director of graduate studies*; Norman E. Bowie; Marcia M. Eaton; Ronald N. Gierre; Jeanette K. Gundel; Keith Gunderson; Geoffrey P. Hellman; Jasper Hopkins; Michael B. Kac; Douglas E. Lewis; H. E. Mason; C. Wade Savage; Naomi B. Scheman; John R. Wallace

Associate Professor: John H. Beatty; Elizabeth S. Belfiore; John M. Dolan; Helen E. Longino; Joseph I. Owens; Sandra L. Peterson; Michael D. Root; C. Kenneth Waters

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Prerequisites for Admission—Recognizing that evidence of ability to pursue graduate study in philosophy is diverse, the department does not specify prerequisites for admission. Normally, those admitted have a broad undergraduate background that includes some courses in philosophy.

Special Application Requirements—

Students must submit a completed application, scores from the General (Aptitude) Test of the Graduate Record Examination, and two or three letters of recommendation—normally by January 7. Decisions can be expected in March. Entry is usually in fall quarter, but may be permitted in other quarters in exceptional cases.

Master's Degree Requirements—Students must exhibit competence, through coursework or examination, in the history of philosophy. Students must pass a final oral examination on their work.

Doctoral Degree Requirements—Students must exhibit competence in the history of philosophy and logic and in the ability to pursue work on a range of philosophical topics in such areas as epistemology, metaphysics, and ethics or political philosophy.

Language Requirements—There is no general language requirement for the M.A. or Ph.D. degree.

For Further Information and

Applications—Further details about the program are presented in two publications: *Graduate Studies: Philosophy and Department Degree Programs: M.A. and Ph.D.*, available from the Department of Philosophy, University of Minnesota, 355 Ford Hall, 224 Church Street S.E., Minneapolis, MN 55455 (612/625-6563; fax 612/626-8380).

Phil 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Phil 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Phil 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5004. SOCRATIC DIALOGUES. (4 cr; prereq 3001 or #; offered when feasible) Dahl, Hopkins, Lewis, Peterson

5005. PLATO. (4 cr; prereq 3001 or #; offered alt yrs) Hopkins, Peterson
Analysis of major dialogues.

5008. ARISTOTLE. (4 cr; prereq 1 qtr hist of phil or #; offered alt yrs) Dahl, Peterson
Selected passages from major works.

5021. MEDIEVAL PHILOSOPHY. (4 cr; prereq 3001, 3002 or #; offered alt yrs) Hopkins
Selected topics in writings of medieval philosophers; e.g., Augustine, Anselm, Aquinas, Scotus, and Ockham.

5033. RATIONALISM. (4 cr; prereq 3003 or #) Philosophies of Descartes, Spinoza, and Leibniz.

5034. DESCARTES. (4 cr; prereq 3003 or #; offered alt yrs) Lewis, Root
Philosophical works.

5035. SPINOZA. (4 cr; prereq 3003 or #; offered when feasible) Lewis

5036. LEIBNIZ. (4 cr; prereq 3003 or #; offered when feasible) Dahl

5041. LOCKE. (4 cr; prereq 3003 or #; offered alt yrs) Gunderson, Lewis
The Essay Concerning Human Understanding.

5042. BERKELEY. (4 cr; prereq 3003 or #; offered when feasible) Lewis

5043. HUME. (4 cr; prereq 3003 or #; offered alt yrs) Lewis
Hume's Treatise and Inquiry.

5046. KANT. (4 cr; prereq 3003 or 3004 or #; offered alt yrs) Dahl
Selected passages from major works.

5054. KIERKEGAARD. (4 cr; prereq 1 qtr hist of phil or #; offered when feasible) Mason

5068. LATER PHILOSOPHY OF WITTGENSTEIN. (4 cr; prereq 5231 or 3003 or #; offered alt yrs) Mason, Scheman
Philosophical Investigations.

5101. METAPHYSICS. (4 cr; prereq 1 qtr hist of phil or #; offered alt yrs) Dolan, Owens, Root
Philosophical theories concerning nature of reality.

5105. EPISTEMOLOGY. (4 cr; prereq 1001 or #; offered alt yrs) Dolan, Root, Savage, Wallace, Waters
Theories of origin, development, reliability, justification, and scope of knowledge.

5201. SYMBOLIC LOGIC I. (5 cr; prereq 1001 or #) Dahl, Dolan, Hanson, Kac
Development of a formalized language. Syntax and semantics of sentential and first-order predicate logic. Deductive systems.

5202. SYMBOLIC LOGIC II. (5 cr; prereq 5201 or #) Dolan, Hanson, Hellman, Kac, Wallace
Introduction to metatheoretic proofs and methods, including proof by mathematical induction; elements of set theory; metatheorems on soundness, consistency, completeness; extensions of elementary logic.

5203. SYMBOLIC LOGIC III. (4 cr; prereq 5202; offered alt yrs) Dolan, Hanson, Hellman, Wallace
Elementary theory of Turing machines and recursive functions, proofs of limitative results, undecidability of first-order predicate logic, incompleteness of number theory and undefinability of truth therein. Philosophical significance of these results.

Graduate Programs

5211. MODAL LOGIC. (4 cr; prereq 5202 or Math 5162 or #; offered alt yrs) Hanson
Axiomatic and semantic treatment of propositional and predicate logics; problems of interpreting modal languages.

5221. PHILOSOPHY OF LOGIC. (4 cr; prereq 5202 or Math 5162 or #; offered alt yrs) Hanson, Hellman
Attempts to answer the question, "What is logic?" Scope of logic; disputes about alternative logics; various theories on nature of logical truth (e.g., conventionalism, the view that logical truths are contingent).

5222. PHILOSOPHY OF MATHEMATICS. (4 cr; prereq 5202 or 5xxx course in math; offered alt yrs) Hanson, Hellman
Study of major philosophical questions arising in connection with mathematics: What (if anything) is mathematics about? How do we know the mathematics we do? What is the relation between mathematics and the natural sciences?

5231. PHILOSOPHY OF LANGUAGE. (4 cr; prereq 1001, 5201 or #; offered alt yrs) Dolan, Kac, Mason, Owens, Peterson, Root, Wallace
Central topics in the philosophy of language, theories of reference, linguistic truth, relation of language and thought, translation and synonymy.

5232. TOPICS IN THE PHILOSOPHY OF LANGUAGE. (4 cr; prereq 3231 or 5231 or #; offered when feasible) Dolan, Hellman, Kac, Mason, Owens, Peterson, Root, Wallace

5302. HISTORY OF ETHICS: SELECTED CLASSICAL MORALISTS. (4 cr; prereq 1003 or 1 qtr hist of phil or #; offered alt yrs) Dahl, Peterson
Moral philosophy outside of British tradition (see 5301). Specific topics announced in *Class Schedule*.

5311. ETHICAL THEORY. (4 cr; prereq 1003 or #; offered alt yrs) Bowie, Dahl, Mason
Investigation of representative theories on the nature and justification of moral judgments.

5312. FOUNDATIONS OF ETHICS. (4 cr; prereq 1003 or #; offered alt yrs) Dahl, Mason
Discussion of the view that evaluative judgments cannot be based on factual considerations alone, and the relation of this view to the objectivity of ethics.

5321. THEORIES OF JUSTICE. (4 cr; prereq 1003 or 1004 or 5311 or #; offered alt yrs) Bowie, Mason
Philosophical accounts of the concept and principles of justice.

5324. ETHICS AND EDUCATION. (4 cr; prereq 8 cr phil or educ or #; offered when feasible) Scheman, Wallace

5325. BIOMEDICAL ETHICS. (4 cr; prereq # for undergrads)
Survey of topics and issues, including patients' rights and duties, informed consent, confidentiality, ethical issues in medical research, initiation and termination of medical treatment, euthanasia, abortion, maternal/fetal conflicts, allocation of medical resources.

5414. POLITICAL PHILOSOPHY. (4 cr; prereq 1004 or #; offered alt yrs) Bowie, Dolan, Hellman, Root, Wallace
Central concepts and principal theories of political philosophy.

5501. PRINCIPLES OF AESTHETICS. (4 cr; prereq 3502 or #; offered alt yrs) Eaton, Gunderson
Standards of evaluation; aesthetic experience; representation, meaning.

5512. PHILOSOPHY AND LITERARY CRITICISM. (4 cr; prereq 4 cr philosophy or #; offered alt yrs) Eaton, Gunderson
Goals and aims of literary criticism and the problems which arise in attempting to justify various principles of criticism.

5514. ART AND LANGUAGE. (4 cr; prereq 3231, 3502, 5231, 5501 or #; offered alt yrs) Eaton, Gunderson, Mason, Root, Scheman
Similarities and differences between verbal and nonverbal symbols; questions concerning extent to which art can be called a "language."

5521. PHILOSOPHY OF RELIGION. (4 cr, §RelS 5521; prereq 8 cr phil; offered alt yrs) Hopkins, Owens
Conceptual problems arising from attempts to provide rational justification for religious belief.

5601. THE EVALUATION OF SCIENTIFIC HYPOTHESES. (4 cr; prereq 3601 or #) Giere, Hanson, Hellman, Savage, Waters
Philosophical theories of the nature of scientific methods for evaluating scientific hypotheses, of role of experimentation in science, and of how hypotheses come to be accepted within a scientific community.

5602. THE NATURE OF SCIENTIFIC THEORIES. (4 cr; prereq 3601 or #) Giere, Hellman, Savage, Waters
Contemporary issues concerning the nature and role of theories in science: their structure and their relations with models and laws, other forms of representation, experiment, and the world in general.

5603. SCIENTIFIC EXPLANATION. (4 cr; prereq 3601 or #; offered when feasible) Giere, Hellman, Savage, Waters

5604. DETERMINISM AND CAUSATION. (4 cr; prereq courses in phil of sci or natural sci; offered when feasible) Hellman

5605. TIME AND SPACE. (4 cr; prereq courses in phil of sci or natural sci; offered when feasible) Hellman, Savage

5606. PHILOSOPHY OF QUANTUM MECHANICS. (4 cr; prereq 3601 or Phys 3501 or Math 3142 or #) Hellman
Introduction to problems of interpretation of ordinary (nonrelativistic) quantum mechanics: two-slit experiment, Schrödinger cat paradox (measurement problem), Einstein-Podolsky-Rosen paradox; leading approaches to interpretation (Copenhagen, hidden variables, universal wave function) and their connections with philosophical issues.

5607. PHILOSOPHY OF THE BIOLOGICAL SCIENCES. (4 cr; prereq courses in phil of sci or biol; offered when feasible) Beatty, Waters

5611. PHILOSOPHY OF THE SOCIAL SCIENCES I. (4 cr; prereq 12 cr phil or soc sci or #; offered when feasible) Root

5615. MINDS, BODIES, AND MACHINES. (4 cr; prereq 4 cr phil or #; offered alt yrs) Gunderson, Owens
Philosophical relevance of cybernetics, artificial intelligence, and computer simulation.

5617. TWENTIETH-CENTURY PHILOSOPHY OF SCIENCE: LOGICAL EMPIRICISM. (4 cr; prereq phil major or phil grad student or #) Giere, Savage
Historical development of logical empiricism from its European origins in first half of 20th century to its emergence as nearly universal account of science in post-war Anglo-American philosophy.

5618. TWENTIETH-CENTURY PHILOSOPHY OF SCIENCE: THE HISTORICAL SCHOOL. (4 cr; prereq phil major or phil grad student or #) Giere, Savage, Waters
Historical turn in Anglo-American philosophy of science beginning in 1960s with writings of Stephen Toulmin, Russell Hanson, Paul Feyerabend, and Thomas Kuhn and continuing with works of Imre Lakatos, Larry Laudan, and Dudley Shapere.

5622. PHILOSOPHY AND FEMINIST THEORY. (4 cr; prereq 8 cr phil or women's studies or #) Scheman
Critical examination of encounters between philosophy and feminism; e.g., how has gender figured in traditional philosophical problems and methods, and how do theorizing and social role of theorist relate to politics of feminism?

5701. SURVEY OF CONTEMPORARY PHILOSOPHY. (4 cr; prereq 3003 or #; offered alt yrs) Lewis
Current systematic and critical philosophies as represented by their principal exponents.

5720, 5730, 5740. STUDIES IN CONTEMPORARY PHILOSOPHERS. (4 cr per qtr; prereq 3003 or #) Staff
Specific topics announced in *Class Schedule*.

5760, 5770. SELECTED TOPICS IN PHILOSOPHY. (4 cr per qtr; prereq 4 upper div cr in phil or #) Staff
Philosophical problems of contemporary interest. Specific topics announced in *Class Schedule*.

5781. EXISTENTIALISM. (4 cr; prereq 3003 or 3004 or 5054 or #; offered alt yrs) Hopkins, Lewis, Mason
Writings of existentialist philosophers since Kierkegaard.

5970, 5990. DIRECTED STUDY AND RESEARCH. (1-5 cr per qtr; prereq #, Δ, CLA approval) Staff

8090. SEMINAR IN HISTORY OF PHILOSOPHY. (4 cr [may be repeated for cr]) Staff

8110, 8120. SEMINAR: METAPHYSICS. (4 cr per qtr [may be repeated for cr]; prereq 5101 or #) Staff
Topics in metaphysics. Specific topics announced in *Class Schedule*.

8130, 8140. SEMINAR: EPISTEMOLOGY. (4 cr per qtr [may be repeated for cr]; prereq 5105 or #) Staff
Problems in the theory of knowledge. Specific topics announced in *Class Schedule*.

8131. EPISTEMOLOGY SURVEY. (4 cr) Staff
Problems in epistemology.

8180. SEMINAR: PHILOSOPHY OF LANGUAGE. (4 cr [may be repeated for cr]) Staff

8210. SEMINAR: LOGICAL THEORY. (4 cr [may be repeated for cr]; prereq 5201, 5202 or #) Staff
Selected topics in the philosophy of logic.

8220. SEMINAR: PHILOSOPHY OF MATHEMATICS. (4 cr; prereq 5203 or Math 5164 or 8xxx math course or #) Hanson, Hellman
Topics such as significance of limitative metatheorems (Gödel, et al.), assessment of major foundational programs (set theoretic, modern Hilbertian, constructivist), modal and structuralist alternatives to standard platonism.

8310, 8320. SEMINAR: MORAL PHILOSOPHY. (4 cr per qtr [may be repeated for cr]; prereq 5311 or #) Staff
Systematic study of concepts and problems relating to ethical discourse.

8315. ETHICAL ISSUES IN HUMAN EXPERIMENTATION. (4 cr; prereq 5xxx ethics course) Staff
Evolution of ethical protections for human subjects, definition of research, informed consent, competency, and ethics of research on vulnerable subjects such as children, prisoners, and the mentally ill.

8321. ETHICS SURVEY. (4 cr) Staff
Problems in ethics.

8420. SEMINAR: POLITICAL PHILOSOPHY. (4 cr)
Systematic study of selected problems in political philosophy.

8510. SEMINAR: STUDIES IN AESTHETICS. (4 cr [may be repeated for cr]) Eaton, Gunderson, Hellman
Problems in aesthetics. Specific topics announced in *Class Schedule*.

8550. SEMINAR: PHILOSOPHY OF RELIGION. (4 cr [may be repeated for cr]; prereq 5521 or #; offered when feasible) Hopkins

8600. SEMINAR: PHILOSOPHY OF SCIENCE. (4 cr [may be repeated for credit]) Giere, Hellman, Savage, Waters

8605. ISSUES AND APPROACHES IN PHILOSOPHY OF SCIENCE. (4 cr)
Major contemporary approaches to philosophical study of general nature of science.

8606. PHILOSOPHY OF MEDICINE AND THE BIOMEDICAL SCIENCES. (4 cr; prereq 5xxx ethics course) Staff
Aims and goals of medicine; concepts of health, illness, and disease; nature of reasoning in clinical medicine, theoretical evolution in medicine, and role of values in practice of medicine and health care.

Graduate Programs

8610. SEMINAR: PHILOSOPHY OF THE PHYSICAL SCIENCES. (4 cr [may be repeated for cr]; offered when feasible) Staff

8620. SEMINAR: PHILOSOPHY OF BIOLOGY. (4 cr [may be repeated for credit]) Beatty

8640. SEMINAR: PHILOSOPHY OF PSYCHOLOGY. (4 cr, §CgSc 8000; prereq grad in phil or psych or #) Owens, Savage

8970, 8990. DIRECTED STUDY AND RESEARCH. (1-4 cr per qtr; prereq passing grade on written prelim exam for PhD in philosophy, #) Staff

Physical Education and Recreation

See Kinesiology and Leisure Studies.

Physical Medicine and Rehabilitation (PMed)

Professor: Gary T. Athelstan; Essam A. Awad; Robert Patterson

Associate Professor: Dennis Dykstra

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S.P.M. & Rehab. (Plan A only) and Ph.D.P.M. & Rehab.

Curriculum—This field of physical medicine and rehabilitation includes physical therapy, occupational therapy, vocational counseling, guidance, and training of the physically handicapped. Opportunity for clinical and fundamental research as well as for clinical experience and training is offered at the University of Minnesota Hospitals. Additional clinical experience is obtained at the Hennepin County Medical Center, Veterans Administration Medical Center in Minneapolis, Sister Kenny Rehabilitation Institute, Gillette Children's Hospital, and St. Paul-Ramsey Medical Center. Students devote full time to their training programs and may not carry on outside practice.

Prerequisites for Admission—Applicants must hold an M.D. degree from an approved medical school.

Master's Degree Requirements—This program, which also fulfills the didactic requirements of the American Board of

Physical Medicine and Rehabilitation, usually requires three years to complete. For the minor field of study, anatomy, physiology, biophysics, or pathology is highly recommended.

Doctoral Degree Requirements—The Ph.D. degree is for physicians interested in teaching and research careers. Completion requires approximately five years. In addition to the clinical training and participation in the teaching program, extensive experience is obtained in laboratory and clinical research.

Language Requirements—For the Ph.D. degree, either (a) one language and the option of a collateral field of knowledge or (b) two collateral fields of knowledge are required. Routinely acceptable languages are French, German, Italian, Russian, and Spanish.

For Further Information and

Applications—Contact the Department of Physical Medicine and Rehabilitation, University of Minnesota, Box 297 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/626-4050).

PMed 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

PMed 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

PMed 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5950. BIOELECTRIC MEASUREMENTS. (3 cr; prereq PhsI 5441, calculus, college physics) Electrodes, instrumentation, and processing requirements for endogenously generated electric potentials and electrical impedance of tissue. Electrode characteristics, signal processing, and interpretation of physiological events by ECG, EEG, EMG, and EOG. Measurement of respiration, blood flow and volume, and other physiological events by electrical impedance.

8200f,w,s,su. PHYSIATRY SERVICE. (Cr ar) Staff Service at University Hospitals, Hennepin County Medical Center, St. Paul-Ramsey Medical Center, Sister Kenny Rehabilitation Institute, Veterans Administration Medical Center, and other affiliated hospitals.

8206f,w,s,su. READINGS IN PHYSICAL MEDICINE AND REHABILITATION. (2 cr per qtr) Dykstra

8206f,w,s. CONFERENCE ON PHYSICAL MEDICINE AND REHABILITATION. (2 cr per qtr) Dykstra
Topics vary quarterly. Prepared papers required.

8207. BASIC AND APPLIED PHYSIATRY. (2 cr)
Dykstra, staff
Assigned readings, lectures, and discussions on anatomic, physiologic, pathologic, biophysical, and psychological bases of physiatry.

8210f,w,s,su. RESEARCH IN PHYSICAL MEDICINE. (Cr ar) Dykstra, Patterson, staff

8212f,w,s,su. ELECTROMYOGRAPHY. (Cr ar; prereq #) Dykstra, staff
Clinical and lab training in use and interpretation of electromyography.

8213f,w,s. ELECTRODIAGNOSIS CONFERENCE. (Cr ar; prereq 8211 or #) Dykstra, staff
Clinical presentation and discussion of cases examined in the Electrodiagnostic lab.

8214f,w,s. READINGS IN ELECTROMYOGRAPHY. (1 cr; prereq #) Dykstra, staff
Assigned readings and discussions on the anatomic, physiologic, pathologic, and technical developments in electromyography.

8220f,w,s. SEMINAR: PHYSICAL MEDICINE AND REHABILITATION. (Cr ar) Dykstra, staff

Physical Therapy (PMed)

Associate Professor: Richard P. DiFabio, *director of graduate studies;* Robert P. Patterson; Judith E. Reisman

Assistant Professor: Erica B. Stern; LaDora V. Thompson

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.S. (Plan A and Plan B).

Curriculum—The course of study prepares students to teach, conduct research, and develop specialized clinical programs in physical therapy. Teaching practicum experiences in a wide variety of areas are available. Unique research opportunities offered by the program include analysis of movement pathology, motor and sensory influence on function, and analysis of the effects of aging on functional status. Specialized clinical opportunities are available in, for example, orthopedic, geriatric, pediatric, and vestibular disorders.

Prerequisites for Admission—Candidates must be able to demonstrate good aptitude for academic, research, and clinical endeavors.

Special Application Requirements—

Applicants should submit a résumé, a statement of goals, and three letters of reference attesting to their personal, academic, and professional qualifications to the director of graduate studies. Submission of Graduate Record Examination scores is recommended but not required. For international students, a TOEFL score of at least 620 is required. Fall or summer entry is advised for all applicants.

Degree Requirements—Completion of a physical therapy curriculum approved by the American Physical Therapy Association and the Council on Medical Education of the American Medical Association, or its equivalent, is required before graduation. Completion of the curriculum may occur in conjunction with, or before, work on the master's degree.

For the master's degree, practicum courses are required in teaching, research, and clinical practice. Department seminar courses and courses in research design and instrumentation are also required. Research proposals for the Plan A thesis or Plan B paper must be approved by a department committee. A final oral examination is required.

Language Requirement—None.

For Further Information and Applications—Contact the Physical Therapy Program, University of Minnesota, Box 388 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/626-5887).

PMed 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

5135. PATHOKINESIOLOGY. (3 cr; prereq #) DiFabio

Lecture and lab emphasizing anatomical, physiological, and biomechanical aspects of normal and pathological human motion, including techniques for analysis.

5150. KINESIOLOGICAL ELECTROMYOGRAPHY AND NERVE CONDUCTION. (3 cr; prereq #) Staff

Lecture and lab on instrumentation, physiological, anatomical, and kinesiological considerations related to electromyography and nerve conduction.

Graduate Programs

5182. FUNCTIONAL NEUROANATOMY AND NEUROPHYSIOLOGY. (5 cr) Reisman

5810. ASSESSMENT OF THE ELDERLY. (3 cr; prereq #) Ellingham, Thompson

Lecture and lab on developmental aspects of aging, with emphasis on assessment of physical and functional capacity.

5814. PHYSIOLOGICAL ASSESSMENT IN PHYSICAL THERAPY. (1-3 cr) Thompson

Lecture and lab sessions on physiological assessment of, for example, endurance, strength, and coordination.

5817. SPECIAL TOPICS IN PHYSICAL THERAPY. (1-3 cr) Staff

Lecture and lab sessions on such topics as low back pain, neuromuscular and musculoskeletal disorders, cardiopulmonary disease, and developmental disorders.

5841. INSTRUMENTATION AND ANALYSIS TECHNIQUES. (3 cr; prereq Phys 1031, 1032 or equiv) Patterson

8103. PHYSICAL THERAPY CLINIC. (Cr and hrs ar; prereq physical therapist) Staff
Clinical physical therapy in adult and pediatric rehabilitation.

8130. CURRENT LITERATURE SEMINAR IN PHYSICAL THERAPY. (1 cr per qtr) DiFabio, Scudder
Current literature in physical therapy and related medical fields.

8135. ADVANCED KINESIOLOGY. (3 cr) DiFabio
Functional anatomy emphasizing anatomical, physiological, and biomechanical aspects of normal and pathological human motion. Lecture with lab to include various techniques available for analysis.

8150. RESEARCH METHODOLOGY IN PHYSICAL THERAPY; ELECTROMYOGRAPHY AND NERVE CONDUCTION. (3 cr) Allison

8170. SPECIAL TOPICS IN PHYSICAL THERAPY. (1 cr per qtr; prereq #) Staff
Advanced seminar. Topics vary quarterly. Prepared papers required.

8185. PROBLEMS IN PHYSICAL THERAPY. (Cr ar; prereq physical therapist) Staff

8188. TEACHING PRACTICUM. (Cr ar [max 8 cr]; prereq #) Staff
Supervised experience in teaching and evaluation; development of skills in effective use of instructional materials in lecture and lab courses.

8192w. RESEARCH DESIGN IN PHYSICAL THERAPY. (3 cr; prereq #) DiFabio
Critical appraisal of current medical literature; fundamentals of research design and techniques of medical writing.

8193.* RESEARCH PROBLEMS IN PHYSICAL THERAPY. (Cr ar; prereq 8192 or #) DiFabio
Independent study using methods of research appropriate to physical therapy.

8195. RESEARCH IN PHYSICAL THERAPY. (Cr ar; prereq 8192 or #) DiFabio

Physics (Phys)

Professor: Marvin L. Marshak, *head*; Clayton F. Giese, *director of graduate studies*; Benjamin F. Bayman; John H. Broadhurst; Charles E. Campbell; C. Barry Carter; Keith S. Champlin; Lorne M. Chanin; Hans W. J. Courant; E. Dan Dahlberg; Kris D. Davidson; Dietrich K. Dehnhard; Paul J. Ellis; Stephen Gasiorowicz; Robert D. Gehrz; Leonid Glazman; Allen M. Goldman; J. W. Halley; Kenneth Heller; Russell K. Hobbie; Yutaka Hosotani; Cheng-cher Huang; Thomas W. Jones; Joseph I. Kapusta; Paul J. Kellogg; Robert L. Lysak; Konrad Mauersberger; Larry McLerran; Keith A. Olive; Robert O. Pepin; William T. Peria; Earl A. Peterson; Serge Rudaz; Keith Ruddick; Mikhail Shifman; Boris Shklovskii; Wayne A. Stein; Roger H. Stuewer; Yau-Chien Tang; David D. Thomas; Arkady Vainshtein; Oriol T. Valls; Mikhail Voloshin; C. J. Waddington; Thomas F. Walsh; John H. Weaver; Walter V. Weyhmann; William Zimmermann, Jr.

Associate Professor: Cynthia Cattell; Priscilla B. Cushman; Alfonso Franciosi; Roger S. Jones; James Kakalios; Erwin Marquit; Ronald A. Poling; Roger W. Rusack

Assistant Professor: Eric Ganz; Yuichi Kubota; John R. Wygant

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Research areas in experimental physics are cosmic rays, earth's atmosphere, elementary particles, low temperature, mass spectroscopy, molecular collisions, nuclei, plasmas, solar system, and solid state. Research areas in theoretical physics are elementary particles, low temperature, nuclei, plasma, solid state, and statistical mechanics.

Prerequisites for Admission—For major work, an undergraduate major in physics or a strong undergraduate minor in physics is required.

Special Application Requirements—Teaching assistantships and a few fellowships are available on application to the School of Physics and Astronomy; three letters of recommendation are required. Submission of Graduate Record

Examination scores is strongly recommended. Fall quarter entry is strongly recommended for students who have not completed previous graduate study.

Special Examination—During the week before the beginning of fall quarter, new graduate students are expected to participate in the department orientation program. At the start of orientation, a placement examination in quantum mechanics is given to help students decide which level of quantum mechanics to take during the first year.

Master's Degree Requirements—For both Plan A and Plan B, either the classical physics sequence 5051-5052-5053 or the quantum mechanics sequence 5151-5152-5153 is required. The minor or related field requirement may be satisfied by completion of courses in one or two areas outside the area of specialization. Some or all of these courses may be in physics.

The Plan B project requirement can be satisfied in one of the following ways: (1) completion of one to three papers written in connection with three courses (totaling at least 9 credits, with at least two courses in physics or astronomy) that are part of the student's program; (2) completion of a project while registered in 8500; the student must obtain approval of the project topic from a faculty member before registering for the course, and a written report on the project is required. In either case, the papers or written report must be made available to the student's final examination committee, which must certify that the Plan B project has been satisfactorily completed. A final oral examination is required.

Doctoral Degree Requirements—The course sequences 5051-5052-5053, 5151-5152-5153, and a year-long (3-credit total) seminar sequence in the student's research area are required. For the minor or supporting field, see Master's Degree Requirements above.

The department written examination, offered twice each year early in fall and spring quarters, must be passed by fall

quarter of the second year to gain admission to the preliminary oral examination.

Language Requirements—There is no formal language requirement for the master's or doctoral degree. In individual instances, however, the thesis adviser may require a reading knowledge of one or more foreign languages if justified by the nature of the research topic.

Minor Requirements for Students

Majoring in Other Fields—For admission to a physics minor, differential and integral calculus and one year of calculus-level college physics are required. For the Ph.D. minor, 18 credits in physics are required including either of the two sequences in classical physics—5021-5022-5023-5024 or 5051-5052-5053—or one of the two sequences in quantum physics—5101-5102 or 5151-5152-5153.

For Further Information and

Applications—Contact the Physics Program, School of Physics and Astronomy, University of Minnesota, 145 Tate Lab of Physics, 116 Church Street S.E., Minneapolis, MN 55455 (612/624-6366; fax 612/624-4578).

Note—For courses in astronomy and astrophysics, biophysics, and geophysics, see these sections of the bulletin.

Phys 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Phys 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Phys 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5021-5022. INTRODUCTION TO ANALYTIC MECHANICS. (4 cr per qtr; prereq 3011, Math 3231 or equiv; 3 lect, 1 problem hrs per wk)
Analytic course in Newtonian mechanics. Vectors and vector operators; angular momentum; central force problem; systems of particles; tensors; rigid bodies, moving coordinate systems; continuous media; Lagrange's equations. Mathematics beyond prerequisites is developed as required.

5023-5024. INTRODUCTION TO ELECTRIC AND MAGNETIC FIELDS. (4 cr per qtr; prereq 3011, Math 3231 or equiv; 3 lect, 1 problem hrs per wk)
Classical theory of electric and magnetic fields making free use of vector algebra and vector calculus. Maxwell's equations for free space and material media. Wave solutions.

Graduate Programs

5031-5032-5033. TOPICS IN MATHEMATICAL PHYSICS. (4 cr per qtr; prereq two 5xxx mathematics courses; 3 lect, 1 problem hrs per wk)

Survey of mathematical techniques needed for physics. Application of mathematical methods to physical problems.

5051-5052-5053. CLASSICAL PHYSICS. (4 cr per qtr; prereq 5022, 5024, advanced calculus or #; 3 lect, 1 problem hrs per wk)

Classical mechanics, special relativity, and classical electrodynamics. Application of advanced mathematical techniques.

5061. COMPUTATIONAL METHODS IN THE PHYSICAL SCIENCES I. (4 cr, §Ast 5061; prereq CLA jr or sr or IT upper div or grad student or #; 2 lect, 6 lab hrs per wk)

Introduction to problem solving in physical sciences using computer programs. Emphasis on selected numerical methods and general spirit of mapping onto computational algorithms. Arranged lab at scientific computer workstation.

5062. COMPUTATIONAL METHODS IN THE PHYSICAL SCIENCES II. (4 cr, §Ast 5062; prereq CLA jr or sr or IT upper div or grad student, Phys/Ast 5061 or #; 2 lect, 6 lab hrs per wk)

Introduction to advanced techniques in computer simulation through examples from classical statistical mechanics, classical electrodynamics, and fluid dynamics. Computer experiments using graphics capabilities of SUN systems.

5101-5102. INTRODUCTION TO QUANTUM MECHANICS. (4 cr per qtr; prereq 3512; 3 lect, 1 problem hrs per wk)

Mathematical techniques of quantum mechanics. Wave packets; Schrödinger equation; angular momentum; radial equation; spin; perturbation theory; collision theory.

5121. METHODS OF EXPERIMENTAL PHYSICS:

I. (5 cr; prereq 3513 or #; knowledge of computer programming desirable; 3 lect, 4 lab hrs per wk)
Contemporary techniques. Includes probability and errors, introduction to analog and digital electronics, experimental strategy, and introduction to computer-based data acquisition and experimental control.

5122. METHODS OF EXPERIMENTAL PHYSICS:

II. (4 cr; prereq 5121 or #; 2 lect, 6 lab hrs per wk)
Contemporary techniques. Includes applications of Fourier transforms, signal averaging and phase-lock detectors, high vacuum techniques, magnet and charged particle beam design. Lab: problems involving the use of microcomputers for data acquisition and experimental control.

5123. METHODS OF EXPERIMENTAL PHYSICS:

III. (4 cr; prereq 5122 or #; 8 lab hrs per wk)
Contemporary techniques. Lab: choice of experimental projects in low temperature, solid state, nuclear, elementary particle, and cosmic ray physics.

5124. EXPERIMENTAL PROJECT. (Cr ar; prereq 5123, #)

Research project in area of contemporary interest in physics. Project must be approved by faculty coordinator before registration.

5151-5152-5153. QUANTUM MECHANICS. (4 cr per qtr; prereq 5102 or equiv, advanced calculus or #; 3 lect, 1 problem hrs per wk)

Development from first principles. Schrödinger equation, angular momentum, scattering, matrix representations, spin, approximation methods, interaction with electromagnetic field, systems of identical particles, applications to atomic systems.

5162. INTRODUCTION TO PLASMA PHYSICS.

(4 cr; prereq 5022, 5024 or #; offered alt yrs)
Magnetohydrodynamics and properties of collisionless plasmas, with applications to the magnetic field of the earth and sun and to plasma confinement. Transport phenomena and effects of collisions.

5201-5202. THERMAL AND STATISTICAL PHYSICS. (4 cr per qtr; prereq 3513 or equiv; 4 lect hrs per wk)

5201: Thermodynamics, statistical mechanics. 5202: Applications of thermodynamics and statistical mechanics, kinetic theory, fluctuations, transport theory.

5211. INTRODUCTORY SOLID STATE PHYSICS.

(4 cr; prereq 5101, 5202 or equiv; 4 lect hrs per wk)
Diffraction of waves in solids; electron band structure; crystal binding and vibrations; optical, dielectric, and magnetic properties of solids.

5231-5232-5233. INTRODUCTION TO SOLID-STATE PHYSICS. (4 cr per qtr; for grad students or advanced undergrads in physics, science, and engineering; 4 lect hrs per wk)

5231: Crystal structure and binding; diffraction; phonons; thermal and dielectric properties of insulators. 5232: Free electron model; band structure; semiconductors; diamagnetism and paramagnetism; ferromagnetism and antiferromagnetism. 5233: Optical phenomena, lasers; superconductivity; surface properties; ferroelectricity.

5301. INTRODUCTION TO NUCLEAR PHYSICS.

(4 cr; prereq 5102 or equiv; 3 lect, 1 problem hrs per wk)
Static properties and dynamic processes of atomic nuclei. Provides survey of field for nonspecialists and a first course for those intending to specialize in nuclear physics.

5371. INTRODUCTION TO ELEMENTARY PARTICLE PHYSICS. (4 cr; prereq 5102 or equiv; 3 lect, 1 problem hrs per wk)

Relativistic kinematics; mass, spin, isospin, and strangeness of elementary particles; SU3 classification and the quark model; particle reactions and decays; experimental methods of detection and analysis.

5401. INTRODUCTION TO CONTEMPORARY PROBLEMS IN COSMIC RAY AND SPACE PHYSICS. (4 cr; primarily for students specializing in other branches of physics; prereq #; offered alt yrs)

Cosmic rays, their characteristics and their motion in the interplanetary and interstellar medium. Topics in X-ray and radio astronomy.

5461. PHYSICS AND CHEMISTRY OF THE EARTH'S UPPER ATMOSPHERE. (4 cr; prereq general physics, calculus; offered alt yrs)
Survey of atmosphere above 15 km; physics and chemistry of the stratosphere, mesosphere, and thermosphere; temperature and density profiles; major and minor constituents and their distributions; aspects of pollutants; reactions and rates; global variation of constituents; the energy budget of the atmosphere.

5551. TOPICS IN PHYSICS FOR BIOLOGY AND MEDICINE: MECHANICS AND MOLECULAR PHYSICS. (5 cr; prereq general physics and calculus; offered alt yrs)
Statics (forces in bones and joints). Graphical analysis. Statistical physics (entropy, reversibility, Boltzmann factor and Nernst equation, Brownian movement, free energy). Diffusion, bulk flow, and osmosis.

5552. TOPICS IN PHYSICS FOR BIOLOGY AND MEDICINE: ELECTRICITY AND SIGNALS. (5 cr; prereq general physics and calculus; offered alt yrs)
Electricity and circuits (electrocardiogram, networks, nerve conduction); transducers and amplifiers; oscillators; feedback and control; signal analysis (Fourier analysis, correlation functions, power spectra).

5553. TOPICS IN PHYSICS FOR BIOLOGY AND MEDICINE: LIGHT, ATOMS, AND NUCLEI. (5 cr; prereq general physics and calculus; offered alt yrs)
Atoms (dispersion, absorption, spectra, polarized light). X-rays (production, absorption, dosimetry). Nuclei (nuclear size, mass, decay).

5801. MODERN OPTICS. (4 cr; prereq 5024 or #; 4 lect hrs per wk; offered alt yrs)
Modern theoretical and experimental optics, broadly defined to include, for example, radio astronomy, matrix methods in geometrical optics including charged particle optics, optical detectors and noise, and phenomena in intense coherent radiation including nonlinear effects.

5805. CONTEMPORARY OPTICS. (4 cr; prereq #; 3 lect, 1 problem hrs per wk)
Current developments in optics. Theory of lasers and of their application in holography, nonlinear optics, etc. Nonlinear optics. Optics of anisotropic media. Theory of image formation and spatial filtering. Properties of optical detectors.

5911. CONCEPTS IN PHYSICS. (4 cr [no cr for physics majors]; prereq 3511, 3512, 3513, 3515 or equiv; 3 lect, 2 lab hrs per wk; offered alt yrs)
Intermediate-level conceptual physics, primarily for science education majors. Conservation laws, basic interactions, models of matter, particles and waves, fields, reference frames, modern physics. Emphasis on physical phenomena, thematic development, physical reasoning, and unifying principles.

5924. HISTORY OF 19TH-CENTURY PHYSICS. (4 cr, §HSci 5924; prereq general physics or #)
Conceptual developments in physics in the 19th century (Young, Fresnel, Oersted, Ampère, Faraday, MacCullagh, Maxwell, Hertz, Lorentz, Lavoisier, Rumford, Dalton, Mayer, Joule, Helmholtz, Carnot, Clausius, Kelvin, Boltzmann, Mach, others). Relationships of these developments to social, philosophical, and theological influences.

5925. HISTORY OF 20TH-CENTURY PHYSICS. (4 cr, §HSci 5925; prereq general physics or #)
Conceptual developments in relativity (Michelson, Lorentz, Poincaré, Einstein, others), quantum mechanics (Planck, Einstein, Rutherford, Bohr, Sommerfeld, Ehrenfest, Pauli, Millikan, Compton, Heisenberg, de Broglie, Schrödinger, Born, others), and nuclear physics (Chadwick, Gamow, Fermi, others). Relationships of these developments to social, philosophical, and theological influences.

5940. PHYSICS FOR HIGH SCHOOL TEACHERS: EXPERIMENTAL FOUNDATIONS. (3-4 cr [may be repeated for cr]; does not carry grad major or minor cr in physics; prereq general physics, #; 3 integrated lect-lab hrs per wk)
Conceptual theme in physics and its experimental foundations. Typical themes are kinematics and dynamics from Aristotle through Einstein; nature of charge; nature of light; energy and thermodynamics; electricity, magnetism, and quantized fields; structure of matter.

5950. SEMINAR. (Cr ar; primarily for sr physics majors; prereq Δ)

5970. DIRECTED STUDIES. (1-5 cr; prereq #, Δ)
Independent, directed study in areas arranged by student and faculty member.

5980. RESEARCH SEMINAR. (1 cr; primarily for beginning grads and advanced undergrad physics majors; 1 sem hr per wk)
Introduction to research activities of School of Physics and Astronomy.

5990. DIRECTED RESEARCH. (Cr ar; prereq jr, Δ)
Problems, either experimental or theoretical, of special interest to student. Written reports.

Special prerequisites are noted for certain courses below. Seminar, special topics, and research courses may be taken more than once for credit.

8081-8082. GENERAL RELATIVITY. (3 cr per qtr; prereq 5053 or #; offered alt yrs)
Introduction to the physical basis of general relativity, its mathematical formulation, and its cosmological implications.

8083. COSMOLOGY AND PARTICLE PHYSICS. (3 cr; prereq 5371, 8082 or #; offered alt yrs)
Construction of cosmological models directly from general relativity. Standard big-bang model; connection between early universe and particle physics. Big-bang nucleosynthesis, baryogenesis, inflation, and dark matter.

8121. ADVANCED QUANTUM MECHANICS. (3 cr; prereq 5153 or #)
Advanced topics in nonrelativistic quantum mechanics, with emphasis on the use of second quantization to treat many-body and radiating systems. Diagrammatic and Green's function techniques introduced.

Graduate Programs

8122. RELATIVISTIC QUANTUM MECHANICS. (3 cr; prereq 8121 or #)

Relativistic wave equations and their properties under Lorentz transformations. Application of relativistic perturbation theory to particle interactions with the electromagnetic field. Invariant interactions of elementary particles.

8123. RELATIVISTIC QUANTUM FIELD THEORY. (3 cr; prereq 8122 or #)

Renormalization theory, analytic properties of amplitudes, reduction formulas and dispersion relations.

8131. SYMMETRY AND ITS APPLICATIONS TO PHYSICAL PROBLEMS. (4 cr; prereq 5153 or #)

Use of symmetry methods (group theory) to study systems too complicated for exact solution. Applications to atomic, molecular, nuclear, solid-state, and elementary particle physics.

8161. ATOMIC AND MOLECULAR STRUCTURE. (3 cr; prereq 5153 or #; offered when feasible)

8163-8164. PLASMA PHYSICS. (3 cr per qtr; prereq 5162; offered alt yrs)

Study of properties of plasmas at an advanced theoretical level. Transport phenomena, radiation from plasma, thermonuclear machines and their instabilities, and waves in magnetized plasma.

8165. ADVANCED TOPICS IN PLASMA PHYSICS. (Cr ar)

Possible topics: theory of waves and instabilities in hot plasma.

8200. SEMINAR: CONDENSED MATTER PHYSICS. (Cr ar; prereq #; S-N only)

8211. EQUILIBRIUM STATISTICAL MECHANICS. (3 cr; prereq 5153 or #)

Equilibrium properties of macroscopic classical and quantum systems. Simple interacting systems, phase transitions, and effects of external fields.

8212. TRANSPORT THEORY. (3 cr; prereq 5153 or #)

Transport and relaxation phenomena in classical and quantum systems. Irreversible thermodynamics, Boltzmann equation, and linear response theory.

8216. MANY-BODY THEORY. (3 cr; prereq 8121 or #)

Infinite systems of bosons and fermions using Hartee and Hartee-Fock approximations; diagrammatic techniques and Green's function methods.

8221-8222-8223. SOLID-STATE PHYSICS. (3 cr per qtr; prereq 5152-5153, 5211 or #)

Fundamental properties of crystals; dynamics of the lattice and of electrons in a periodic structure. Effects of electric and magnetic fields on metals.

8232. MAGNETISM. (3 cr; prereq 8222 or #; offered when feasible)

8233. SUPERCONDUCTIVITY. (3 cr; prereq #; offered when feasible)

8238. ADVANCED TOPICS IN SOLID-STATE AND LOW-TEMPERATURE PHYSICS. (Cr ar; offered when feasible)

8300. SEMINAR: NUCLEAR PHYSICS. (Cr ar; prereq #; S-N only)

8311. NUCLEAR STRUCTURE. (3 cr; prereq 5151 or 5151)

Low energy nucleon-nucleon interaction. Phenomenological and microscopic models of ground and excited states, including single particle and collective degrees of freedom.

8312. NUCLEAR REACTIONS. (3 cr; prereq 5152 or 5152)

Nuclear reaction mechanisms and use of reactions to obtain information about nuclear structure and nuclear matter.

8313. RELATIVISTIC NUCLEAR MANY-BODY THEORY. (3 cr; prereq 8122 or #)

Relativistic field theory applied to many-body problem. Nuclear matter, quark-gluon plasma, symmetry restoration at high temperature; applications to neutron stars and early universe.

8370. SEMINAR: ELEMENTARY PARTICLE PHYSICS. (Cr ar; prereq #; S-N only)

8371-8372-8373. ELEMENTARY PARTICLE PHYSICS. (3 cr per qtr; prereq 8122 or #)

Accelerators, particle detectors, and particle interactions in matter; basics of scattering and quark model; techniques and Feynman diagram calculation for electroweak interactions and chromodynamics; grand unification.

8381-8382-8383. MODERN QUANTUM FIELD THEORY AND ITS APPLICATIONS. (3 cr; prereq 8123 or #; offered alt yrs)

Review of general properties of field theory, renormalization of interacting scalar field theory, global and local symmetries, path integrals and functional formalism, quantization of non-Abelian gauge theories (quantum chromodynamics, Weinberg-Salam model, grand unified theories), renormalization group in particle physics and critical phenomena, lattice gauge theory.

8400. SEMINAR: SPACE PHYSICS. (Cr ar; prereq #; S-N only)

8411. COSMIC RAY AND SPACE PHYSICS. (3 cr; prereq 5102, 5053 or #; offered alt yrs)

Properties of energetic particles in both solar-terrestrial and astrophysical environments. The earth's radiation belts, effects of the earth's magnetic field on charged particles, energy and charge spectrum of cosmic rays, the structure and evolution of the galaxy, motion of particles in the galactic and intergalactic medium, and topics in X-ray and radio astronomy.

8421-8422. SOLAR AND MAGNETOSPHERIC PHYSICS. (3 cr per qtr; prereq #; offered alt yrs)

Solar surface physics including photosphere, chromosphere, and corona; spectroscopic observations and their interpretation; solar active regions, sunspots, plages; associated magnetic fields, optical, radio, and particle effects and the solar wind; the terrestrial magnetic field and trapped radiation, auroral phenomena, and geomagnetic storms.

8500. PLAN B PROJECT. (4 cr [no cr toward PhD]; prereq #; S-N only)

May be taken once to satisfy project requirement for Plan B master's program. May appear on master's program but does not count toward 20-credit minimum in major field. Project topic to be arranged between student and instructor. Written report required.

8950. SEMINAR: PROBLEMS OF PHYSICS TEACHING AND HIGHER EDUCATION. (Cr ar; prereq #)

Lectures and informal discussions of courses and curricula, techniques, and materials important in undergraduate physics instruction; relation to general problems of higher education.

8990. RESEARCH IN PHYSICS. (Cr ar; prereq #)**Physiology**

See Cellular and Integrative Physiology.

Planning

See Public Affairs.

Plant Biological Sciences (PBio)

Regents' Professor: Eville Gorham (ecology, evolution, and behavior); Ronald L. Phillips (agronomy and plant genetics)

Professor: Irwin Rubenstein (plant biology), *head*; Burt G. Gengenbach (agronomy and plant genetics), *director of graduate studies*; Robert M. Brambl (plant biology); Mark L. Brenner (horticultural science); William R. Bushnell (plant pathology); John V. Carter (horticultural science); Edward J. Cushing (ecology, evolution, and behavior); Gary M. Gardner (horticultural science); Florence K. Gleason (plant biology); Peter H. Graham (soil science); Wesley P. Hackett (horticultural science); Robert J. Jones (agronomy and plant genetics); Willard L. Koukkari (plant biology); Sagar V. Krupa (plant pathology); Paul H. Li (horticultural science); David J. McLaughlin (plant biology); Chester J. Mirocha (plant pathology); Patrice A. Morrow (ecology, evolution, and behavior); James A. Perry (forest resources); Peter B. Reich (forest resources); Carolyn D. Silflow (genetics and cell biology); Steve R. Simmons (agronomy and plant genetics); David A. Somers (agronomy and plant genetics); Joseph R. Sowokinos (horticultural science); Edward I. Sucoff (forest resources); G. David Tilman (ecology, evolution, and behavior); Carroll P. Vance (agronomy and plant genetics); Clifford M. Wetmore (plant biology); Susan M. Wick (plant biology); Donald L. Wyse (agronomy and plant genetics)

Associate Professor: Deborah L. Allan (soil science); Judith G. Berman (plant biology); David D. Biesboer (plant biology); Iris D. Charvat (plant biology); John F. Doebley (plant biology); Glenn R. Furnier (forest resources); J. Stephen Gantt (plant biology); John W. Gronwald (agronomy and plant genetics); Albert H. Markhart (horticultural science); Neil E. Olszewski (plant biology); Thomas K. Soulen (plant biology)

Assistant Professor: Michael D. Marks (genetics and cell biology); Georgiana May (plant biology); Shahid Naeem (ecology, evolution, and behavior); Michael J. Sadowsky (soil science); Ruth G. Shaw (ecology, evolution, and behavior); Alan G. Smith (horticultural science); Les J. Szabo (plant pathology); Cindy B. Tong (horticultural science); Nevin D. Young (plant pathology)

Adjunct Assistant Professor: Paula M. Pijut (North Central Forest Experiment Station)

Research Associate: Anita F. Cholewa (plant biology)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Plant biological sciences encompasses all aspects of the basic biology of both higher and lower plants. Major emphases include molecular and physiological approaches to development; physiological, structural, and functional studies at the cellular and organismal levels; systematic and evolutionary biology; and molecular genetics and applied biotechnology. Program faculty reside in eight plant-oriented departments in the Colleges of Agriculture, Biological Sciences, and Natural Resources. Students in the program have the opportunity to study plants from the subcellular and molecular to the whole plant and community levels of biological organization. Opportunities also exist for laboratory and field research at state, national, and international levels. Each student's program is planned to meet individual requirements within the framework of a multidisciplinary core of coursework. Seminars are an integral part of the program.

Prerequisites for Admission—Prospective students are expected to have completed a year of coursework in at least three of the following four areas: differential and integral calculus, organic and inorganic chemistry, biology, and physics. For students of demonstrated ability, background deficiencies, as determined by the admissions committee, can be made up during the first year of graduate studies. All admitted students are assigned to an adviser in the graduate program before they begin their studies.

Graduate Programs

Special Application Requirements—

Applicants must submit scores from the General Test of the Graduate Record Examination, three letters of recommendation from persons familiar with their scholarship and research potential, a complete set of official transcripts, and a clearly written statement of career interests, goals, and objectives. Students may apply at any time; however, submission of all application materials by January 15 is strongly encouraged to ensure priority consideration for fellowships and teaching and research assistantships awarded for the next academic year.

Master's Degree Requirements—Course programs are planned by the student in consultation with an advisory committee. Students are expected to take a minimum of six courses, including one course from each of four discipline areas (cell and molecular biology; plant physiology; plant structure, diversity, and development; ecology, systematics, and evolution) and two or more courses from the primary area of specialization. As required by the Graduate School, the student must finish at least 20 credits in the major field and 8 credits in one or more related fields with a minimum GPA of 2.80. A thesis proposal and seminar are required.

Doctoral Degree Requirements—Specific course requirements are the same as for the master's degree with additional coursework to be approved by the student's advisory committee. All Ph.D. students are required to develop their teaching skills by participating in a teacher training program and then serving as a teaching assistant for two quarters. A dissertation proposal and two non-credit seminars are required of all Ph.D. students.

Language Requirements—None, except as specified by a faculty adviser in consultation with the student.

For Further Information and Applications—Contact the director of graduate studies, Graduate Program in Plant Biological Sciences, University of

Minnesota, 220 Biological Sciences Center, 1445 Gortner Avenue, St. Paul, MN 55108 (612/625-1234; fax 612/625-1738).

PBio 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

PBio 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

PBio 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5001. BASIC BOTANY. (Cr ar, §Bot 5001; prereq Biol 1008 or Biol 1009, #, Δ)

For beginning graduate students who need to strengthen their botanical background.

5103f.* ALGAE, FUNGI, AND BRYOPHYTES. (5 cr, §Bot 5103; prereq Biol 1103 or Biol 3012; offered alt yrs) McLaughlin

Characteristics of groups, evolutionary relationships, life cycles, comparative morphology (including ultrastructure), comparative nutrition. Lab emphasizes living organisms and isolation of algae and fungi into culture.

5105w.* MORPHOLOGY OF VASCULAR PLANTS. (5 cr, §Bot 5105; prereq Biol 1103 or Biol 3012 or #; offered alt yrs) May

Ferns and their allies, gymnosperms (cycads, ginkgo, conifers) and angiosperms (flowering plants). Comparative morphology of vegetative and reproductive structures; life cycles; evolutionary relationships.

5107s. MYCOLOGY: BASIDIOMYCETES. (4 cr; prereq PIPa 5105 or equiv or intro microbiol or 5103 or #; offered alt yrs) May, McLaughlin

Ecology, evolutionary relationships, systematics (taxonomy and nomenclature), morphology (including ultrastructure and life cycles of basidiomycetes). Labs parallel lectures, with living and preserved representatives of Uredinales, Auriculariales, Septobasidiales, Exobasidiales, Sporobolomycetales, Ustilaginales, Tilletiales, Tremellales, Dacrymycetales, Tulasnellales, Aphylophorales, Agaricales, and Gasteromycetes.

5109w. MOLECULAR GENETICS AND BIOCHEMISTRY OF YEASTS AND FILAMENTOUS FUNGI. (4 cr, §PIPa 5109; prereq one course each in genetics and biochem or #) Berman, Brambl

Chromosome structure and function, regulation of nuclear gene expression, mitochondrial gene organization and expression, membrane and organelle biogenesis, cell cycle regulation, morphogenesis, mating and reproduction, recombination and gene switching, spore formation and germination, viruses, plasmids, and toxins.

5111w.* PLANT CELL, TISSUE, AND ORGAN DEVELOPMENT. (5 cr, §Bot 5111; prereq Biol 1103 or Biol 3012; offered alt yrs) Biesboer
Microscopic structure of vascular plants; development in root, stem, and leaf.

5131f.s. SURVEY OF PLANT PHYSIOLOGY. (4 cr, §3131; prereq BioC 3021 or BioC 5331 or Biol 5001, Biol 1103 or Biol 3012 or Biol 3812) Gantt, Gleason, Olszewski, Soulen

Physiological principles underlying processes that occur in living plants, with emphasis on higher plants. Growth and development, mineral nutrition, transport, water relations, and metabolism, emphasizing photosynthesis and nitrogen assimilation. Weekly discussion section.

5132f. PLANT PHYSIOLOGY LABORATORY. (2 cr; prereq 3131 or 5131 or ¶3131 or ¶5131)
Lab to accompany 3131 or 5131.

5141f. PLANT CELL BIOLOGY. (4 cr, §Bot 5141; prereq Biol 5004 or equiv; offered alt yrs) Wick
Structural, functional, developmental, and biochemical aspects of cellular components and processes specific to plants. Cell walls, dictyosome activity, plastids, plant cytoskeleton, modes of plant cytokinesis, cell-cell communication, lectins and cell recognition, vacuoles, cytoplasmic streaming.

5182s.* PLANT METABOLISM. (3 cr; prereq 5131 or equiv, course in biochemistry) Soulen
Plant metabolism including photosynthesis, respiration, and synthesis of macromolecules. Structure-function relations at the plant, cell, and subcellular level. Energy flow in the plant system and regulation of plant metabolism.

5183w. WATER, MINERALS, AND TRANSLOCATION. (4 cr; prereq 5131 or equiv) Allan, Markhart

Membrane phenomena and osmotic properties of cells. Uptake, movement, and loss of water in plants, including the effects of external factors. Translocation of organic substances. Absorption, distribution, and function of inorganic elements.

5184f. PLANT GROWTH AND DEVELOPMENT. (3 cr; prereq 5131 or equiv) Olszewski, Smith
Survey of plant growth and development ranging from germination to death, with emphasis on physiology, biochemistry, and molecular biology. Major topics include developmental processes related to: mobilization of macromolecules during germination; cell division and cell extension during axis growth; photomorphogenesis, chloroplast and microbody ontogeny; flowering, fruit and seed formation, senescence; and how plant growth substances control these developmental events.

5186w. TOPICS IN PLANT BIOCHEMISTRY. (3 cr; prereq BioC 5331 or Biol 5001; offered alt yrs) Gleason
Biochemical processes unique to plants, with emphasis on structures of macromolecules involved and their reactions and regulation. Major topics: light reaction of photosynthesis, secondary metabolism, and carbohydrates. Minor topics: carbon dioxide fixation and nitrogen fixation.

5203w. HERBARIUM TECHNIQUES. (1 cr; prereq 1009 or 3201 or equiv) Cholewa
Hands-on approach to museum curating procedures in the herbarium. Students are exposed to all aspects of herbarium management and assist with some curating of plant specimens.

5221w. PLANT MOLECULAR EVOLUTION. (3 cr; prereq Biol 5003 or GCB 3022 or GCB 5022; offered alt yrs) Doebley, Furnier

Application of molecular genetics to study of processes and products of evolution. Phylogenetic reconstruction, chromosomal evolution, multigene families, molecular aspects of morphological changes, role of transposons in evolution, DNA sequence evolution, and measures of genetic diversity.

5231f. INTRODUCTION TO THE ALGAE. (5 cr, §Bot 5231; prereq 10 cr botany or biology or #; offered alt yrs) McLaughlin
Structure, reproduction, and life histories of major algal divisions.

5801su. PLAINS AND BOREAL FLORA. (5 cr, §Bot 5801; prereq course in taxonomy, Δ; offered when feasible in Lake Itasca Biology Session)

5811su. FRESHWATER ALGAE. (5 cr, §Bot 5811; prereq 10 cr botany or biology or zoology or equiv, Δ; offered when feasible in Lake Itasca Biology Session)

5890su. RESEARCH PROBLEMS. (1-5 cr, §Bot 5890; prereq Δ; offered in Lake Itasca Biology Session)
Individual research for undergraduates and graduates.

5960f,w,s.* SPECIAL TOPICS. (Cr ar; prereq #, Δ) Staff
Treatment in depth of a specialized botanical topic.

5970f,w,s,su. DIRECTED STUDIES. (Cr ar, §Bot 5970; prereq #, Δ) Staff
Individual study of selected topics or problems with emphasis on selected readings and use of scientific literature.

5990f,w,s,su. DIRECTED RESEARCH. (Cr ar, §Bot 5990; prereq #, Δ)
Lab or field investigation of selected areas of research.

8287s. PLANT MOLECULAR BIOLOGY. (3 cr, §Bot 8287; prereq BioC 5753 or GCB 5034; offered alt yrs) Gantt, Olszewski
Gene expression and regulation, gene structure, gene transfer in higher plants.

8301w.* POLLEN MORPHOLOGY AND QUATERNARY PALYNOLOGY. (3-5 cr, §Bot 8301; prereq plant taxonomy or #) Cushing
Morphology and nomenclature of pollen grains and pteridophyte spores, survey of pollen and spores of major plant families, lab techniques. Research topics in pollen analysis of Quaternary sediments and pollen morphology.

8950f,w,s. SEMINAR. (1 cr, §Bot 8950; prereq #) Staff

8990f,w,s,su.* RESEARCH PROBLEMS. (Cr ar, §Bot 8990; prereq #, Δ) Staff

Other Acceptable Courses

Certain courses from other University departments and colleges that are listed in this bulletin are acceptable as part of a major

Graduate Programs

in plant biological sciences. The following are examples of acceptable courses:

Agro 8050. PHYSIOLOGY OF FIELD CROPS

Agro 8230. CYTOGENETICS

Biol 5125. RECOMBINANT DNA LABORATORY

EEB 5014. ECOLOGY OF VEGETATION

FR 8101. RESEARCH PROBLEMS: FOREST-TREE PHYSIOLOGY

GCB 8148, 8149. ADVANCED CELL BIOLOGY I AND II

Hort 8045. PLANT RESPONSE TO ENVIRONMENTAL STRESS

MicB 5321. PHYSIOLOGY OF BACTERIA

PIPa 5206. BIOLOGY OF FUNGI

Soil 5241. MICROCLIMATOLOGY

Plant Breeding

Professor: Peter D. Ascher; Donald K. Barnes; Robert H. Busch; David W. Davis; Franklin D. Enfield; Burle G. Gengenbach; Florian I. Lauer; Carl A. Mohn; James H. Orf; Ronald L. Phillips; Donald C. Rasmuson; David A. Somers; Robert E. Stucker; Deon D. Stuthman

Adjunct Professor: Howard W. Rines

Associate Professor: Nancy J. Ehlke, *director of graduate studies*; John Doebley; James J. Luby

Assistant Professor: Mark S. Strefeler

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Graduate study in plant breeding is available through the Department of Agronomy and Plant Genetics and the Department of Horticultural Science. Students may emphasize applied breeding or more basic aspects of plant breeding and genetics, including biotechnology. The program is intended for qualified students who wish to prepare for research and teaching positions in universities, government agencies, private industry, and international agricultural agencies.

A wide range of courses in plant breeding and genetics is offered. In addition, courses are available in several disciplines related to plant breeding and plant genetics. The course list below emphasizes breeding, genetics, cytogenetics, and molecular,

physiological, and population genetics. For additional courses that may be included in a plant breeding major, see the agronomy, genetics, and horticulture sections of this bulletin.

Prerequisites for Admission—Applicants should have completed the bachelor's degree in agriculture or a related field and have a good background in biological and other sciences. Students with an inadequate background are asked to make up deficiencies before starting the graduate program.

Special Application Requirements—Three letters of recommendation are required. Graduate Record Examination scores and a statement outlining career goals and experience are strongly encouraged. Information about graduate assistantships is available from either of the two departments administering the program. Students are admitted in any quarter.

Master's and Doctoral Degree Requirements—Information about the M.S. and Ph.D. programs is available from either of the two departments administering the program.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Agronomy and Plant Genetics, University of Minnesota, 411 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108 (612/625-7773); or the Department of Horticultural Science, University of Minnesota, 305 Alderman Hall, 1970 Folwell Avenue, St. Paul, MN 55108 (612/624-5300).

Note—For descriptions of courses, consult the course listings of the respective departments.

PIBr 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

PIBr 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

PIBr 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Agro 5020w. INTRODUCTION TO PLANT BREEDING. (4 cr; prereq GCB 3022 or Hort 3003 or equiv) Orf

Agro 5310su,f. ORIENTATION TO FIELD CROP BREEDING. (1 cr; prereq 5020 or #) Stuthman

Agro 8200w. PLANT BREEDING PRINCIPLES AND METHODS I. (3 cr; prereq 5020, Stat 5301 or equiv) Rasmusson

Agro 8210s. PLANT BREEDING PRINCIPLES AND METHODS II. (3 cr; prereq 8200, Stat 5301, GCB 5042) Stucker

Agro 8220f. APPLICATION OF QUANTITATIVE GENETICS TO PLANT BREEDING. (3 cr; prereq 8210, 8260, GCB 5042 or #) Ehlike

Agro 8230f. CYTOGENETICS. (4 cr; prereq GCB 5034 or #; 3 lect, 2 lab hrs per wk) Phillips

Agro 8240w. CELLULAR AND MOLECULAR GENETICS OF PLANT IMPROVEMENT. (3 cr; prereq GCB 5034) Gengenbach, Somers

Agro 8250s. ADVANCED PLANT GENETICS. (2 cr; prereq 8240 or GCB 8131) Gengenbach, Somers

Agro 8270f,w. SEMINAR: PLANT BREEDING. (1 cr) Staff

Agro 8280s. CURRENT TOPICS IN PLANT BREEDING. (2 cr; prereq 8210 or #) Stuthman

Agro 8330f,w,s,su. RESEARCH IN PLANT GENETICS. (Cr ar) Staff

Agro 8340f,w,s,su. DIRECTED STUDIES FOR THESIS RESEARCH. (Cr ar; pereq PhD student in agro or in plant breeding or #; S-N only) Staff

Biol 5003f,w,s. GENETICS. (4 cr, §GCB 3022, §GCB 5022; prereq 5001 or BioC 3021 or BioC 5331)

FR 5152.* FOREST GENETICS. (3 cr; prereq Biol 1103, Stat 3011) Mohn

GCB 5034w. INTERMEDIATE MOLECULAR GENETICS. (4 cr; prereq Biol 5003, 5004, advanced bioscience undergrad or non-bioscience grad student) Shaw

GCB 8060f,w,s. CURRENT TOPICS. (2 cr [may be repeated for cr]; offered when feasible)

GCB 8131w. ADVANCED GENETICS I. (4 cr, §5031; prereq 3022 or Biol 5003, Biol 5001 or BioC 5751 or #) Lefebvre

GCB 8132f. ADVANCED GENETICS II. (4 cr, §5032) Hackett

Hort 8022w. BREEDING ASEXUALLY PROPAGATED CROPS. (3 cr; prereq Agro 5020; offered alt yrs) Lauer

Hort 8023f.* EVOLUTION OF CROP PLANTS. (3 cr) Ascher

Hort 8061f,w,s.* DISCUSSIONS IN PLANT REPRODUCTIVE BIOLOGY. (1 cr; prereq #) Smith

Hort 8063f,w,s.* SEMINAR: DISCUSSIONS IN HORTICULTURAL PLANT BREEDING. (1 cr; prereq #) Davis, Lauer, Luby, Strefeler

Stat 5301. DESIGNING EXPERIMENTS. (5 cr, §5163; prereq 3012 or 5021 or 5133 or 5153 or #)

Plant Pathology (PIPa)

Professor: Neil A. Anderson, *head*; Sagar V. Krupa, *director of graduate studies*; Ernest E. Bantari; Robert A. Blanchette; Robert M. Brambl; William R. Bushnell; James V. Groth; Philip O. Larsen; Kurt J. Leonard; Benham E. L. Lockhart; David H. MacDonald; Richard A. Meronuck; Chester J. Mirocha; Robert F. Nyvall; James A. Percich; Francis L. Pflieger; Darroll D. Skilling; Ward C. Stienstra; Richard J. Zeyen

Associate Professor: Roger K. Jones; Donald V. McVey; Thomas H. Nicholls; Carol E. Windels; Nevin D. Young

Assistant Professor: Ruth Dill-Macky; Linda L. Kinkel; Deborah A. Samac; Les J. Szabo

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Plant pathology interfaces with all plant science disciplines and, through mycotoxicology, with food sciences and veterinary medicine. Areas of concentration include biological control of plant disease, forest pathology and microbial degradation of wood, microbial ecology, mycotoxicology, physiological and molecular plant-microbe interactions, and resistance and virology. The course of study varies with the requirements of the area of concentration and interests of the student.

Prerequisites for Admission—Master's degree applicants must have a sound college background in the basic biological and physical sciences and mathematics, including 35 quarter credits in biology with at least one course in each of the following areas: botany, zoology, genetics, plant physiology, and microbiology. Applicants must also have completed at least one course in inorganic chemistry, organic chemistry, biochemistry, and physics. If prerequisite deficiencies exist, they must be corrected during the first year

Graduate Programs

of the graduate program. All students accepted into the department with a B.S. degree are admitted into the M.S. degree program. After a minimum of two quarters, students who qualify may elect to change their degree status to a Ph.D. program. Criteria for the change includes scholastic standing, potential for success in completing a Ph.D., and writing competency. Ph.D. applicants must satisfy all the prerequisites for the master's degree program in plant pathology and have a master's degree in plant pathology or in any field of natural science.

Special Application Requirements—Graduate Record Examination (GRE) scores are required for domestic and international students. A statement of objectives and three letters of recommendation are required of all students and must be submitted to the department.

Master's Degree Requirements—Students must take or have taken the equivalent of PIPa 5201 and 5202. Students are also required to take PIPa 5204 and one quarter of PIPa 8201. Remaining coursework is determined by the student's graduate advisory committee and the director of graduate studies according to general Graduate School requirements. The final examination for coursework and thesis defense is oral.

Doctoral Degree Requirements—Students must take three quarters (6 credits) of PIPa 8200 and two quarters of PIPa 8201. Students entering the doctoral program without having taken the equivalent of PIPa 5201, 5202, and 5204 are required to take these courses. The written comprehensive examination, which covers the major and related field(s), is administered each January.

Language Requirements—A foreign language is usually not required for either the M.S. or the Ph.D. degree. Knowledge of a foreign language may be necessary, however, for students doing research in certain geographical areas.

Minor Requirements for Students Majoring in Other Fields—For M.S. students, 9 credits are required. For Ph.D. students, 18 credits are required. The graduate student develops a comprehensive program in consultation with the student's academic adviser and the director of graduate studies in plant pathology.

For Further Information and Applications—Contact the Department of Plant Pathology, University of Minnesota, 495 Borlaug Hall, 1991 Buford Circle, St. Paul, MN 55108 (612/625-8200; e-mail anna@puccini.crl.umn.edu).

PIPa 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

PIPa 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

PIPa 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5102su. ECOLOGY OF FUNGI. (3 cr; prereq 5 cr botany or #) Staff

Ecological studies and identification of fungi. Fungal symbioses, morphology, coevolution, and applicable ecological theory. Student teams determine species richness in aquatic, grassland, and forest habitats.

5109w. MOLECULAR GENETICS AND BIOCHEMISTRY OF YEASTS AND FILAMENTOUS FUNGI. (4 cr, \$PBio 5109; prereq 1 course each in genetics and biochem or #; offered alt yrs) Berman, Brambl

Chromosome structure and function, regulation of nuclear gene expression, mitochondrial gene organization and expression, membrane and organelle biogenesis, cell cycle regulation, morphogenesis, mating and reproduction, recombination and gene switching, spore formation and germination, viruses, plasmids, toxins.

5201f. BIOLOGY OF PLANT DISEASES. (3 cr; prereq Biol 3012 or equiv) Percich
Principles and concepts of plant disease caused by selected bacteria, fungi, viruses, and nematodes. In-depth presentation of pathogen biology, factors that cause disease, and introduction and interaction of pathogens with plants. Epidemiology and control measures appropriate to plant diseases.

5202f. BIOLOGY OF PLANT DISEASES LABORATORY. (2 cr; prereq §5201) Percich
Techniques of plant pathogen isolation, culture, and inoculation. Selected bacteria, fungi, viruses, and nematodes and diseases they cause.

5203s. PHYSIOLOGICAL AND MOLECULAR PLANT-MICROBE INTERACTIONS. (3 cr; prereq intro course in biochem or plant physiology or #)

Young, Zeyen

Genetics, physiology, and molecular biology of plant-microbe interactions. Communication between plants and microbes, signal transduction, control of gene expression, symbiosis and parasitism, plant host response mechanisms, plant disease physiology.

5204su (formerly 5650). FIELD PLANT PATHOLOGY. (2 cr; prereq 3001 or 3002 or 5201, 5202) MacDonald, staff

Characteristics and management of plant diseases in field, forest, golf course, greenhouse, and urban environments.

5205su (formerly 5750). PLANT DISEASE DIAGNOSIS. (2 cr; prereq intro plant path course or #; two 2-hr labs) Lockhart

Principles and methodology of diagnosing problems affecting plant health. Biotic and abiotic disease agents, disease diagnosis at both field and lab levels, and current detection methods using immunological and electrophoretic techniques.

5206f (formerly 5105). BIOLOGY OF FUNGI. (4 cr; prereq Biol 1009 or #) Anderson, Groth

Survey of fungal kingdom, including recognition of all major fungi groups and their roles in ecosystems and human affairs, environmental and nutritional needs, and modes of dissemination and survival. Representative species of fungi observed and manipulated in lab.

5209s. BIOCHEMISTRY OF PLANT DISEASE. (3 cr; prereq organic chem or biochem or equiv; offered alt yrs) Mirocha

Biochemistry of metabolic reactions in diseased plants: phytoalexins, phytotoxins, induced resistance mechanisms, carbon metabolism, metabolic sinks.

5211w (formerly 8111). FUNGAL GENETICS. (4 cr; prereq intro genetics; offered alt yrs) Anderson, Groth

Attributes of genetics of fungi using classical approaches, including mendelian and quantitative traits, ecological and population genetics, incompatibility systems, tetrad analysis, heterokaryosis, somatic recombination, plasmids, genetics of parasitism, and molecular genetics techniques.

5212s (formerly 5050). DISEASES OF FOREST AND SHADE TREES. (4 cr) Blanchette

Biology of tree diseases and ecological relationships among trees, microbes, and environment. Lecture, discussion, lab.

5213s. PLANT NEMATOTOLOGY. (4 cr; prereq 3001 or 5201, 3002 or 5200; offered alt yrs) MacDonald

Modified case study approach to evaluating the significance of plant parasitic nematodes in Upper Midwest field, garden, turfgrass, and greenhouse situations.

5214f (formerly 5005). PLANT VIROLOGY. (4 cr; prereq PBio 3012 or equiv; offered alt yrs) Bantari, Lockhart

Importance, symptomatology, transmission, and identification of viroid, virus, and virus-like diseases of plants. Epidemiology and principles of control. Biological and biochemical properties of virus, viroid, and virus-like pathogens. Lab exercises including current techniques for plant virus identification and characterization, using transmission, immunodiagnosis, electron microscopy, and other experimental manipulation of these pathogens.

5215s. INSECTS IN RELATION TO PLANT DISEASES. (3 cr; prereq 1 course each in entomology and plant path or #; offered alt yrs) Lockhart, Ragsdale

Insect transmission and dissemination of plant pathogens; plant insect relationships; habits of principal insect vectors.

5500w. EPIDEMIOLOGY AND ECOLOGY OF PLANT DISEASE. (3 cr; prereq 5002 or 5050 or #) Kinkel

Concepts and methodology in quantitative study of plant disease epidemics, emphasizing ecology of interacting host plant and microbial populations. Disease forecasting, disease in natural (nonagricultural) systems, and biological and chemical approaches to disease control.

8000f. SUPERVISED TEACHING EXPERIENCE. (2 cr; prereq #) Young

Classroom or extension teaching experience in one of the following departments: agronomy and plant genetics, soil science, plant pathology, or horticultural science. Discussion of teaching topics to strengthen skills and develop personal teaching philosophy.

8090.* ADVANCED PROCEDURES AND RESEARCH IN PLANT PATHOLOGY. (Cr ar) Staff

Special assignment of work in lab and field problems in pathological research.

8200f.w. CURRENT TOPICS IN PLANT PATHOLOGY. (2 cr; prereq #)**8201w. SEMINAR.** (1 cr) Staff

Critical review and presentation of current problems and progress in plant pathology; presented by graduate students, invited specialists, and faculty.

8500. RESEARCH IN PLANT PATHOLOGY. (1-8 cr)

Lab or field research in selected areas of plant pathology.

Graduate Programs

Political Psychology

Professor: Eugene Borgida (psychology); Karlyn K. Campbell (speech-communication); William H. Flanigan (political science); David W. Johnson (educational psychology); Paul E. Johnson (information and decision sciences); Geoffrey M. Maruyama (educational psychology; director, Center for Applied Research and Educational Improvement); Barbara J. Nelson (public affairs); Steven D. Penrod (law); James R. Rest (educational psychology); W. Phillips Shively (political science); Mark Snyder (psychology); James A. Stimson (political science); John L. Sullivan (political science); Auke Tellegen (psychology)

Associate Professor: Patricia G. Avery (curriculum and instruction); William Brustein (sociology); Ronald J. Faber (journalism and mass communication); Martha H. Gonzales (psychology); Martin W. Sampson III (political science); John M. Taborn (Afro-American studies); Albert R. Tims, Jr. (journalism and mass communication)

Course of Study—Minor in political psychology, applicable to doctoral programs.

Curriculum—Political psychology is an interdisciplinary minor that is concerned with psychological aspects of political behavior and encompasses a variety of interdisciplinary research perspectives. Its roots lie in research in social and political attitudes and cognition, judgment and decision making, group relations, personality and leadership, and political socialization. The curriculum provides students with broad theoretical and methodological foundations for research in political psychology.

Prerequisites for Admission—Admission to the political psychology graduate minor is contingent upon prior admission to the Graduate School and a doctoral program in a degree-granting department. Applicants are required to demonstrate knowledge of research methods useful in the study of political psychology by successfully completing (grade of B or above) two or more of the following: EPsy 8261, 8262, or 8266; Pol 8121, 8123, or 8127; Psy 5206 or 8884; Soc 8812 or 8813; or Stat 5021 or 5302. Admission to the minor program is by permission of the director of graduate studies in political psychology.

Minor Requirements—Students seeking to complete the political psychology minor at the Ph.D. level are required to take the

following core courses: Pol 8307, Pol 8308, Pol 8309 (or Psy 8211, Psy 8212, Psy 8213), Pol 8310, and Psy 8201. The minor requires a minimum of 21 credits. Additional credits beyond the required courses must be selected from a designated course list that includes about 45 courses from 12 departments. Additional credits must also be distributed across two of four modules: psychological aspects of political behavior; political socialization and human development; politics in sociocultural context; and psychological approaches to political decision making in public policy and international relations. Credits from courses in the student's major department, however, do not count toward the minor.

Language Requirements—None specific to the minor program.

For Further Information and

Applications—Contact the Doctoral Minor in Political Psychology, Department of Political Science, University of Minnesota, 1414 Social Sciences Building, 267 19th Avenue S., Minneapolis, MN 55455 (612/624-4144 or 612/624-4305; fax 612/626-7599; e-mail polisci@polisci.umn.edu or jsull@polisci.umn.edu); or Doctoral Minor in Political Psychology, Department of Psychology, University of Minnesota, N-218 Elliott Hall, 75 East River Road, Minneapolis, MN 55455 (612/625-4042 or 612/625-3381; fax 612/626-2079; e-mail borgi001@maroon.tc.umn.edu).

Political Science (Pol)

Regents' Professor: Frank J. Sorauf

Professor: Edwin Fogelman, *chair*; William H. Flanigan, *director of graduate studies*; Charles H. Backstrom; Terence W. Ball; Raymond D. Duvall; James Farr; John R. Freeman; Virginia H. Gray; Robert T. Holt; Samuel Krislov; Robert B. Kvavik; Paul C. Light; Thomas M. Scott; W. Phillips Shively; Steven S. Smith; James A. Stimson; John L. Sullivan

Associate Professor: Mary G. Dietz; Lawrence R. Jacobs; Daniel Kelliher; August H. Nimtz, Jr.; Martin W. Sampson; Kathryn A. Sikkink

Assistant Professor: Evelyn B. Davidheiser; Lisa Disch; Jeffrey W. Legro; Kevin T. McGuire; Ido Oren; Richard M. Price; Diana E. Richards

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B), as part of the Ph.D. program; special M.A., considered terminal; joint M.A./Ph.D. program with the Hubert H. Humphrey Institute of Public Affairs; and Ph.D.

Curriculum—The curriculum is divided into five subfields: formal models and methodology, political theory, American politics, international relations, and comparative politics.

Prerequisites for Admission—For a detailed statement of prerequisites, contact the director of graduate studies.

Special Application Requirements—All students, except those in the special master's program, are admitted directly into the Ph.D. program. The following should be sent directly to the department: Graduate Record Examination scores; a complete set of transcripts in addition to that required by the Graduate School; a brief statement expressing the applicant's purpose and goals in pursuing graduate work (in addition to and separate from the statement required as part of the Graduate School application form); three letters of recommendation from professors who know the applicant's academic work, particularly in political science; and samples of the applicant's written work (papers written for political science courses preferred). Send photocopies of written work; the department cannot guarantee that materials will be returned.

Graduate study in the Ph.D. program must begin in fall quarter; the application deadline is January 5. Graduate study in the special M.A. program may begin in any quarter; application deadlines are those established by the Graduate School.

The department and the Humphrey Institute of Public Affairs jointly offer a program that leads to an M.A. in public affairs and a Ph.D. in political science. To be eligible, students must be admitted separately by political science and public affairs. Normally, students begin their study

in public affairs and later apply to the Ph.D. program in political science. However, students may begin in either program, so it is possible to apply initially to either program or both. Students interested in this joint degree program should contact the director of graduate studies.

Master's Degree Requirements—Students in the Ph.D. program may earn an M.A. while completing the Ph.D. requirements. The special master's program annually admits a small number of students with clear, career-oriented goals. The degree is not a research degree and does not ordinarily lead to the Ph.D. degree. Programs are tailored to individual needs. Individuals with an interest in foreign or domestic government employment should apply to programs offered, for example, by the Hubert H. Humphrey Institute of Public Affairs.

For further information about master's degree requirements, contact the Department of Political Science.

Doctoral Degree Requirements—Required coursework includes three of four core seminars (8200, 8300, 8400, 8600) plus 8101, 8102, and 8103. In addition to seminar work, two substantial research papers are required.

Language Requirements—For the master's degree, none. For the doctoral degree, students must demonstrate either proficiency in two languages, high proficiency in one language, proficiency in one language and a research tool, or high proficiency in a research tool.

Minor Requirements for Students

Majoring in Other Fields—For the Ph.D. degree, at least 9 credits of 8xxx courses and an examination must be included in the minor program.

For Further Information and

Applications—Contact the Department of Political Science, University of Minnesota, 1414 Social Sciences Building, 267 19th Avenue South, Minneapolis, MN 55455 (612/624-4144; fax 612/626-7599; e-mail polisci@polisci.umn.edu).

Graduate Programs

Pol 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Pol 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Pol 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

8990. DIRECTED READINGS IN POLITICAL SCIENCE. (1-7 cr; prereq 45 cr 8xxx pol sci courses)

Political Science Methodology

8101. SCOPE AND METHODS OF POLITICAL SCIENCE. (3 cr; prereq pol sci grad major or Δ) Farr, Fogelman

The field of political science; epistemological problems in political inquiry; political values and their relationship to inquiry; approaches to the study of politics.

8102. APPROACHES TO POLITICAL RESEARCH. (3 cr; prereq pol sci grad major or Δ) Flanigan, Holt, Shively

Constructing a problem in political research; development and articulation of political theories; conceptualization and measurement; designs for research. Critical evaluation of examples of political research.

8103. POLITICAL SCIENCE AS A PROFESSION. (3 cr; prereq pol sci grad major) Staff

Acquaints future political scientists with intellectual issues, techniques, and resources pertinent to their future professional roles. Modules in teaching (required module), writing and applying for grants and sponsored research, and writing for publication; students must complete at least two modules.

8140. INDIVIDUAL READINGS AND RESEARCH IN METHODOLOGY. (1-3 cr; prereq pol sci grad major or #, Δ) Staff

8150. RESEARCH SEMINAR: METHODOLOGY. (3 cr; prereq pol sci grad major or #) Staff

Supervised research and research training in selected topics and problems.

8160. SELECTED TOPICS IN MODELS AND METHODS. (3 cr; prereq pol sci grad major or #) Staff

Readings and research in special topics or problems.

Formal Models and Methodology of Political Analysis

8120. POSITIVE THEORY. (3 cr; prereq pol sci grad major or #; offered alt yrs) Richards

Extensive survey of positive political theory and rational-choice models. Individual preferences and utility theory, social welfare functions, collective action and externalities, markets and elections, and spatial models of electoral competition.

8121. INTRODUCTION TO QUANTITATIVE ANALYSIS. (4 cr; prereq pol sci grad major or Stat 5021 or #) Flanigan

Survey of data collection; levels of measurement; measures of association; substantive exercises in political analysis.

8122. FORMAL MODELS. (3 cr; prereq 1 yr calculus or equiv, pol sci grad major or #; offered alt yrs) Richards

Survey of the application and use of mathematical models in political science. Emphasis on structure of assumptions, logical deduction, and empirical testing of a wide class of models. Mathematical techniques covered may include mathematical programming, difference and differential equations, and stochastic processes.

8123. ADVANCED TOPICS IN REGRESSION ANALYSIS. (4 cr; prereq 8121 or equiv or #; lab section required; offered alt yrs) Freeman, Sullivan

General linear model; extensions of linear model; problems in regression analysis; causal models.

8124. GAME THEORY. (3 cr; prereq pol sci grad major or #; offered alt yrs) Richards

Theory and application of games in political science. Utility theory, two-person games and solution concepts. N-person games, the power index, and coalition theory. Applications drawn from voting analysis, institutional designs, international relations, and regulation theory.

8125. DYNAMIC ANALYSIS. (4 cr; prereq 8121 or equiv or #; lab section required; offered alt yrs) Freeman, Stimson

Time series regression analysis; simultaneous equations; stochastic processes.

8127. MEASUREMENT THEORY. (4 cr; prereq 8121 or equiv or #; lab section required; offered when feasible) Sullivan

Political Theory

5610. TOPICS IN POLITICAL THEORY. (4 cr; 3051 or 1061 or 8 cr social sci or #) Staff

Topics specified in the *Class Schedule*.

8200. UNDERSTANDING POLITICAL THEORY. (4 cr; prereq pol sci grad major or Δ) Ball, Dietz, Farr, Fogelman

Introduction to major approaches and concepts in political theory.

8240. INDIVIDUAL READING AND RESEARCH IN POLITICAL THOUGHT. (3 cr per qtr; prereq pol sci grad major or #, Δ) Staff

8260. TOPICS IN POLITICAL THEORY. (3 cr; prereq pol sci grad major or #) Staff

Readings and research in special advanced topics or problems.

Development of Western Political Thought

5654. DEVELOPMENT OF POLITICAL THOUGHT: ANCIENT AND MEDIEVAL (PLATO TO AQUINAS). (4 cr; 1061 or 9 cr social sci recommended) Ball, Dietz, Disch
Thucydides; classical Greek thought; Plato and Aristotle; rise of empire and Roman thought; Augustine; Middle Ages; Aquinas.

5655. DEVELOPMENT OF POLITICAL THOUGHT: EARLY MODERN (RENAISSANCE TO THE AGE OF REVOLUTION). (4 cr; 1061 or 9 cr social sci recommended) Ball, Dietz, Farr
Renaissance; Machiavelli; More; Reformation; Luther; Calvin; liberalism; Hobbes and Locke; Enlightenment; Montesquieu; Rousseau.

5656. DEVELOPMENT OF POLITICAL THOUGHT: MODERN. (4 cr; prereq 1061 or 9 cr social sci) Dietz, Disch, Farr, Fogelman
French Revolution and reaction; Burke; utilitarianism; Bentham; Hegel; socialism; Marx; rise of democracy; Mill; Tocqueville; other selected mainly 19th-century thinkers.

5657. THE DEVELOPMENT OF POLITICAL THOUGHT: CONTEMPORARY. (4 cr; 1061 or 9 cr social sci recommended) Dietz, Disch, Farr
Twentieth-century thinkers and issues: Weber, Dewey, Lenin, Arendt, Camus, Sartre, Weil, de Beauvoir, Orwell, Marcuse, Popper, Rawls, Habermas, Foucault, liberalism, socialism, feminism, pragmatism, communitarianism.

8201, 8202, 8203, 8204. DEVELOPMENT OF POLITICAL THOUGHT. (3 cr per qtr; prereq pol sci grad major or #) Ball, Dietz, Disch, Farr, Fogelman
In general, topics in 8201 relate to ancient and medieval, in 8202 to early modern, in 8203 to modern, and in 8204 to contemporary political thought.

8215. AMERICAN POLITICAL THOUGHT. (3 cr; prereq pol sci grad major or #) Ball, Farr, Fogelman
Major issues and thinkers (e.g., political leaders, novelists, academics). Relation of political thought to problems of American culture.

Analytical and Political Inquiry

8220. PHILOSOPHY OF POLITICAL INQUIRY. (3 cr; prereq pol sci grad major or #) Ball, Farr
Issues and themes in philosophy of social sciences as they relate to political science theories and practices. Explanation, interpretation, criticism, theories, and theory change discussed in context of competing models of political inquiry.

8231. DEMOCRATIC THEORY. (3 cr; prereq pol sci grad major or #) Disch, Farr, Fogelman
Classical and modern theories of democracy including consideration of historical roots and philosophical foundations of the theories, the majority principle, role of the democratic citizen and representative institutions, with attention to the significance of recent social science findings regarding classical democratic theory formulations.

American Politics

5303. THE AMERICAN DEMOCRACY. (4 cr; prereq 1001 or equiv or #) Jacobs
American political system, its institutions and processes. Political decision making, influence, and elites. Ideals and reality of democracy in the United States.

8300. AMERICAN POLITICS. (4 cr; prereq pol sci grad major or Δ) Flanigan, Gray, Smith, Sorauf
Introduction to main themes of research in American politics, institutions, law, and policy.

8340. INDIVIDUAL READING AND RESEARCH IN AMERICAN POLITICS. (3 cr per qtr; prereq pol sci grad major or #, Δ) Staff

8350. RESEARCH SEMINAR: AMERICAN POLITICS. (3 cr; prereq pol sci grad major or #) Staff
Supervised research and research training in selected topics or problems.

8360. TOPICS IN AMERICAN POLITICS. (3 cr; prereq pol sci grad major or #) Staff
Readings and research in special topics or problems.

Individual Political Behavior

5710. ADVANCED TOPICS IN POLITICS AND BEHAVIOR. (4 cr; prereq 3051 or #) Staff
Topics of current analytic or policy importance in political behavior.

5765. POLITICAL PSYCHOLOGY OF CONFORMITY, ENMITY, AND HEROISM. (4 cr; prereq 1001 or equiv or #)
Conformity and obedience in politics; spiral of silence and groupthink; pathways from conformity and obedience to malignant political aggression; psychological basis and political use of torture, terrorism, and genocide; role of individual, group, and institutional preconditions and consequences; political altruism and heroism in face of malignant aggression; role of ordinary people and extraordinary leadership; case studies.

5766. AMERICAN POLITICAL CULTURE AND VALUES. (4 cr; prereq 3085 or equiv or #) Sullivan
Empirical analysis of basic political values: individualism, freedom, and equality; dominant beliefs about democratic principles, postmaterialism, and capitalism; citizenship and political participation; political intolerance and patriotism; heroism and political leadership.

5767. PUBLIC OPINION AND VOTING BEHAVIOR. (5 cr; prereq 1001 or equiv or #) Flanigan, Stimson
Major factors influencing electoral decisions; political attitude formation and change. Data analysis lab required.

8301. PUBLIC OPINION AND POLITICAL PARTICIPATION. (3 cr; prereq pol sci grad major or #) Flanigan, Stimson
Description and analysis of public opinion, opinion leaders, and opinion elites; attitudinal and social determinants of voting behavior, campaign participation, and other political activity; analysis and interpretation of electoral decisions.

Graduate Programs

8307, 8308, 8309. PROSEMINAR IN POLITICAL PSYCHOLOGY. (1 cr per qtr, §Psy 8211, 8212, 8213; prereq pol psych grad minor) Sullivan
Required for Ph.D. minor in political psychology. Background, issues, and trends. Current research topics and methods. Faculty colloquium series and student research presentations.

8310. POLITICAL PSYCHOLOGY. (3 cr; prereq #) Sullivan
Personality and political behavior, political learning, operant subjectivity and Q-methodology, emotion and political cognition. Focuses on individual-level political thinking and behavior.

Organizational Political Behavior

5737. AMERICAN POLITICAL PARTIES. (4 cr; prereq 1001 or equiv or #) Backstrom, Sorauf
American two-party system; party influence in legislatures and executives; decline of parties and their future.

5738. AMERICAN POLITICAL CAMPAIGNS AND ELECTIONS. (4 cr; prereq 1001 or equiv or #) Backstrom, Flanigan
National, state, and local campaigns and elections, research in local political parties and campaigns.

8303. POLITICAL PARTIES. (3 cr; prereq pol sci grad major or #) Backstrom, Sorauf
Party systems and subsystems; party organizational characteristics, goals, and incentives; distribution of power and authority within the party; chief party functions; party as an organizer of governmental power; determinants of party structure and role.

8305. INTEREST GROUPS. (3 cr; prereq pol sci grad major or #) Flanigan, Gray, Jacobs
Description and analysis of role of interest groups; leadership, maintenance of following, and representation of values; theories of groups, group behavior, and overlapping group membership; interest group relations with other political organizations.

National Governmental Processes

5523. THE POLITICS OF THE REGULATORY PROCESS. (4 cr; prereq 1001 or equiv or #; offered alt yrs) Krislov
Operations of regulatory agencies considered in political and legal environment. Federal administrative law principles, informal procedures, interest group activity. Philosophy of regulation. Politics and processes of deregulation.

8312. LEGISLATIVE PROCESS. (3 cr; prereq pol sci grad major or #) Backstrom, Smith
National and state legislatures; their internal organization; party organizations and influences with legislatures; interest groups and other external influences; legislative roles and behavior; policymaking processes in American legislatures.

8313. EXECUTIVE PROCESS. (3 cr; prereq pol sci grad major or #) Jacobs, Light
The political executive, cabinets, and staff aides; relations with legislatures; the executive as party and popular leader; the executive and administrative agencies.

8314. JUDICIAL PROCESS. (3 cr; prereq pol sci grad major or #) Krislov, McGuire
Judicial systems and roles; selection of judges; organizing and supporting litigation; influences on judicial decisions; impact and enforcement of judicial decisions; courts and other institutions of government.

8317. ORGANIZATIONAL BEHAVIOR. (3 cr; prereq pol sci grad major or #) Light
Organization theory and models; bureaucracy in a political system; impact of organization on individual political opinion and behavior; decision making and bargaining within political institutions and organizations.

State and Local Government

5315. STATE GOVERNMENT AND POLITICS. (4 cr; prereq 1001 or equiv or #) Backstrom, Gray
Political institutions, political behavior, and public policies in American states; comparisons among states, between state and national political systems.

5327. LOCAL GOVERNMENT AND POLITICS. (4 cr; prereq 1001 or equiv or #) Backstrom, Scott
Development and role of American local government; forms and structures; relationships with states and the federal government; local politics and patterns of power and influence.

8321. URBAN POLITICS. (3 cr; prereq pol sci grad major or #) Backstrom, Scott
Selection of local leadership; relationship of the political system to governmental forms and social institutions; role and impact of political institutions; policymaking at the local level; studies in policy problems; the emerging metropolis.

8325. STATE POLITICS AND INTERGOVERNMENTAL RELATIONS. (3 cr; prereq pol sci grad major or #) Gray
Application of comparative method to study of American state politics; emphasis on measurement of concepts, usefulness of conceptual frameworks, analytic techniques, and selection of units of analysis.

Public Law and Judicial Process

5501. PRINCIPLES OF AMERICAN CONSTITUTION I. (5 cr; prereq 1001 or equiv) Krislov, McGuire
Nature of constitutions, judicial review, organization and powers of national government; nation-state, and interstate relations.

5502. PRINCIPLES OF AMERICAN CONSTITUTION II. (5 cr; prereq 1001 or equiv, 5501 or 3309 or sr) Krislov, McGuire
Due process; civil rights and civil liberties.

8314. JUDICIAL PROCESS. (3 cr; prereq pol sci grad major or #) Krislov, McGuire, Sorauf
For description, see National Governmental Processes subdivision of American Politics subfield listing.

8331. CONSTITUTIONAL LAW. (3 cr; prereq 5501, 5502 or #) Krislov, McGuire

Public Policy

5322. AMERICAN SOCIAL POLICY. (4 cr; prereq 1001 or equiv or #) Gray, Jacobs
American government actions affecting the distribution of social benefits such as health care, education, and housing; social burdens such as taxation and regulation of social conduct. Relationships between government action and social problems; possibilities for change.

5323. AMERICAN DEFENSE POLICY. (4 cr; prereq 3836 or 6 cr ROTC or non-pol sci grad student or #; offered when feasible) Staff

8335. PUBLIC POLICY. (3 cr; prereq pol sci grad major or #) Gray, Jacobs
Politics of the policymaking process; interest group, client and constituent pressures; decision making and bargaining in policymaking; topics in major areas of regulation, planning, fiscal, and welfare policy.

8412. AMERICAN FOREIGN POLICY. (3 cr; prereq 8411 or #) Sampson
For description, see Foreign Policy subdivision of International Relations subfield listing.

International Relations

5810. ADVANCED TOPICS IN INTERNATIONAL POLITICS AND FOREIGN POLICY. (1-4 cr; prereq 3835 or 3836 or non-pol sci grad student or #) Staff
Topics of current analytic or policy importance in international relations and foreign policy. Topics vary.

8400. INTERNATIONAL RELATIONS. (4 cr; prereq pol sci grad major or Δ) Duvall, Legro, Oren, Price, Sampson
Introduction to analysis of international relations and foreign policy.

8440. INDIVIDUAL READING AND RESEARCH IN INTERNATIONAL RELATIONS. (1-3 cr; prereq pol sci grad major or #, Δ) Staff

8450. RESEARCH SEMINAR: INTERNATIONAL POLITICS AND FOREIGN POLICY. (3 cr; prereq pol sci grad major or #) Staff
Supervised group research and research training in selected topics or problems.

8460. TOPICS IN INTERNATIONAL POLITICS. (3 cr; prereq pol sci grad major or #) Staff
Readings and research in advanced topics or problems; content varies with instructor.

International Politics

5875. U.S. FOREIGN ECONOMIC POLICY. (4 cr; prereq 3836 or non-pol sci grad student or #)
Issues and processes related primarily to economic aspects of U.S. foreign policy; global and regional trade, investment, monetary, and aid policies; implications for U.S. defense and domestic policies; problems of coordinating information gathering, decision making, and implementing foreign policy apparatus under non-crisis conditions.

5881. INTERNATIONAL LAW. (5 cr; prereq 3835 or non-pol sci grad student or #) Price
Growth and character of international law; sources and evidences; relations to national law; subjects (individuals, states, international agencies); international courts and jurisdiction; state territory; law of the sea; legal responsibility of states; treaties and agreements of diplomatic and consular agents; human rights.

5883. INTERNATIONAL ORGANIZATIONS. (4 cr; prereq 3835 or non-pol sci grad student or #; offered all yrs) Duvall, Price
International politics of cooperation in institutional arenas; decision making in the United Nations and related agencies; organizational impact on international conflict, international economic and social relations.

5885. INTERNATIONAL CONFLICT AND SECURITY. (4 cr; prereq 3835 or non-pol sci grad student or #) Legro, Oren, Price
Use of military force in international politics, including threat perception, nuclear strategy, arms races and arms control, and ethical perspectives on war.

5886. INTERNATIONAL DIPLOMACY, BARGAINING AND NEGOTIATION. (4 cr; prereq 3835 or non-pol sci grad student or #; offered alt yrs) Legro
Strategies and processes of international diplomacy, bargaining and negotiation to resolve contemporary international disputes, including international security, arms limitation, and disarmament.

5889. THE POLITICS OF GLOBAL ECONOMIC RELATIONS. (4 cr; prereq 3835 or non-pol sci grad student or #) Duvall, Legro
Trade, aid, investment, and international monetary relations as political-economic processes; role of multinational corporations; problems of dependence and interdependence; strategic issues in international economic relations.

8401. ADVANCED INTERNATIONAL RELATIONS THEORY. (3 cr; prereq pol sci grad major or #) Duvall, Legro, Oren, Price
Basic theories and approaches to study of international politics; survey of representative theoretical and applied works; central issues and problems of continuing relevance to scholarship in international politics.

8402. CONFLICT DYNAMICS AND SECURITY. (3 cr; prereq pol sci grad major or #) Oren
Contending major theories concerning incidence and causes of various forms of conflict in the international system, especially war; role of arms races, alliances, international crises in the conflict process.

Graduate Programs

8404. INTERNATIONAL HIERARCHY. (3 cr; prereq pol sci grad major or #) Duvall
Asymmetric structures and processes of international relations; systemic conditions and implications of informal empire and structures of dependency and hegemony.

8405. INTERNATIONAL POLITICAL ECONOMY. (3 cr; prereq pol sci grad major or #) Duvall, Freeman
Political implications and political bases of international economic relations; policy coordination under complex interdependence; political constraints of economic dependence; political determinants of economic foreign policy.

Foreign Policy

5323. AMERICAN DEFENSE POLICY. (4 cr; prereq 3836 or non-pol sci grad student or 6 cr ROTC or #; offered when feasible) Staff

5877. COMPARATIVE FOREIGN POLICY. (4 cr; prereq 3836 or non-pol sci grad student or #) Sampson
Comparative analysis of foreign policies of major states; national and international determinants of foreign policy behavior.

8411. FOREIGN POLICY AND DECISION MAKING. (3 cr) Sampson
Introduction to major approaches of foreign policy literature. Topics include models of policy formulation, individual characteristics of decision makers, and applied foreign policy analysis.

8412. AMERICAN FOREIGN POLICY. (3 cr; prereq 8411 or #) Sampson
Processes of American foreign policy decision making and implementation; recent American foreign policies regarding such areas as strategy, economics, arms control, and energy, and impact of these policies on the international environment.

Comparative Politics

5410. ADVANCED TOPICS IN GOVERNMENT AND POLITICS. (4 cr; prereq 3051 or non-pol sci grad student or #) Staff
Topics of current analytic or policy importance in comparative politics. Topics vary.

8600. INTRODUCTION TO COMPARATIVE POLITICS. (4 cr; prereq pol sci grad major or Δ) Davidheiser, Holt, Kelliher, Shively, Sikkink
Main analytic approaches to comparative political analysis.

8640. INDIVIDUAL READINGS AND RESEARCH IN COMPARATIVE POLITICS. (3 cr per qtr; prereq pol sci grad major or #, Δ) Staff

8650. RESEARCH SEMINAR: COMPARATIVE POLITICS. (3 cr; prereq pol sci grad major or #) Staff
Supervised research and research training in selected topics and problems.

8660. TOPICS IN COMPARATIVE POLITICS. (3 cr; prereq pol sci grad major or #) Staff
Readings and research in special advanced topics or problems.

Comparative Analysis

5481. THE POLITICS OF NATIONAL ECONOMIC RELATIONS. (4 cr; prereq 3051 or non-pol sci grad student or #) Freeman
How politics shapes and is shaped by economic relations within nation-states; economic determinants of voting; political-business cycles; business and unions as interest groups; the political determinants of government spending patterns.

8633. COMPARATIVE SOCIOPOLITICAL CHANGE. (3 cr; prereq pol sci grad major or #) Davidheiser, Nimitz
Critical evaluation of the literature and theoretical perspectives; comparative examination of social and political change and the interrelationship between both processes.

8637. COMPARATIVE POLITICAL ECONOMY. (3 cr; prereq pol sci grad major or #) Duvall, Freeman
Comparison of political and economic systems of industrialized countries; political-business cycles, business and unions as interest groups; patterns of government spending.

8641. COMPARATIVE MASS POLITICAL BEHAVIOR. (3 cr; prereq pol sci grad major or #) Kelliher, Nimitz, Shively
Mass political behavior, examined from a cross-national perspective: the development of political participation, mobilization and its effects; the development of political cleavages and of political parties as vehicles of conflict; modes of political behavior under varied systems of representation and under varied party systems.

8643. COMPARATIVE POLITICAL ORGANIZATIONS. (3 cr; prereq pol sci grad major or #) Holt
Structures and behavior of political parties and interest groups in different political environments; evaluation of theoretical approaches and comparative frameworks.

8645. COMPARATIVE ANALYSIS OF ELITES IN AN INSTITUTIONAL CONTEXT. (3 cr; prereq pol sci grad major or #) Nimitz
Comparative analysis of political elites in a variety of social settings; recruitment patterns; leadership training and attitudes; elite behavior in civil and military bureaucracies and legislative structures; impact of elites on political change.

Country and Regional Studies

5461. WESTERN EUROPEAN GOVERNMENT AND POLITICS. (5 cr; prereq 3051 or non-pol sci grad student or #) Holt, Shively
Political institutions in their social setting; problems of power and responsibility, government stability; political decision making, government and the economic order.

5471. POLITICS OF RUSSIA AND THE COMMONWEALTH OF INDEPENDENT STATES.(4 cr; prereq 3051 or non-pol sci grad student or #)
Davidheiser

Politics in the former Soviet Union, now the Commonwealth of Independent States. Evolution of the system: theories of revolution and their relation to Russia's experience in 1917; emergence and breakdown of stable Soviet government. Current attempts to re-establish political stability and cope with problems facing political system in Commonwealth and Russia.

5473. CHINESE GOVERNMENT AND POLITICS.(4 cr; prereq 3051 or non-pol sci grad student or #)
Kelliher

Traditional Chinese society; fragmentation of China and rise of the Communists to power; sources and nature of Communist Chinese ideology; institutional character of the Communist Party system; sources of power; role of the party and functional groups; patterns of change.

5477. MIDDLE EASTERN GOVERNMENT AND POLITICS.

(4 cr; prereq 3051 or non-pol sci grad student or #) Krislov, Sampson

Domestic politics of Turkey, Iran, selected Arab states, and Israel with emphasis on ruling elites and linkages between regimes and societies. Secular/religious tensions, political aspects of ethnic diversity, and political effects of economic change.

5478. GOVERNMENT AND POLITICS OF AFRICAN COUNTRIES.

(4 cr; prereq 3051 or non-pol sci grad student or #) Nimtz

Political institutions and behavior of sub-Sahara African countries in their social and cultural settings; influence of class and tribal structure; parties and elections; source and nature of ideologies; economic and social policies.

5479. LATIN AMERICAN GOVERNMENT AND POLITICS.

(5 cr, §5455; prereq 3051 or non-pol sci grad student or #) Sikkink

Latin American political heritage, political processes, and contemporary public policy issues; problems of social, economic, and political change in selected countries.

8601. GOVERNMENT AND POLITICS IN WESTERN EUROPE.

(3 cr; prereq pol sci grad major or #) Kvavik, Shively

Analysis of political institutions; political development; social structures; ideologies; parties and pressure groups; voting behavior.

8605. GOVERNMENT AND POLITICS OF AFRICA.

(3 cr; prereq pol sci grad major or #) Nimtz

Political systems and processes of African countries with emphasis on local politics and problems of political change, political ideology, and political leadership.

8608. GOVERNMENT AND POLITICS OF RUSSIA AND THE COMMONWEALTH OF INDEPENDENT STATES.(3 cr; prereq pol sci grad major or #)
Davidheiser

Sources of stability and instability; evolution of institutions; relationship of social forces to political structures; economic policy; ethnic politics.

8611. CHINESE POLITICS.(3 cr; prereq pol sci grad major or #) Kelliher
Social divisions and sources of change since 1949, including class conflict, ideological controversy, reform, relations between state and society, issues of equality, debates over development strategy, and Chinese conceptions of democracy.**8619. GOVERNMENT AND POLITICS OF LATIN AMERICA.**(3 cr; prereq pol sci grad major or #)
Sikkink

Political institutions and processes with emphasis upon selected countries; social and economic basis of politics; parties and interest groups; political instability and change.

Portuguese

See Hispanic and Luso-Brazilian Literatures and Linguistics.

Psychology (Psy)*Regents' Professor:* Ellen S. Berscheid

Professor: Mark Snyder, *chair*; John P. Campbell, *director of graduate studies*; Phillip L. Ackerman; Gary T. Athelstan (physical medicine and rehabilitation); Eugene Borgida; Thomas J. Bouchard, Jr.; Dwight A. Burkhardt; James N. Butcher; Robert A. Cudeck; Mark L. Davison (educational psychology); René V. Dawis; Marvin D. Dunnette; Byron Egeland (child development); Patricia Faunce (University Counseling and Consulting Services); Paul W. Fox; Jo-Ida C. Hansen; Willard W. Hartup (child development); William G. Iacono; Paul E. Johnson (information and decision sciences); Ruth Kanfer; Thomas J. Kiresuk (psychiatry); Eric Klingler (social sciences, Morris campus); Gordon E. Legge; Gloria R. Leon; Rodney G. Loper (University Counseling and Consulting Services); David T. Lykken; Matthew McGue; David H. Olson (family social science); J. Bruce Overmier; Steven D. Penrod (law); Dallis K. Perry (University Counseling and Consulting Services); Herbert L. Pick, Jr. (child development); Ivan Ross (marketing and logistics management); Sheldon B. Sparber (pharmacology); Alan L. Sroufe (child development); Auke Tellegen; Neal F. Viemeister; David M. Wark (University Counseling and Consulting Services); Richard A. Weinberg (child development); David J. Weiss; James E. Ysseldyke (educational psychology)

Clinical Professor: Zigfrids T. Stelmachers

Associate Professor: Gail B. Peterson, *associate chair*; Marilyn E. Carroll (psychiatry); Charles R. Fletcher; Patricia A. Frazier; Martha H. Gonzales; William M. Grove; Daniel J. Kersten; Carol H. Pazandak (College of Liberal Arts administration); Carolyn L. Williams (epidemiology)

Assistant Professor: Paul F. Chapman; Kathy J. Christensen (neurology); John C. Gonsiorek; Harriett L. C. Haynes (University Counseling and Consulting Services); Eileen M. Palace

Graduate Programs

Clinical Assistant Professor: Linda K. Van Egeren;
Susan Nicol

Research Associate: James P. Cleary (medicine); Darwin
D. Hendel (Academic Affairs)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Doctoral program specialties are offered in clinical (adult or child clinical/developmental psychopathology), cognitive and biological, counseling, industrial/organizational, school, and social psychology; biological psychopathology; differential/behavior genetics; personality research; and psychometrics. An M.A. program is offered in psychometrics.

Prerequisites for Admission—Prospective students generally have completed at least 15 quarter credits in psychology, including one course in statistics or psychological measurement. Applicants to clinical psychology also must have completed at least one course in abnormal psychology. An undergraduate major in psychology is desirable, but not necessary.

Special Application Requirements—A statement of career goals, three letters of recommendation, and Graduate Record Examination (GRE) scores should accompany applications for both the M.A. and Ph.D. programs. Applications are accepted only for fall admission; the deadline is January 15. Minimum acceptable GPAs and GRE scores and other specific requirements are available from the psychology graduate admissions office.

Master's Degree Requirements—Each student's program is individually planned in consultation with the adviser.

Doctoral Degree Requirements—In addition to the requirements of the Graduate School, students must satisfy the general preliminary examination requirement in four areas outside their specialty and a preliminary examination covering the major area of concentration. There are no general

departmental course requirements. Each student's program is individually planned in consultation with the adviser to meet both the individual's goals and the area requirements. The programs in clinical psychology and counseling psychology include specific requirements for applied coursework and for practicum and internship experience. Each specialty area also requires completion of a series of Ph.D.-level seminars that teach scholarship and research skills.

Language Requirement—None.

Minor Requirements for Students

Majoring in Other Fields—For a Ph.D. minor, requirements are designed according to individual student needs, and generally include 20 to 28 credits of coursework.

For Further Information and

Applications—Contact the Department of Psychology, University of Minnesota, 105 Elliott Hall, 75 East River Road, Minneapolis, MN 55455 (612/625-8520; fax 612/626-2079).

Psy 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Psy 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Psy 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5011. THEORIES OF LEARNING AND COGNITION. (4 cr; prereq 3011 or #) Peterson Learning theories and contemporary theories of information processing and cognition. Examples from human and animal research.

5012-5013. PSYCHOLOGY OF LEARNING. (4 cr per qtr; prereq 1005, 3011 or EBB 3111 or #, except for grads) Overmier Classical conditioning, instrumental learning, and elementary cognitive processes. Evaluation of relevant theories. Emphasis on animal models.

5014. PSYCHOLOGY OF HUMAN LEARNING AND MEMORY. (4 cr; prereq 1005 or 3011 or 3051 or #, except for students in honors sequence and grads) Fox Processes and principles in human learning, memory, and cognition. Feedback, instruction and learning, cognitive processes and theories in learning and memory.

5015. COGNITIVE PROCESSES. (4 cr; prereq 3011 or 3051 or 5014, except for students in honors sequence and grads)

Cognitive processes in human pattern recognition, attention, and memory.

5031. PERCEPTION. (4 cr, §NSc 5031; prereq 3051 or 3031 or #) Legge

Data and principles of visual perception: color vision, pattern vision, object recognition, abnormal vision, and physiological optics.

5034. PSYCHOBIOLOGY OF VISION. (4 cr, §NSci 5034; prereq 3031 or #) Burkhardt

Analysis of properties and biological bases of sensory perception in humans and animals. Emphasis on color vision, visual sensitivity and adaptation, and nerve cell circuits of eye and brain.

5036. VISION: COMPUTATIONAL THEORY TO NEURAL SYSTEMS. (4 cr; prereq 3031, CSci 3104, Math 3211 or #) Kersten

Applications of psychology, neuroscience, and computer science to understanding design principles underlying visual perception. Comparisons of biological and physical processing of images with respect to image formation, encoding, filtering, scene inference, and recognition.

5037. PSYCHOLOGY OF HEARING. (4 cr; prereq 3031 or #) Viemeister

Biological and physical aspects of hearing; auditory psychophysics; theories and models of hearing; perception of complex sounds, including music and speech; clinical and other applications.

5038. INTRODUCTION TO NEURAL NETWORKS. (4 cr; prereq 3061 or 5061, CSci 3104, Math 3251 or #)

Parallel distributed processing models in neural and cognitive science. Linear models, Hebbian rules, self-organization, non-linear networks, information optimization, and representation of information. Applications to sensory processing, perception, learning, and memory.

5051. PSYCHOLOGY OF HUMAN-MACHINE INTERACTION. (4 cr; prereq 3051 or 3031 or #) Legge

Psychological perspectives on human-machine interaction and factors that limit performance. Cognitive and perceptual aspects of computer use, telepresence, and design and evaluation of sensory aids.

5054. PSYCHOLOGY OF LANGUAGE. (4 cr; prereq 3011, except for students in honors sequence and grads) Fletcher

Theories and experimental evidence involved in past and present conceptions of psychology of language.

5061. BIOLOGICAL PSYCHOLOGY. (4 cr, §3061; prereq 1005 or Biol 1009 or #) Chapman

Physiological and neuroanatomical mechanisms underlying behavior of animals. Neural basis of learning and memory, sleep, wakefulness, attention processes. Effects of drugs on behavior.

5101. PERSONALITY. (4 cr, §3101; prereq 5862 or §5862, honors or grad student) Tellegen

Review of personality theories as alternative orienting viewpoints. Trait-oriented discussion of findings and conceptual and methodological problems of contemporary personality research.

5121. HISTORY AND SYSTEMS OF

PSYCHOLOGY. (4 cr; prereq 8 cr 5xxx psych courses or equiv or grad student or #)

Survey of history, methods, and content of modern psychological theory, research, and application. Schools of psychology (e.g., structuralism, functionalism, behaviorism, gestalt psychology) and central theories of psychology reviewed in their historical and philosophical contexts.

5135. INTRODUCTION TO INDIVIDUAL DIFFERENCES. (4 cr, §3135; prereq 3801 or equiv, 5862 or #) Bouchard

Differential methods in study of human behavior. Overview of nature of psychological traits and influence of age, sex, heredity, and environment in causation of individual and group differences in ability, personality, interests, and attitude.

5136. HUMAN ABILITIES. (4 cr; prereq 3135 or 5135, 5862 or equiv or #) Ackerman

Theory, methods, and applications of research in human abilities. Intelligence, aptitude, achievement, specific abilities, information processing/learning and intelligence, aptitude/treatment interactions, and quantitative measurement issues.

5137. INTRODUCTION TO BEHAVIORAL

GENETICS. (4 cr; prereq 3135 or 5135 or #) McGue
Application of genetic methods to study of human and animal behavior. Emphasis on use of genetic designs and methods to address psychologically relevant questions concerning nature and etiology of individual differences in behavior. Examples include intelligence, schizophrenia, manic depressive illness, alcoholism.

5138w. PSYCHOLOGY OF AGING. (4 cr; prereq 3135 or 5135, 5862 or #) McGue

Analysis of behavioral changes that occur in mid and late adulthood, from psychological, biological, and sociological perspectives. Description of methodologies appropriate for studying behavioral change and application to cognitive, personality, and mental health changes associated with aging.

5141. PSYCHOLOGY OF WOMEN. (4 cr; prereq 1001) Frazier

Survey of current theory and research regarding psychology of women and psychological sex differences. Topics unique to women (e.g., pregnancy) and sex differences in personality, abilities, and behavior.

5202. ATTITUDES AND SOCIAL BEHAVIOR. (4 cr; prereq 3201 or #) Borgida

Survey of attitude theory, measurement, and persuasion research in social psychology. Focus on structure, function, and formation of attitudes; relationship between attitudes and various social behaviors; basic principles of persuasion.

Graduate Programs

5204. PSYCHOLOGY OF INTERPERSONAL RELATIONSHIPS. (4 cr; prereq honors or grad student or 3201 or #) Berscheid

Theory and research of interpersonal relationships, focusing on dyadic interaction processes and patterns and their implications for the individual. Issues in relationship research methodology; developmental, sociobiological, social psychological approaches to relationships; processes of relationship initiation, development, maintenance, and dissolution.

5205. APPLIED SOCIAL PSYCHOLOGY. (4 cr; prereq 3201 or grad student or #) Gonzales

Overview of field. Applications of social psychology research and theory to criminal justice system, media, behavioral medicine, desegregation, institutions, and energy conservation programs.

5206. RESEARCH METHODS IN SOCIAL PSYCHOLOGY. (4 cr; prereq #)

Overview of experimental and quasi-experimental methods suitable for research in social psychology. Statistical, interpretive, operational, and ethical issues in social psychological research.

5207. PERSONALITY AND SOCIAL BEHAVIOR.

(4 cr; prereq 3101 or 3201 or # except for honors and grad students)

Conceptual and methodological strategies for scientific study of individuals and their social worlds; applications of theory and research to issues of self, identity, and social interaction.

5501. VOCATIONAL PSYCHOLOGY. (4 cr; prereq 3801 or #) Dawis

Individual differences analysis of the work personality and the work environment; vocational development and vocational choice; work adjustment; work motivation and performance; work satisfaction and satisfactoriness; psychological problems connected with work.

5604H. ABNORMAL PSYCHOLOGY. (4 cr, §3604; prereq honors major or # for grad students) Leon
Comprehensive review of psychopathological disorders. Etiology, diagnostic criteria, and clinical research findings emphasized.

5606. BIOLOGICAL PSYCHOPATHOLOGY. (4 cr; prereq 1004, 1005 or equiv, 3061 or 5061, 3604 or 5604H or #)

Theories of and empirical research on psychophysiology, neuroanatomy, and neurochemistry of major psychopathological disorders.

5701. PERSONNEL AND INDUSTRIAL PSYCHOLOGY. (4 cr; prereq 3801 or equiv, 8 cr psych or #) Campbell

Applying principles of individual differences and psychological measurement to problems of recruiting, selecting, and appraising members of ongoing organizations. Job analysis, job behavior description, models of complex performance, performance measurement, selection and placement strategies, utility of personnel decision-making procedures, and minority group employment issues.

5702. PSYCHOLOGY OF INDIVIDUAL BEHAVIOR IN ORGANIZATIONS. (4 cr; prereq 3801 or equiv, 8 cr psych or #) Kanfer

Application of psychological research and methodology to study of human behavior in organizations. Measurement of work-related beliefs and attitudes, interpersonal relations, effects of group processes on problem solving and decision making, organizational socialization, leadership, supervision, organizational structure and climate.

5703. PSYCHOLOGY OF ORGANIZATIONAL TRAINING AND DEVELOPMENT. (4 cr; prereq 3801 or equiv, 8 cr psych or #) Campbell

Theories, methods, and research pertaining to improving performance of individuals at work through learning and instruction: training needs analysis, models of instructional design, aptitude-treatment interactions, training evaluation, knowledge structures, specific training programs.

5705. WORK MOTIVATION. (4 cr; prereq 3801 or equiv, 8 cr Psycor #) Kanfer

Motivational processes and job satisfaction in organizational contexts. Motivational process theories of task behavior and performance, goal setting, turnover/withdrawal, work attitudes, and interpersonal influences.

5862. PSYCHOLOGICAL MEASUREMENT: THEORY AND METHODS. (4 cr; prereq 3801 or equiv, honors or grad student or #) Weiss

Types of measurement (tests, scales, inventories) and their construction; theory and measurement of reliability and validity.

5865. MEASUREMENT OF LATENT TRAITS. (4 cr; prereq 5862 or #; offered alt yrs) Weiss

Theory and methods for the measurement of latent psychological variables using dichotomous item response theory methodology. One-, two-, and three-parameter models. Item calibration, scoring, information, and applications to instrument construction, equating, bias, adaptive testing and mastery testing.

5960. TOPICS IN PSYCHOLOGY. (1-5 cr per qtr; prereq 1001, #)

Special classes or seminars offered infrequently for juniors, seniors, and graduate students. Topics listed in the psychology office.

8004. SEMINAR: PHILOSOPHICAL

PSYCHOLOGY. (3 cr; prereq logic or phil course, psych or phil PhD major or #; offered alt yrs)
Selected philosophical and methodological problems.

8010. ADVANCED TOPICS IN LEARNING. (3 cr;

prereq 5012-5013 or #; S-N only) Overmier
Critical analysis of contemporary topics in learning and behavior theory.

8015. SEMINAR: ANALYSIS OF OPERANT

BEHAVIOR. (3 cr; prereq 5019 or #; offered alt yrs)
Readings in classic and recent books, monographs, and articles in operant conditioning.

8020. SEMINAR: CONDITIONING AND LEARNING. (3 cr; prereq 5011 or 5012 or psych grad student or #; S-N only) Overmier, Peterson, staff
Review and discussion of ongoing research and perspectives on future research.

8026. NEURO-IMMUNE INTERACTIONS. (3 cr, §NSc 8026, §PNI 8026, §VMic 8026; prereq MicB 5218 or equiv, NSc 5111 or equiv)
Regulatory systems (neuroendocrine, cytokine, and autonomic nervous systems) linking brain and immune systems in brain-immune axis. Functional effects of bidirectional brain-immune regulation.

8031. SEMINAR: VISUAL PERCEPTION. (3 cr; prereq 5031 or #) Legge
Physiological, psychological, and cognitive determinants of visual perception. Discussion of current research.

8037. PSYCHOPHYSICS AND AUDITION. (3 cr; prereq #) Viemeister
Modern and classical psychophysics. Psychophysical and physiological correlates of audition. Theories of hearing.

8040-8041. PSYCHOPHYSIOLOGY. (4 cr per qtr; prereq #) Iacono, Lykken
Basic principles and techniques; electrodermal, cardiovascular, EEG, EMG, and other physiological response systems having psychological relevance. Includes lab experience.

8056. SEMINAR: PSYCHOLOGY OF LANGUAGE. (3 cr; prereq 5054, #) Fletcher

8070. SEMINAR: PSYCHOPHARMACOLOGY. (1 cr; prereq #) Carroll, Hatsukami, Overmier, Sparber, staff
Selected topics in drug-behavior research.

8107s. CROSS-CULTURAL STUDY OF PERSONALITY. (3 cr; prereq 5101, 5604 or equiv or #) Butcher
Methodological issues and status of current research.

8114-8115†. THE SCIENTIFIC STUDY OF PSYCHOPATHOLOGY. (3 cr per qtr; prereq #)
Theory and research in psychopathology; evaluation of current experimentation in various behavior disorders.

8120. PERSONALITY, THERAPY, AND WOMEN. (4 cr; prereq 5101, 8 cr Psyor #) Faunce
Personality theories as they relate to women; ways of helping women; new concepts and theories about women.

8121. ACHIEVEMENT MOTIVATION AND WOMEN. (3 cr; prereq 8 cr psychology, grad student, #) Faunce
Theories, concepts, and perspectives relevant to female achievement and achievement motivation.

8201. SOCIAL COGNITION. (3 cr; prereq #) Borgida
Classic and contemporary theory and research in social cognition and behavioral decision making.

8202. ADVANCED SOCIAL PSYCHOLOGY—CLOSE RELATIONSHIPS. (3 cr; prereq #; offered when feasible) Berscheid

8203. IMPRESSION MANAGEMENT. (3 cr; prereq #; 8208 recommended) Gonzales
Discussion of classic and contemporary theory and research concerning interpersonal strategies of impression management.

8204-8205-8206. SEMINAR: RESEARCH IN SOCIAL PSYCHOLOGY. (3 cr per qtr; prereq PhD candidate in psychology, #) Berscheid, Borgida, Gonzales, Snyder
Survey of contemporary theoretical positions and related research.

8208. ADVANCED SOCIAL PSYCHOLOGY—THE SELF. (3 cr; prereq #) Snyder
Discussion of social psychological theory and research concerning the self and social behavior.

8211, 8212, 8213. PROSEMINAR IN POLITICAL PSYCHOLOGY. (1 cr per qtr, §Pol 8307, 8308, 8309; prereq pol psych grad minor) Borgida
Required for Ph.D. minor in political psychology. Background, issues, and trends. Current research topics and methods. Faculty colloquium series and student research presentations.

8410. PERSPECTIVES IN LEARNING, PERCEPTION, AND COGNITION. (1 cr; S-N only) Broen, Overmier, Yonas, staff
Presentations, analyses, and discussions of current research in learning, perception, and cognition with multidisciplinary orientation.

8501. COUNSELING PSYCHOLOGY I: HISTORY AND THEORIES. (3 cr; prereq counseling Psy student or #) Frazier
Theories of counseling, their psychological assumptions and implications for practice; origins, development, and current status of vocational counseling.

8502. COUNSELING PSYCHOLOGY II: ASSESSMENT. (4 cr; prereq counseling Psy student or #) Dawis
Counseling use of selected assessment procedures and instruments including intelligence, abilities, interests, needs, values, and personality.

8503. COUNSELING PSYCHOLOGY III: INTERVIEWING AND THEORIES. (4 cr; prereq 8501, 8502, counseling Psy student or #) Counseling psychology staff
Emphasis on development of counseling skills and strategies of behavior change in the interview; research on counseling effectiveness.

8514-8515-8516. PRACTICUM IN STUDENT COUNSELING. (4 cr per qtr; prereq 8501, 8502, 8503 or equiv; S-N only) Loper, staff
Counseling experience with students in an academic setting; emphasis is on the educational, vocational, and personal problems of college students.

Graduate Programs

8517-8518-8519. PRACTICUM IN COUNSELING PSYCHOLOGY. (1-4 cr per qtr; prereq 8501, 8502, 8503 or equiv or # if not in counseling psych program; S-N only) Hansen

Beginning counseling practice experience in public and private mental health agencies.

8520-8521-8522. PRE-PRACTICUM IN APPLIED PSYCHOLOGY. (1-6 cr per qtr; prereq counseling psych grad student or #; S-N only) Keierleber, Pazandak, Wark

Counseling observation and experience in applied settings.

8541. MULTICULTURAL ISSUES IN COUNSELING. (2 cr; prereq counseling psych grad student or #) Haynes

Increasing counselors' sensitivity to cultural values and biases they bring to their work with clients of diverse backgrounds. Issues important to diverse populations that may influence counseling.

8542. ETHICAL ISSUES IN PSYCHOLOGY. (3 cr; prereq counseling or clinical psych grad student or #) Frazier, Grove

8544, 8545, 8546, 8547, 8548, 8549. SEMINAR: RESEARCH IN COUNSELING PSYCHOLOGY.

(1 cr per qtr; prereq counseling grad student or # for 8544, 8544 or # for 8545-8549; S-N only) Dawis, Frazier, Hansen

Presentation and discussion of research in counseling psychology with emphasis on quantitative methods; process, outcome, and vocational research; and research with diverse populations. *8544:* Introduction to counseling research. *8545:* Process research. *8546:* Outcome research. *8547:* Vocational research. *8548:* Diverse populations. *8549:* Quantitative methods.

8560. ADVANCED PRACTICUM/INTERNSHIP IN COUNSELING PSYCHOLOGY. (1-6 cr per qtr [max 24 cr]; prereq #; S-N only) Hansen

8564. SEMINAR: VOCATIONAL COUNSELING FOR WORK ADJUSTMENT. (2 cr; prereq counseling psych grad student or #; S-N only; offered alt yrs) Dawis
Topics and problems in vocational counseling for work adjustment. Research, operationalization, and application of theory of work adjustment to vocational counseling.

8574s. SEMINAR: STRONG INTEREST INVENTORY. (2 cr; prereq counseling psych grad student or #; S-N only; offered alt yrs) Hansen
Lectures and discussion on history and development of Strong Interest Inventory. Scale construction methodology; research applications; interpretation and use of instrument.

8611, 8612, 8613. PROFESSIONAL METHODS IN CLINICAL PSYCHOLOGY I: ASSESSMENT. (4 cr per qtr; prereq clinical psych major) Butcher, Grove, Tellegen, staff

Theory and practice in clinical application of assessment techniques and interviewing. Lab: observation, administration, scoring, interpretation.

8620. PRACTICUM IN CLINICAL PSYCHOLOGY. (1-6 cr; prereq #; S-N only) Leon
Field experience in professional work in clinical settings.

8621, 8622. PROFESSIONAL METHODS IN CLINICAL PSYCHOLOGY II. (3, 4 cr per qtr; prereq clinical psych major, 8611, 8612, 8613) Leon, Palace
Seminar on theories of individual and group treatment techniques. Lectures on and demonstrations of contemporary theories of methods of psychological intervention with adults and children. *8621:* Theories of intervention. *8622:* Adult behavior therapy.

8631, 8632. PROFESSIONAL METHODS IN CLINICAL PSYCHOLOGY III. (1-3, 3 cr per qtr; prereq clinical psych major, 8611, 8612, 8613) Ayers, Fischler, Iacono
Lectures, demonstrations, and supervised experience in the application of treatment techniques with psychologically disturbed persons in community and clinical settings. *8631:* Community psychology and crisis intervention. *8632:* Descriptive psychopathology.

8640. SEMINAR: TOPICS IN CLINICAL PSYCHOLOGY. (1-6 cr; prereq #; S-N only) Clinical psychology staff
Discussion of various topics in clinical psychology of interest to class and instructor.

8660. SEMINAR: THE PSYCHOPATHIC PERSONALITY: THEORY AND RESEARCH. (2 cr; prereq #) Lykken
Research-oriented consideration of the nature and etiology of psychopathic behavior.

8664. PERSONALITY ASSESSMENT. (4 cr; prereq #) Tellegen
Current methodological issues and important substantive developments and findings.

8690. SEMINAR: RESEARCH AND CLINICAL PRACTICE IN HUMAN SEXUALITY. (3 cr; prereq #) Palace
Current findings, issues, and developments in sex research and practice of sex therapy from multidisciplinary approach. For students with research interests in or contact with patients who have sexual difficulties, disorders, or dysfunction.

8701-8702. SEMINAR: INDUSTRIAL AND ORGANIZATIONAL PSYCHOLOGY. (4 cr per qtr; prereq #; offered alt yrs) Campbell, Dunnette, Kanfer

8703, 8704. SEMINAR: INDUSTRIAL AND ORGANIZATIONAL PSYCHOLOGY. (4 cr per qtr; prereq #; offered alt yrs) Campbell, Dunnette, Kanfer

8881-8882-8883†. SEMINAR: PSYCHOMETRIC METHODS. (1 cr per qtr; prereq #) Weiss
Reviews and individual research on current topics in psychological measurement, statistics.

8884. METHODS FOR MULTIVARIATE DATA ANALYSIS. (4 cr; prereq EPsy 5261, EPsy 8260, 8261, 8262 or #) Cudeck

Survey of topics in applied multivariate data analysis, including aspects of multiple regression, discriminant analysis, classification, multivariate hypothesis tests, principal components, and canonical correlation. Extensive use of computer exercises.

8900. SEMINAR IN BEHAVIORAL GENETICS.

(2 cr; prereq #)

Advanced topics in human and animal behavioral genetics. Joint faculty and student participation in team teaching. Focuses on current literature, doctoral thesis research in progress, and faculty research.

8970. SEMINAR: SPECIAL AREAS OF PSYCHOLOGY AND RELATED SCIENCES. (1-6 cr; prereq #; offered when demand warrants)**8980. DIRECTED TEACHING IN PSYCHOLOGY.**

(1-6 cr; prereq #) Staff

Supervised experience in teaching psychology.

8990.* RESEARCH PROBLEMS. (1-6 cr; prereq #)

Graduate staff

Psychoneuroimmunology (PNI)

Professor: J. Bruce Overmier (psychology); Phillip K. Peterson (medicine); Philip S. Portoghesse (medicinal chemistry); Virginia S. Seybold (cell biology and neuroanatomy); Burt M. Sharp (medicine)

Associate Professor: Marilyn E. Carroll (psychiatry); Martha A. Mellencamp (clinical and population sciences); Thomas W. Molitor (clinical and population sciences); Michael P. Murtaugh (veterinary pathobiology)

Assistant Professor: Chun C. Chao (medicine); Kristin M. Linner (medicine); Shannon G. Matta (medicine); Susan E. Nicol (psychology); Claire Pomeroy (medicine); Nahid Shahabi (medicine)

Course of Study—Minor in psychoneuroimmunology, applicable to doctoral programs only.

Curriculum—Psychoneuroimmunology (PNI) is a new field that seeks to elucidate the bidirectional connections between the central nervous system and the immune system, and the effect of these connections on the functioning of each system. These connections involve soluble factors, secreted primarily by the neuroendocrine system and peripheral immune tissues, and neural innervation of immune tissues by the autonomic system. PNI research also considers the effects of psychological function on the immune system and

underlying mechanisms. PNI is an interdisciplinary effort at the interface of neuroscience, immunology, psychology, endocrinology, microbiology, and medicinal chemistry.

Prerequisites for Admission—Admission to the psychoneuroimmunology graduate minor is contingent upon prior admission to a doctoral degree-granting program within the Graduate School and is by permission of the director of graduate studies in psychoneuroimmunology.

Minor Requirements—The following core courses are required: CBN 5111, MicB 8217, Phs1 5112, and PNI 8026 (cross-listed with NSc, Psy, and VMic 8026), as is participation in a colloquium (no credit) and the PNI and addiction seminar series (no credit). The minor requires a minimum of 18 graduate-level quarter credits. It is suggested that credits beyond the required courses be selected from the elective courses.

Alternative selections may be applied toward the minor if they are approved by the student's program adviser and the director of graduate studies in PNI. Credits from courses in the student's major program will not count toward the minor.

For Further Information and Applications—Contact Thomas W. Molitor, Ph.D., Department of Clinical and Population Sciences, University of Minnesota, 300E Veterinary Teaching Hospitals, 1365 Gortner Avenue, St. Paul, MN 55108 (612/625-7244; fax 612/625-6241).

Core Courses**CBN 5111. HUMAN NEUROSCIENCE A****MicB 8217. FRONTIERS OF IMMUNOLOGY II: CELLULAR IMMUNOLOGY****Phs1 5112. HUMAN NEUROSCIENCE B****PNI 8026. NEURO-IMMUNE INTERACTIONS.**

(3 cr, \$NSc 8026, \$Psy 8026, \$VMic 8026; prereq MicB 5218 or equiv, NSc 5111 or equiv)

Regulatory systems (neuroendocrine, cytokine, and autonomic nervous systems) linking brain and immune systems in brain-immune axis. Functional effects of bidirectional brain-immune regulation.

Graduate Programs

Elective Courses—PSYCHOLOGY

Psy 5012. PSYCHOLOGY OF LEARNING

Psy 8070. PSYCHOPHARMACOLOGY SEMINAR

Elective Courses—NEUROSCIENCE

CBN 8222. CENTRAL REGULATION OF AUTONOMICFUNCTION

CBN 8223. NEUROBIOLOGY OF ENDOCRINE REGULATION

NSc 5462. NEUROSCIENCE PRINCIPLES OF DRUG ABUSE

NSc 5660. BEHAVIORAL NEUROSCIENCE

VB 5102. VETERINARY NEUROBIOLOGY

VB 5400. VETERINARY PHARMACOLOGY AND THERAPEUTICS I

VB 5460. NEUROCHEMICAL COMMUNICATION

Elective Courses—IMMUNOLOGY

CAPS 8193. ADVANCES IN CLINICAL IMMUNOBIOLOGY

MicB 5218. IMMUNOLOGY

MicB 5424. BIOLOGY OF VIRUSES

MicB 8216. FRONTIERS OF IMMUNOLOGY I: MOLECULARIMMUNOLOGY

MicB 8218. FRONTIERS OF IMMUNOLOGY III: CLINICALIMMUNOLOGY

MicB 8231. ADVANCED TOPICS IN MICROBIAL PATHOGENESIS

MicB 8421. VIROLOGY AND TUMOR BIOLOGY

Public Affairs (PA)

Professor: G. Edward Schuh, *dean*; Richard S. Bolan, *director, planning degree program*; Dean E. Abrahamson; John S. Adams; John E. Brandl; Geraldine K. Brookins; John M. Bryson; Nancy N. Eustis; Donald P. Geesaman; Stephen A. Hoenack; James E. Jernberg; Morris M. Kleiner; Robert T. Kudrle; Paul C. Light; Samuel L. Myers, Jr.; Barbara J. Nelson

Associate Professor: Sandra O. Archibald, *director of graduate studies*; Sanders D. Korenman

Assistant Professor: Sheila D. Ards; Ragui Assaad; Barbara J. Kanninen; Deborah Levison; Thomas F. Luce

Other: Harry C. Boyte; Charles B. Finn; Marsha A. Freeman; Barbara L. Lukermann

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—Public Affairs: M.A. (Plan B only); Planning: M.Plan. (Plan B only).

Curriculum—The master of arts (M.A.) program in public affairs provides individualized curricula in policy analysis, administration, and topical areas of interest in public affairs. The master of planning (M.Plan.) program offers professional training in planning. The central concern in both programs is governance—the formulation and achievement of actions in the public interest. Focus is on decision making, public and private, and on techniques of analysis, synthesis, and process appropriate to different circumstances.

Prerequisites for Admission—The core curriculum for both degrees assumes a knowledge of intermediate microeconomics and the rudiments of statistical inference and American government. Applicants with deficiencies may be admitted with the understanding that these deficiencies must be removed before enrollment. Special remedial courses in intermediate microeconomics and quantitative methods are offered in the five weeks before the beginning of fall quarter.

Special Application Requirements—A statement of purpose and three letters of recommendation evaluating the applicant's potential for graduate study in public affairs should be sent directly to the Hubert H. Humphrey Institute of Public Affairs. All applicants must submit Graduate Record Examination scores. Admission is in fall quarter only. Complete applications must be postmarked by January 15 to ensure they are reviewed for fall admission and initial financial aid offers. Applications postmarked after January 15 are reviewed on a space-available basis.

Master's Degree Requirements—For the M.A. degree, students complete at least 64 credits of graduate coursework, including the core curriculum and at least 18 credits in a primary concentration plus 12 credits in a secondary concentration; one Plan B project; and an arranged internship of at least three months full-time. The internship requirement can be waived for persons having equivalent experience.

For the M.Plan. degree, students complete at least 64 credits of graduate coursework, including the core curriculum, a required set of generic planning courses, at least 12 credits in an additional area of concentration and 6 workshop credits; one Plan B project; and an arranged internship of at least three months full-time. The internship requirement can be waived for persons having equivalent experience.

An oral final examination is required for both degrees.

Dual Degrees—Dual degrees, consisting of a degree in public affairs or planning taken concurrently with a degree in law, social work, or political science, are available. Applicants must submit separate applications to the two programs.

Language Requirements—None specific to the minor program.

Minor Requirements for Students

Majoring in Other Fields—For the master's degree, students complete at least 9 credits chosen from core courses or from a field of concentration. For the doctoral degree, students complete at least 18 credits chosen from core courses and a field of concentration.

For Further Information and Applications—Contact the admissions committee, Hubert H. Humphrey Institute of Public Affairs, University of Minnesota, 230 Humphrey Center, 301 19th Avenue South, Minneapolis, MN 55455 (612/625-9505).

Core Courses

5001. POLITICS, PLANNING, AND DECISION MAKING. (4 cr; prereq PA or planning major or #) Boyte, Bryson, Nelson
Overview of policy process. Section 1: Social movements, politics, and public policy. Section 2: Planning and public decision making, including types of planning (policy, regulatory, budgetary, program, project) and planning processes. Section 3: Public philosophy, including classic concepts of public life, republican tradition, theories of public world and power, and concepts of political arts. All sections address ethics. Students take one section.

5002. PLANNING AND MANAGEMENT OF ORGANIZATIONAL RELATIONS. (4 cr; prereq PA or planning major or #) Jernberg, Light
Overview of management of organizations and organizational behavior, including personnel management, conflict and negotiation, strategic planning, institutional design, and overall structure of public and non-profit organizations. Students organized into consulting teams to work with government and non-profit agencies to solve an organizational problem. Examination of real-world cases.

5011. POLICY ANALYSIS I: APPLIED MICROECONOMICS FOR POLICY ANALYSIS. (4 cr; prereq intermediate microeconomics, PA or planning major or #) Brandl, Kudrle, Myers
"Market failure" concept. Overview of public finance. Cost-benefit analysis, systems analysis, and incentive issues in public organizations.

5012. POLICY ANALYSIS II. (4 cr; prereq 5011, PA or planning major or #) Archibald, Hoenack, Korenman
Microeconomic analysis, emphasizing spatial distribution of activity. Policy evaluation, survey research, impact analysis, and decision theory.

5021. QUANTITATIVE METHODS IN PUBLIC AFFAIRS AND PLANNING I. (4 cr; prereq 5901, PA or planning major or #) Ards, Levison, Luce
Basic statistical tools for empirical analysis in evaluation of public policy alternatives. Frequency distributions, descriptive statistics, elementary probability; binomial and normal distributions; estimation and hypothesis testing; analysis of variance; and introduction to simple and multiple regression and correlation. Quantitative analysis of data sets augment problem sets using University's Microcomputer Lab.

5022. QUANTITATIVE METHODS IN PUBLIC AFFAIRS AND PLANNING II. (4 cr; prereq 5901 or equiv experience working with computer software programs such as SPSS or Quattro Pro, PA or planning major or #) Assaad, Kleiner, Kudrle
Regression analysis, bivariate and multivariate models and the assumptions behind them, and problems in using the models when assumptions are not met. Exercises in data analysis.

Fields of Interest

Program requirements in each field may be satisfied by courses offered by the Humphrey Institute of Public Affairs or by other University units. Only those courses offered by the Humphrey Institute of Public Affairs are listed below. For complete offerings in each field, consult the special publications available upon request from the institute.

Management of Public and Nonprofit Organizations

5101. INTERGOVERNMENTAL RELATIONS. (3 cr; prereq grad student or adult spec or Δ) Jernberg, Luce
Evolution of federal system and modern system of intergovernmental relations in United States. Comparisons with other federal nations. Administrative, fiscal, policy issues and problems. Impact of changes and proposals for change on operation and capacities of national, state, and local government units.

5102. LEGAL ENVIRONMENT OF PUBLIC AFFAIRS. (3 cr; prereq PA or planning major or Δ) Gardebring
Legal context of public policy and decision making. Role of courts in public participation, policymaking, and administration. Legal reasoning and use of law and legal resources in resolving policy issues and managing administrative processes.

5111. MANAGEMENT OF PUBLIC AND NONPROFIT ORGANIZATIONS. (3 cr)
Applying organizational and behavioral theory to management problems. Case studies drawn from national, state, local, foreign, and international situations. Analysis of organizational effectiveness; strategies of institution redesign and change; selection, training, motivation, control, evaluation, and reward of organization members; organizational leadership; techniques for improving public sector productivity, job satisfaction, quality of work life.

5112. ORGANIZATIONAL DESIGN AND CHANGE. (3 cr; prereq 5002, grad student or adult spec or #) Light
Key concepts and specific change techniques. Public sector, nonprofit, and for-profit organizations. Single organization and inter-organizational networks.

5113. PUBLIC SERVICES REDESIGN. (3 cr; prereq grad student or adult spec or Δ) Brandl
Theory, strategy, politics, and some practical mechanics required to adapt public service system given constraints on resources and continuing pressure for effectiveness and equity. In-class and out-of-class interviews of persons involved in redesign.

5114. CONFLICT MANAGEMENT: THEORY AND PRACTICE. (3 cr; prereq adult spec or grad student or Δ) Fiutak
Integrates current theory with application models of interpersonal, group, organizational, and systemic conflict. Phases of negotiation and theory behind negotiation process within settings of interpersonal conflict, managerial mediation, large-group mediation, and alternatives for dispute resolution within and among corporate or organizational systems, e.g., mini-trials and summary jury trials.

5121-5122†. PUBLIC BUDGETING I-II. (4 cr per qtr; prereq grad student or PA or planning major or #; sequence must be taken in same academic yr) Brandl, Jernberg

5121: Development of macroeconomic policy and institutions; fiscal processes and theory applied to national, state, and local government; relationship of fiscal and monetary policy to operating and capital budgets; problems of equity, efficiency, impact on sectors of economy of tax, budget, and monetary policies. **5122:** Operating and capital budgets and budget processes in legislative and executive branches of federal, state, and local government; program planning evaluation and administration; techniques of budget and program analysis; use of budget as policy and management tool; analysis of fund flows within and among governments.

5123. FINANCIAL MANAGEMENT IN PUBLIC AND NONPROFIT ORGANIZATIONS. (3 cr; prereq Δ) Stevens
Design, installation, and use of accounting and control systems in public and nonprofit agencies. Public accounting standards and practices. Financial administration. Debt management. Controllership and post auditing. Financial reporting. Contract and procurement management systems.

5125. STATE AND LOCAL PUBLIC FINANCE. (3 cr; prereq grad student or adult spec or Δ) Luce
Analysis of management, efficiency, and equity concerns associated with primary financial instruments used by U.S. state and local governments. Property, income, and sales taxation; user fees; debt instruments; tax increment financing; exactions; impact fees; intergovernmental grant systems. Emphasizes interstate comparisons of institutional arrangements and relationships between financing choices and public goals in different policy areas.

5191, 5192, 5193, 5194, 5195, 5196, 5197, 5198, 5199. TOPICS IN PUBLIC AND INDEPENDENT SECTOR MANAGEMENT. (3 cr per qtr; prereq grad student or adult spec or Δ)
Analysis of selected topics, e.g., public personnel policy and labor relations, affirmative action policy, compensation systems, services redesign, local administration, administrative support systems, operations management, procurement policy, negotiation and conflict resolution, intergovernmental administration, functions of the executive, information systems.

8191, 8192, 8193, 8194, 8195, 8196, 8197, 8198, 8199. SEMINAR/WORKSHOP: ADVANCED TOPICS IN PUBLIC AND INDEPENDENT SECTOR MANAGEMENT. (1-3 cr per qtr)
See 5191, 5192, 5193, 5194, 5195, 5196, 5197, 5198, 5199 above for description.

Planning and Urban Affairs

5112. ORGANIZATIONAL DESIGN AND CHANGE. (3 cr; prereq 5002, grad student or adult spec or #)
See Management of Public and Nonprofit Organizations for description.

5200. INTRODUCTION TO PLANNING. (3 cr)

Lukermann

Concepts and issues in planning as profession. Historical development of planning as public activity. Organization and role of planning in public agencies and private organizations.

5201. PLANNING THEORY. (3 cr; prereq Δ) Bolan

Theory of planned action. Philosophical roots of planning. Models of planned change. Planning theory and practice.

5202. PLANNING METHODS. (4 cr) Lukermann

Techniques for analysis, plan making, and plan evaluation at local and regional levels of government; field exercises and case studies requiring application of skills for public and private sector decision making.

5211. GROUP TECHNIQUES IN PUBLIC AFFAIRS AND PLAN MAKING. (4 cr; prereq Δ) Bryson

Nature, role, uses, and limitations of group techniques in public affairs and planning; specific techniques. Interorganizational focus.

5221. LAW AND URBAN AFFAIRS. (3 cr) Sellergren

Law's role in and influence on local government services, urban development, land use, and quality of life.

5230. STRATEGIC PLANNING AND MANAGEMENT. (3 cr; prereq #) Bryson

Strategy formulation, adoption, and implementation in government and nonprofit agencies. Agency strengths and weaknesses, external opportunities and threats. Stakeholder management. Case examples.

5231. STRATEGY AND TACTICS IN PROJECT PLANNING. (3 cr) Bolan

Effect of goals and contextual factors on planning. Appropriate strategic and tactical choices to make during planning process; case examples of planning for public programs, projects, products, or services.

5241. POLICY PLANNING STRATEGY. (3 cr; prereq adult spec or grad student or #)

Designing appropriate planning strategies, plan format and content, and plan preparation based on public issues, public attitudes, social structure, decision-making process and organization, and planning agency capabilities. State, regional, and local case studies.

5291, 5292, 5293, 5294, 5295, 5296, 5297, 5298, 5299.

TOPICS IN PLANNING. (3 cr per qtr; prereq grad student or adult spec or Δ)

Analysis of topics, e.g., national urban policy, planning in post-industrial society, industrial policy, and public facility, telecommunications, social, and national economic planning. Workshops involve client projects.

5602-5603. METROPOLITAN ANALYSIS I-II. (4 cr per qtr) Adams

Urban systems and metropolitan areas, structure and growth; daily and simulated urban systems; metropolitan dynamics; social area analysis; transportation systems; travel behavior; land use; retail structure change. 5603 also includes neighborhood transition: conflicts in housing, location of facilities, urban renewal.

5622. MANAGING URBAN GROWTH AND CHANGE. (4 cr; prereq grad student or adult spec or Δ)

Luca

Theory and practice of promoting and controlling economic growth and change in urban areas. Critical examination of economic development and growth management tools available to state and local policymakers and historical context of their use in the United States; legal, social, and economic constraints in implementing local strategies; complex problems created by interactions among economic, social, and demographic trends in U.S. metropolitan areas.

5701. SCIENCE AND STATE I. (3 cr; prereq grad student or adult spec or #)

Relationship of science and technology to ideological bases of society; technology's significance to policy process; analysis of society's institutions for governing technologies.

5702. SCIENCE AND STATE II. (3 cr; prereq grad student or adult spec or #)

Relationship of science and technology to ideological bases of society; technology's bases of society; technology's significance to policy process; analysis of society's institutions for governing technologies.

8291, 8292, 8293, 8294, 8295, 8296, 8297, 8298, 8299.
WORKSHOP/SEMINAR: ADVANCED TOPICS IN PLANNING. (3 cr per qtr)

Advanced analysis of topics, e.g., national urban policy, planning in post-industrial society, industrial policy, and public facility, telecommunications, social, and national economic planning. Workshops involve client projects.

Policy Analysis**5301, 5302. POPULATION AND POLICY IN DEVELOPING COUNTRIES AND THE UNITED STATES I-II.** (3 cr per qtr; prereq for both: grad student or adult spec or Δ; also for 5302: 5022 or 5301, section 2) Levison

Basic demographic techniques and economic theory applied to analysis of topics such as marriage and divorce, fertility, mortality, migration, age structure, and relationship of household structure to poverty.

5310. POLICY AND EVALUATION RESEARCH.

(3 cr; prereq grad student or adult spec or Δ) Eustis
Quantitative and qualitative methods used in policy analysis, formulation, and evaluation; alternative frameworks for understanding policy, both in terms of what is commonly called "policymaking" and in terms of "experience of policy" by ordinary people. Measurement, experimental design, survey research, evaluation research, fieldwork.

5391, 5392, 5393, 5394, 5395, 5396, 5397, 5398, 5399.
TOPICS IN POLICY ANALYSIS. (Cr ar; prereq grad student or adult spec or Δ)

Advanced work in application of policy analysis techniques to complex policy problems.

8300. CASE STUDIES IN POLICY ANALYSIS. (3 cr; prereq 5011, 5012) Brandl

Topics in microeconomics applied to systems problems of government. Market and nonmarket resource allocation; cost-effectiveness and cost-benefit analysis. Case method employed.

Graduate Programs

8391, 8392, 8393, 8394, 8395, 8396, 8397, 8398, 8399. WORKSHOP/SEMINAR: ADVANCED TOPICS IN POLICY ANALYSIS. (Cr ar)

Advanced work in application of policy analysis techniques to complex policy problems.

Social Policy

5401. SOCIAL POLICY. (3 cr; prereq grad student or adult spec or Δ) Ards

Public policies regarding satisfaction of human needs, e.g., health, education, employment, day care, and housing. Organizational framework, both public and private, for income transfer and provision of services. Historical and political context.

5411. ISSUES IN AGING. (3 cr; prereq Δ)

Intensive reading and class presentations on policy-relevant findings of gerontological research. Current and potential approaches of and constraints on decision makers, bureaucrats, and practitioners. Existing legislation and programs designed for older Americans.

5412. LONG-TERM CARE. (3 cr; prereq grad student or adult spec or Δ)

Analysis of legislation and policies encompassing care for dependent older persons or other groups (e.g., physically or mentally disabled younger adults), nursing homes and non-institutional housing and services. Social, political, and economic context for public and private efforts. Funding and organization of community (non-institutional) care.

5413. SEMINAR: AGING POLICY. (3 cr; prereq Δ)

Analysis of major issues in field of aging.

5414. MULTIDISCIPLINARY PERSPECTIVES ON AGING. (4 cr, §AdEd 5440, §CPsy 5305, §HSU 5009,

§PubH 5737, §Soc 5960, §SW 5024; prereq grad student or adult spec or Δ) Eustis

Introduction to aging and aging process.

5415. ECONOMIC ASPECTS OF AGING. (4 cr; prereq intro economics, grad student or adult spec or #) Korenman

Economic analysis of problems, challenges, and opportunities raised by an aging population in context of contemporary health, social, and economic policy debates.

5430. LABOR POLICY. (3 cr; prereq 5021 or equiv, grad student or adult spec or #) Kleiner

Analysis of public policies regarding employment, unions, and labor markets. Public programs affecting wages, unemployment, training, worker mobility, security, and quality of work life. Policy implications of changing nature of work.

5431. SOCIAL WELFARE ADMINISTRATION.

(3 cr; prereq grad student or adult spec or Δ)

Integration of service programs. Problems of simplification and integration of eligibility, service, fiscal, and planning functions of local administration. Concentration on federal welfare programs. Expenditure control, revenue maximization, program quality assurance, training, and retraining. Deinstitutionalization and community service strategies and programs of "long-term" populations.

5432. POVERTY AND PUBLIC POLICY. (4 cr; prereq grad student or adult spec or Δ; familiarity with economics and statistics recommended) Korenman
Measurement, extent, and distribution of poverty; causes of poverty; trade-offs faced by policymakers in reducing poverty; underclass literature.

5433. SOCIAL WELFARE REFORM AND INCOME SUPPORT POLICY. (3 cr; prereq grad student or adult spec or Δ)

Analysis of major issues, e.g., poverty, income redistribution, equality, criteria for evaluating programs, development and impact of current income maintenance systems; limited analysis of selected existing or proposed programs; policy alternatives and related consequences. Papers in memorandum form emphasizing analytical skills required.

5441. SURVEY OF WOMEN AND PUBLIC POLICY IN THE UNITED STATES. (4 cr; prereq grad student

or adult spec or Δ) Jones, Nelson
Gender, the state, and public policy; theories of social change and political action implied by various feminist theories; theories of difference and policymaking. Comparison of political activities in social movements, voluntary organizations, electoral politics, judicial politics, and bureaucracies. Elections and women's representation; reproductive rights; employment, taxes, and social programs; health; and politics of peace and war.

5442. SEMINAR ON WOMEN AND PUBLIC POLICY. (3 cr; prereq grad student or adult spec or Δ)

Nelson
Systematic presentation and evaluation of theoretical, historical, and policy-specific material relating to women and public policy, coupled with in-depth examination of one or more issues concerning women or gender considerations in public policy. Research paper required.

5491, 5492, 5493, 5494, 5495, 5496, 5497, 5498, 5499. TOPICS IN SOCIAL POLICY. (3 cr per qtr; prereq grad student or adult spec or Δ)

Advanced analysis of topics, e.g., juvenile justice, underclass issues, comparable worth policy, redesign of services, health care cost containment.

8441. SEMINAR: HIGHER EDUCATION POLICY. (3 cr; prereq #)

Analysis of major issues in higher education.

8451. SEMINAR: HEALTH CARE POLICY. (3 cr; prereq grad student or Δ)

Analysis of selected health policy issues. Description and assessment of current policies; proposing alternative solutions. Research papers required.

8491, 8492, 8493, 8494, 8495, 8496, 8497, 8498, 8499. WORKSHOP/SEMINAR: ADVANCED TOPICS IN SOCIAL POLICY. (3 cr per qtr)

Advanced analysis of topics, e.g., juvenile justice, underclass issues, comparable worth policy, redesign of services, health care cost containment.

Economic and Community Development

5501. ECONOMIC DEVELOPMENT I. (3 cr; prereq grad student or adult spec or Δ) Schuh

Introduction to theories on functioning of regional economies, role of government in economic change. Industrial location, development and growth, international and interregional trade, labor markets, migration, regional models, and government efforts to influence regional development.

5502. ECONOMIC DEVELOPMENT II. (4 cr; prereq grad student or adult spec or Δ) Assaad

Conceptual approach to economic development at national and regional levels. Interdependencies between developed and developing countries and effect of changes in global economy on national and regional economies. Competing theoretical paradigms and case studies from variety of contexts.

5511. COMMUNITY-BASED COMMUNITY AND ECONOMIC DEVELOPMENT. (3 cr) Cantrell

Community-based housing and economic development in larger context of neighborhood empowerment movement. Topics include role of community organizing, capital markets and community development, development techniques, and conflict between technical and political goals.

5522. DEVELOPMENT PLANNING. (3 cr; prereq PA or planning major or grad student or #, 5022 section 2, 5501 or 5502 or equiv) Assaad

Assumptions and techniques of development planning at national, regional, and project levels. Macroeconomic accounting and modeling, input-output analysis and social accounting matrices, project planning, cost-benefit analysis.

5591, 5592, 5593, 5594, 5595, 5596, 5597, 5598, 5599. TOPICS IN ECONOMIC AND COMMUNITY DEVELOPMENT. (Cr ar; prereq grad student or adult spec or Δ)

Advanced analysis of topics, e.g., specific client-related projects, Third World development, vitalization of distressed communities, industrial policy, capital markets, community-based economic development, neighborhood redevelopment, subsidies, and incentives.

5820. THE MULTINATIONAL CORPORATION.

(4 cr; prereq intermediate microeconomics, grad student or adult spec or Δ) Kudrle

Economic, political, social, and legal significance of multinational corporation; major policy options open to both individual and international bodies.

8591, 8592, 8593, 8594, 8595, 8596, 8597, 8598, 8599. WORKSHOP/SEMINAR: ADVANCED TOPICS IN ECONOMIC AND COMMUNITY DEVELOPMENT. (Cr ar)

See 5591, 5592, 5593, 5594, 5595, 5596, 5597, 5598, 5599 above for description.

Land Use and Human Settlements

5202. PLANNING METHODS. (4 cr) Lukermann

See Planning and Urban Affairs for description.

5601. LAND USE. (4 cr; prereq grad student or adult spec or Δ) Lukermann

Physical, spatial basis for community and regional development. Private sector development processes. Public regulatory frameworks, guidance, and interventional strategies. Integration of physical, social, and economic factors in land use policy, planning and decision making.

5602-5603. METROPOLITAN ANALYSIS I-II. (4 cr per qtr) Adams

See Planning and Urban Affairs for description.

5611. HOUSING POLICY. (3 cr; prereq grad student or adult spec or Δ)

Role of American national, state, and local governments in financing, control, taxation, and construction of housing.

5621. PRIVATE SECTOR DEVELOPMENT. (3 cr;

prereq grad student or adult spec or Δ) Smith
Developer's perspective, financial considerations. Role of local government, federal programs, and regulations. Land acquisition. Development management. Marketing. Citizen involvement.

5622. MANAGING URBAN GROWTH AND CHANGE. (4 cr; prereq grad student or adult spec or Δ)

Luce

See Planning and Urban Affairs for description.

5623. GEOGRAPHIC INFORMATION SYSTEMS.

(4 cr; prereq grad student or adult spec or #) Brown
Geographic information systems structure; theory and applications for geographic research, location and resource analysis, and regional planning; location principles, data structure, variable attributes.

5691, 5692, 5693, 5694, 5695, 5696, 5697, 5698, 5699. TOPICS IN LAND USE AND HUMAN SETTLEMENTS. (3 cr per qtr; prereq grad student or adult spec or Δ) Lukermann

Analysis of large-scale planned communities, agricultural preservation, historical preservation, infrastructure planning and programming, and urban transportation policy.

8691, 8692, 8693, 8694, 8695, 8696, 8697, 8698, 8699. WORKSHOP/SEMINAR: ADVANCED TOPICS IN LAND USE AND HUMAN SETTLEMENTS. (3 cr per qtr)

Analysis of large-scale planned communities, agricultural preservation, historical preservation, infrastructure planning and programming, and urban transportation policy.

Technology, Energy, and Environmental Policy

5701. SCIENCE AND STATE I. (3 cr; prereq grad student or adult spec or #)

See Planning and Urban Affairs for description.

5702. SCIENCE AND STATE II. (3 cr; prereq grad student or adult spec or #)

See Planning and Urban Affairs for description.

Graduate Programs

5711. ENERGY POLICY I. (4 cr; prereq grad student or # for undergrad) Abrahamson

Role of energy in contemporary societies; means to supply energy services; life-cycle costing; energy supply and use patterns in industrialized and nonindustrialized countries; fuel cycles, environmental and social impacts, resource base, and relationship to energy policy options. Primarily lectures and readings.

5712. ENERGY POLICY II. (4 cr; prereq 5711 or #) Abrahamson

Energy systems for industrialized and nonindustrialized economies. Primarily seminar.

5721. ENVIRONMENTAL POLICY I. (3 cr; prereq grad student or adult spec or #) Abrahamson

Major environmental issues and national and international responses; growing human enterprise; the changing climate, atmosphere, and hydrosphere; toxic and radioactive contamination; loss of biodiversity. Strategies for sustainable development.

5722. ENVIRONMENTAL POLICY II. (3 cr; prereq grad student or adult spec or #; 5721 not required) Geesaman

Historical, ideological, philosophical, and scientific themes of environmentalism and their relationship to environmental policy and law and contemporary political context.

5731. TECHNOLOGY POLICY. (3 cr; prereq PA or planning major) Archibald

Methodologies for exploring and assessing role of policy in development, diffusion, and adoption of technologies nationally and internationally; means to evaluate impacts of technology policy on sustainable economic growth and development, including social costs and benefits. Technological lock-in and increasing returns.

5741. ECONOMICS OF ENVIRONMENTAL AND RESOURCE POLICY. (4 cr; prereq PA or planning major) Archibald

Develops appropriate economic concepts, methodologies, and policy mechanisms and applies them to environmental and natural resource problems. Social-benefit cost analysis, cost-effective policy mechanisms for pollution control, policies for renewable and nonrenewable resource use.

5791, 5792, 5793, 5794, 5795, 5796, 5797, 5798, 5799. TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY. (3 cr per qtr; prereq grad student or adult spec or #)

Topics include hazardous waste, energy efficiency, nuclear technologies, and atmospheric carbon dioxide.

8791, 8792, 8793, 8794, 8795, 8796, 8797, 8798, 8799. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY. (3 cr per qtr)

Abrahamson, Geesaman
Topics include hazardous waste, energy efficiency, nuclear technologies, and atmospheric carbon dioxide.

Foreign Policy and International Affairs

5801. U.S. FOREIGN POLICY: PROCESS AND ANALYSIS. (3 cr; prereq Econ 3101, grad student or adult spec or #) Kudrle

Introduction to essential problems of political relations among states, overview of U.S. foreign policy process. Topics include national security policy and foreign economic policy.

5820. THE MULTINATIONAL CORPORATION.

(4 cr; prereq intermediate microeconomics, grad student or adult spec or #) Kudrle

See Economic and Community Development for description.

5830. U.S. FOREIGN ECONOMIC POLICY

ANALYSIS. (4 cr; prereq Econ 1001, Econ 1002 or #, grad student or adult spec or #) Kudrle
Policy problems facing U.S. decision makers in areas of trade, investment, aid, and monetary affairs; close attention paid to domestic political context.

5891, 5892, 5893, 5894, 5895, 5896, 5897, 5898, 5899. TOPICS IN FOREIGN POLICY. (Cr ar; prereq grad student or adult spec,)

Analysis of such topics as management of international organizations, practice of diplomacy, management of foreign posts, and reexamination of disarmament strategies.

8891, 8892, 8893, 8894, 8895, 8896, 8897, 8898, 8899. WORKSHOP/SEMINAR: ADVANCED TOPICS IN FOREIGN POLICY. (Cr ar)

Analysis of such topics as management of international organizations, practice of diplomacy, management of foreign posts, and reexamination of disarmament strategies.

General Courses

5691, 5692, 5693, 5694, 5695, 5696, 5697, 5698, 5699. TOPICS IN LAND USE AND HUMAN

SETTLEMENTS. (3 cr per qtr; prereq grad student or adult spec or #) Lukermann

See Land Use and Human Settlements for description.

5901. COMPUTER APPLICATIONS IN PUBLIC AFFAIRS. (2 cr; prereq PA or planning major or #) Finn

Comprehensive introduction to computer systems and applications as used in fields of public affairs.

8900. PUBLIC AFFAIRS INTERNSHIP. (1-6 cr [max 6 cr]; prereq PA or planning major, 5001, 5002, 5011, 5012, 5021, 5022 or #)

Supervised fieldwork in approved local, state, or federal agency, or private or nonprofit organization. Formal report on internship required.

8901. PLAN B PAPER TUTORIAL. (4 cr; prereq PA or planning major, 5001, 5002, 5011, 5012, 5021, 5022; S-N only)

Supervised research and writing for completing Plan B paper.

8910. INDEPENDENT STUDY. (1-3 cr [may be taken only once toward PA or planning MA]; prereq #) Individual reading or research project.

8998. SEMINAR: LEADERSHIP AND PROFESSIONAL PRACTICE IN PUBLIC AFFAIRS. (3 cr; prereq 8900, PA or planning major or #, completion of 36 cr incl internship) Roles, styles, and techniques of executive and policy leadership in public affairs. Emphasis on leadership of groups, organizations, public agencies, and movements; setting and managing public agendas; and cooperative strategies. Integrative function of leader in dealing with complexity and specializations, pluralism, and conflict. Ethical issues in professional practice and decision making.

Public Health (PubH)¹

Professor: Michael L. Baizerman; Robert W. Blum; Judith E. Brown; Stanley L. Diesch; Judith M. Garrard; Robert W. Jeffery; Robert W. ten Bensel; Robert L. Veninga

Associate Professor: Carolyn L. Williams, *director of graduate studies*; Mila A. Aroskar; Lester E. Block; Susan G. Gerberich; Barbara J. Leonard; Michael D. Resnick; Rexford D. Singer; Barbara A. Spradley

Adjunct Associate Professor: Lee E. Schacht

Assistant Professor: Debra G. Froberg; Patricia M. McGovern; Joan M. Patterson

Course of Study—Minor in public health, applicable to master's (M.A. and M.S.) and doctoral programs outside the School of Public Health.

Curriculum and Minor Requirements—Both the master's requirement of at least 12 graduate credits and the doctoral requirement of at least 21 graduate credits need to be taken from courses offered in the School of Public Health. The minor program is shaped to suit the particular needs and interests of the students with the proviso that a graduate-level course each in environmental health and in epidemiology be included. Suggested courses for this requirement include PubH

¹ *Inquiries concerning coursework leading to the master of public health or master of health care administration degree should be addressed to the associate dean of academic affairs of the School of Public Health, University of Minnesota, Box 197 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455. Applicants wishing to pursue an M.S. or Ph.D. degree in biostatistics; environmental health; epidemiology; health services research and policy (M.S.); or health services research, policy, and administration (Ph.D.) are referred to the separate listings for these programs in this bulletin.*

5151, PubH 5152, and PubH 5330.

Alternative courses may be substituted with the approval of the public health adviser and director of graduate studies.

Courses for the minor program should be selected from among those offered in the School of Public Health in consultation with a faculty adviser assigned by the director of graduate studies in public health. Early planning is important, as public health courses frequently have prerequisites or enrollment limitations. Public health courses offered outside the School of Public Health may be taken with the approval of the public health adviser and director of graduate studies.

Prerequisites for Admission—Admission to the public health graduate minor is contingent upon prior admission to a master's or doctoral degree-granting program within the Graduate School. Students enrolled in graduate programs within the School of Public Health are not eligible for this minor. Admission to the minor program is limited and only by permission of the director of graduate studies in public health.

Special Application Requirements—Contact the director of graduate studies in public health for an Intent to Enroll form. Students are encouraged to submit the form as early as possible before filing the student degree program for their major field of study. Enrollment is contingent upon approval by the director of graduate studies in public health and assignment of a minor program adviser.

Language Requirement—None specific to the minor program.

For Further Information and Applications—Contact the Student Services Center, School of Public Health, University of Minnesota, Box 819 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (612/626-3500 or 1/800/774-8636; fax 612/626-6931; e-mail sph-uofm@greg2.sph.umn.edu).

Graduate Programs

5003. FUNDAMENTALS OF ALCOHOL AND DRUG ABUSE. (2 cr, §3003, §3004, §5023; prereq educ major or #) Rothenberger

Lecture, discussion, and special readings on scientific, sociocultural, and attitudinal aspects of alcohol and other drug abuse problems. Incidence, high risk populations, prevention, and intervention.

5004. FIELD INSTRUCTION IN PUBLIC HEALTH. (Cr ar; prereq #)

Generalized, function- or discipline-oriented community experience under academic and professional supervision. Applying acquired knowledge and skills to relevant health issues and problems.

5005.* TOPICS IN PUBLIC HEALTH. (Cr ar; prereq #) Staff

Directed instruction. Selected readings in public health with discussion based on these readings.

5010. PUBLIC HEALTH APPROACHES TO AIDS. (3 cr; prereq upper div or grad-level student)

Rothenberger

Survey of HIV infection from public health perspective with emphasis on intervention.

5015. TOPICS IN INTERDISCIPLINARY STUDIES. (Cr ar; prereq #)

5017. CULTURE AND HEALTH BEHAVIOR. (3 cr; prereq grad student or #) Williams

For increasing cultural sensitivity regarding public health practice and individuals' health behaviors. Impact of cultural diversity on health behaviors. Etic (universal) and emic (culture-specific) approaches.

5020. PUBLIC HEALTH SOCIAL WORK INTEGRATIVE SEMINAR. (3 cr, §SW 5020; prereq grad student in public hlth or social work or dual-degree MSW/MPH student or #) Bracht

Integrated, synthesized public health social work philosophy; roles, function, knowledge, skills for practical application to major contemporary social health problems. Expansionistic, social epidemiological, conceptual problem analysis, and community intervention.

5022. PERSONAL AND COMMUNITY HEALTH.

(3 cr, §3001, §3004, §5023, §GC 3114; prereq educ major or #) Rothenberger
Fundamental principles of health conservation and disease prevention.

5023. BASIC CONCEPTS IN PERSONAL AND COMMUNITY HEALTH. (5 cr, §3001, §3003, §3004, §5003, §5022, §GC 3114; prereq educ major or #) Rothenberger

Scientific, sociocultural, and attitudinal aspects of communicable and degenerative diseases, environmental and occupational health hazards, and alcohol and drug problems. Role of education in health conservation, disease control, and drug abuse.

5026. PSYCHOSOCIAL APPROACHES TO HEALTH BEHAVIOR CHANGE. (3 cr; prereq for fall qtr: community hlth educ major or #; for spring qtr: student in public hlth or grad student in epi or HSRP or HSRP&A or biostats or environ hlth or #) Finnegan, Lytle

Foundations of community health education, with emphasis on individual behavior change.

5027. COMMUNITY AND ENVIRONMENTAL APPROACHES TO HEALTH BEHAVIOR CHANGE. (3 cr; prereq 5026, community hlth educ student or #) Wagenaar

Socioenvironmental factors influencing health-related behavior. Role of groups, institutions, and social structures in encouraging healthy or unhealthy behavior. Interventions to improve health behavior through changes in social environment; economic, social, and political structures and practices creating barriers to effective interventions.

5028. ORGANIZATIONAL AND INSTITUTIONAL SETTINGS OF COMMUNITY HEALTH EDUCATION. (3 cr; prereq 5026, 5027, community hlth educ student or #) Wolfson

Organizational and institutional factors that influence how community health interventions are conducted. Opportunities and constraints within which interventions are conducted.

5040. DYING AND DEATH IN CONTEMPORARY SOCIETY. (3 cr, §Hlth 5402, §Mort 5040, §HSU 5040; prereq hlth sci major or public hlth grad student or educ sr or mort sci major or #) Rothenberger

Concepts, attitudes, ethics, and lifestyle management related to dying, death, grief, and bereavement. Emphasis on preparing community health and helping professionals and educators for educational activities in this area.

5044. TOPICS IN ALCOHOL AND DRUG PROBLEMS. (1-4 cr; prereq #)

Individualized, directed instruction. Readings and discussion. (Not an appropriate substitute for PubH 3003, 3004, 5003, or 5023).

5049. LEGISLATIVE ADVOCACY SKILLS FOR PUBLIC HEALTH. (4 cr; prereq 5398, #) Forster

Introduction to state legislature as arena for public health practice; develops skills necessary to operate in that arena. Analyzes emergence, development, and resolution of legislative issues of public health importance.

5061. PREVENTION AND CONTROL OF ALCOHOL AND DRUG PROBLEMS. (3 cr; prereq public hlth student or #) Wolfson

Theory and practice. Approaches include education, citizen action, and public policy.

5097. TOPICS: SELECTED READINGS. (Cr ar; prereq hlth sci grad student)

Topic in health education not covered in available courses.

5150. TOPICS: ENVIRONMENTAL AND OCCUPATIONAL HEALTH. (Cr ar; prereq #) Greaves, staff

Selected readings and discussions of problems in environmental and occupational health.

5152. ENVIRONMENTAL HEALTH. (2 cr) Vesley
General principles of environmental health relating to macro and micro environments and products consumed or used by people.

5154. PRACTICUM IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH. (1-6 cr, §Nurs 5882; prereq environ hlth major or nursing grad student) Staff
Assignments working with organizations on environmental and occupational health concerns, under joint supervision of faculty adviser and organization staff.

5155. ISSUES IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH. (2 cr, §Nurs 5883; prereq public hlth or grad student or #) Olson
The field, current issues, and principles and methods of health protection. Independent field visits to observe, review, and analyze environmental and occupational health programs.

5156. ENVIRONMENTAL HEALTH SURVEY. (3 cr; prereq environ hlth major) Vesley
Survey of environmental health programs (macro- and microenvironment, products used and consumed by people) and controversial issues associated with these programs.

5158. HEALTH RISK EVALUATION. (3 cr; prereq environ hlth majors or #) Barber
General principles of health risk assessment and management: environmental pollutants; public domain and workplace, legislation and regulations.

5159. SEMINAR: ENVIRONMENTAL HEALTH. (2 cr; prereq environ hlth student) Staff

5165. THE POLITICAL PROCESS IN PUBLIC HEALTH. (3 cr, §5576; prereq public hlth or grad student or #) McGovern
Preparation for assuming leadership in health policy arena. Policy development; political, legislative, and regulatory processes; political strategies in public health.

5166. EMPLOYEE HEALTH SERVICES AND COST CONTAINMENT. (3 cr, §Nurs 5884; prereq occupational hlth nursing student or nursing grad student) McGovern
Trends in corporate health cost containment and their implications for planning and financing healthcare for employees and their families. Associated role development of occupational health nurse specialists.

5168. THEORY AND PRACTICE OF OCCUPATIONAL HEALTH: FIELD EXPERIENCE. (1 cr, §Nurs 5885; prereq 5167 or Nurs 5680) Olson
Arranged field experience, seminar. Applying occupational health and safety concepts.

5171. ENVIRONMENTAL MICROBIOLOGY. (4 cr; prereq MicB 3103 or #) Vesley
Survival, dissemination, transportation, and significance of microorganisms in the environment; application of principles to environmental health problems.

5181. AIR POLLUTION. (4 cr; prereq 2 yrs chem, general physics, calculus or #) Swackhamer
Overview of current air pollution problems, sources of pollutants, gas phase and aerosol phase chemistry, fate of pollutants, and human health and materials effects.

5184. MEASUREMENT OF AIRBORNE CONTAMINANTS IN WORKPLACES. (4 cr; prereq 5210, 5216 or #) Brosseau, Vincent
Lectures, lab, and field exercises involving calibration of field equipment for air contaminant analysis, inhalable and respirable aerosol mass sampling, dust counting and sizing, gas and vapor analysis, direct reading instruments, and sampling strategy.

5192. OCCUPATIONAL SAFETY. (3 cr) Olmstead
Development of occupational safety programs essential to health and safety of worker and integral to public health.

5194. INJURY PREVENTION IN THE WORKPLACE, COMMUNITY, AND HOME. (3 cr, §5594) Gerberich
Injury problems affecting public in workplace, community, and home; epidemiologic approach to strategies for prevention and control.

5195. SEMINAR: SAFETY IN THE WORKPLACE. (1 cr, §5595) Gerberich
Hazard analysis and prevention and control of injuries to the worker.

5197. TOPICS: INJURY PREVENTION IN THE WORKPLACE, COMMUNITY, AND HOME. (1-3 cr, §5597; prereq #) Gerberich
Selected projects: opportunity for students to pursue projects relevant to injury problems.

5198. SAFETY ENGINEERING FUNDAMENTALS. (3 cr) Shutske
Safety engineering design and control principles applied to injury and property loss prevention. Standards, guarding, systems analysis, fire protection, legal/ethical considerations, and engineering controls for noise, vibration, radiation, electrical, and mechanical hazards.

5201. RADIATION PROTECTION AND MEASUREMENT. (2 cr lect only, 3 cr lect and lab) Barber
Ionizing radiation sources, detection and measurement, protection principles, health implications.

5202. RADIATION LABORATORY. (1 cr; prereq 5201 or §5201) Barber
Radiation lab for 5201.

5210. INTRODUCTION TO INDUSTRIAL HYGIENE. (3 cr; prereq environ hlth major or student with background in physical sci or engineering or environ sci)
Theory and practice. Historical development of occupational health; role of legislation and regulations; recognizing, evaluating, and controlling hazards. Variety of hazards and industrial processes.

Graduate Programs

5212. VENTILATION CONTROL OF ENVIRONMENTAL HAZARDS. (3 cr; prereq 5210 or #) Vincent

Theory and application of exhaust ventilation for controlling airborne environmental hazards. Principles of air movement and mixing, design of appropriate ventilation controls, and techniques for measuring and evaluating controls. For environmental health, engineering, and other students interested in industrial hygiene.

5213. ERGONOMICS IN OCCUPATIONAL HEALTH. (2 cr)

Risks associated with failure to apply ergonomic principles; how to evaluate workspaces; principles to use when designing workspaces, tools, equipment; procedures to reduce the likelihood of specific injury types.

5216. PROPERTIES OF WORKPLACE AIRBORNE CONTAMINANTS. (3 cr; prereq environ hlth major or grad student with physical sci or engineering or environmental sci background) Brosseau, Vincent
Review of properties of aerosols and gaseous contaminants found in workplace atmospheres, exposure and health effects, monitoring, and ventilation for hazard control.

5218. FIELD PROBLEMS IN OCCUPATIONAL HEALTH. (3 cr, §Nurs 5886; prereq 5210 or 5211, environ hlth major or nursing grad student or #) Olson
Guided evaluation of potential occupational health problems; recommendations and design criteria for correction if indicated.

5233. BIOLOGICAL SAFETY. (2 cr; prereq #) Vesley
Assessment of risk; primary barriers; lab design criteria; safety devices and equipment; personnel practices; sterilization and decontamination; lab animals; and shipping and disposal of biohazardous agents.

5239. MICROBIOLOGY OF THE HUMAN ENVIRONMENT: SEMINAR. (1 cr; prereq #) Vesley
Topics of current research interest on infectious disease and injury prevention through environmental intervention.

5242. ENVIRONMENTAL HEALTH ASPECTS OF GROUNDWATER SYSTEMS. (2 cr) Singer
Groundwater geology, quality, and treatment, well design, construction, and maintenance; special references to public and environmental health problems.

5243. WATER AND HEALTH. (3 cr) Singer
Occurrences, health effects, and treatment of physical, chemical, and biological agents in transmission of waterborne diseases.

5250. ENVIRONMENTAL AND OCCUPATIONAL HEALTH MASTER'S PROJECT. (1-4 cr; prereq environ hlth major, #; S-N only) Staff
Directed study.

5253. INTRODUCTION TO HAZARDOUS WASTE MANAGEMENT. (3 cr) Thompson
Review of roles of public and private sectors as generators, disposers, and regulators of hazardous wastes. Includes definitions, sources, transportation, handling, treatment, recovery, disposal, and public health implications.

5255. HAZARDOUS MATERIALS MANAGEMENT. (3 cr; prereq 5253 or equiv, master's student in div of environ and occupational hlth or #) Brosseau

Proper management and use of hazardous materials. Overview of regulations concerning process safety, transport, air-water releases, hazard communication, and emergency response. Chemical properties and toxicity of hazardous materials, personnel protection, and air sampling techniques.

5261. GENERAL ENVIRONMENTAL TOXICOLOGY. (3 cr; undergrad biol course and some chem recommended)

Application of basic biochemical and physiological principles; assessment of potential health hazards; approaches to solution of problems.

5262. METABOLISM AND DISTRIBUTION OF XENOBIOTICS. (3 cr; prereq 5261 or #) Staff
In-depth examination of mechanisms and regulation of xenobiotic metabolism; kinetic models for distribution of toxicants and metabolites; receptor-mediated toxicity.

5271. OCCUPATIONAL EPIDEMIOLOGY. (3 cr; prereq basic epi, biostats) Mandel
Basic principles and concepts in ascertaining health effects in the workplace; review and discussion of strategies for identifying excess risk, evaluating strengths and weaknesses of research techniques, assessing bias and confounding.

5301. PERSPECTIVES: INTERRELATIONSHIPS OF PEOPLE AND ANIMALS IN SOCIETY TODAY. (2-3 cr, §3301, §CVM 3100, §CVM 5100)
Social, economic, and health consequences of people/animal relationships, including issues such as pets and people sharing an urban environment, animal rights, and influence of differences within cultures regarding animal/human relationships.

5330. EPIDEMIOLOGY I. (4 cr; prereq public hlth or pharmacy or med school or nursing or dentistry or grad student or #) Staff
Basic epidemiologic principles applicable to infectious and noninfectious disease; host-agent-environment complex; factors underlying spread of infectious disease; lab applications of statistical and epidemiologic methods.

5333. PRINCIPLES OF HUMAN BEHAVIOR I. (3 cr; prereq community hlth educ major or epi PhD student or #) Jeffery, Lando
Theoretical perspectives on etiology and modification of health behavior in individuals and communities.

5335. EPIDEMIOLOGY AND CONTROL OF INFECTIOUS DISEASES. (3 cr; prereq hlth sci grad student or #) Lifson
Principles and methods. Strategies for disease control and prevention, including immunization. Relevance of modes of transmission of specific agents for disease spread and prevention. Public health consequences of infectious diseases at local, national, and international levels.

5340. EPIDEMIOLOGY II: STRATEGIES AND METHODS. (4 cr; prereq 5330, 1 biostats course or #)

Folsom, Shahar
Measures of disease occurrence, and strategies and design principles of etiologic and evaluative studies. Measurement problems, interactions, sensitivity and precision, validity and the need for data specification and control of variables.

5341. EPIDEMIOLOGY III: INTERPRETATION OF DATA FROM EPIDEMIOLOGIC RESEARCH.

(4 cr; prereq 5340, 5420, 5454, epi major or #)
McGovern, Murray
Analysis and interpretation of data, including use of standard computer packages.

5348. WRITING RESEARCH GRANTS. (2 cr; prereq epi PhD or postdoc student or #) Luepker
NIH-type grants. Mechanics of grant development and writing, principles of informed consent, budget development, grant review process, and funding source identification.

5361. HOSPITAL INFECTION CONTROL. (2 cr; prereq # or current hospital employment; offered alt yrs)

Rhame
Pathophysiology, epidemiology, and control of nosocomial infection, including evaluation of hospital epidemics, prevention of device-related infections, surveillance of endemic infection, sterilization and disinfection, administrative issues, employee health, interaction with clinical lab, and isolation techniques. Emphasis on applied aspects. Course enhanced by hospital experience, but basic clinical background provided.

5363. COMPUTER APPLICATIONS IN EPIDEMIOLOGY. (2 cr; prereq epi major or #)

McGovern
Epidemiological data collection and analysis with emphasis on microcomputer applications. Creation, maintenance, and analysis of a dataset; statistical power calculations. Software includes SAS, Epi Info, Egret, and Excel.

5370. EPIDEMIOLOGY OF ALCOHOL AND OTHER DRUGS. (3 cr; prereq student in public hlth or pharmacy or med school or dentistry or grad student in epi or biostats or environ hlth or nursing or #)

Wagenaar
Population patterns regarding who uses which drugs, why they use them, and health consequences of alcohol and other drug use. Does not focus on treatment, care, rehabilitation, exploration of personal attitudes, or practices regarding alcohol or other drug use.

5381. GENETIC EPIDEMIOLOGY. (4 cr; prereq 5330, 5414 or equiv, college coursework in genetics)

Rich, Sellers
Etiology, distribution, and control of diseases in groups of relatives and inherited causes of disease in populations. Associations (case-control family studies), concordance (twin studies), disease transmission (segregation analysis), and gene localization (gene mapping).

5382. CLINICAL TRIALS II. (3 cr; prereq epi or biostats major or #) Grimm

Complement to 5462. History of trials, forming major and subgroup hypothesis, participant selection, clinical center issues, and ethical issues. Emphasis on critiquing clinical trials and trial proposals and designing outline for clinical trial that addresses specific hypothesis.

5383. PATHOBIOLOGY OF HUMAN DISEASES.

(4 cr; prereq student in public hlth or med school or dentistry or pharmacy or grad student in epi or biostats or environ hlth or nursing or #) Crow
Basic cell biology and pathology of human diseases. Immunology, infectious diseases, AIDS, cancer, hematology, diabetes, cholesterol, atherosclerosis, cardiovascular diseases, hypertension, nutritional diseases, pulmonary disorders, gastrointestinal disorders, liver diseases, and osteoporosis.

5384. HUMAN PHYSIOLOGY. (4 cr; prereq epi MPH student or epi PhD student or #) Crow

Basic human physiologic functions and mechanisms related to coronary heart disease, stroke, diabetes, exercise tolerance, and aging. Progressing from cellular function to organ function to coordinated body function. Consistency of internal environment, the need for homeostasis; adaptation to change, including chronic disease; energy use; integrated control systems; age and physiologic function.

5386. PUBLIC HEALTH ASPECTS OF CARDIOVASCULAR DISEASES. (3 cr; prereq 5330, 5450 or equiv) Elmer

Evaluating population studies and trials on cardiovascular diseases; modifiable risk factors for coronary heart disease; preventing other types of heart disease.

5387. CANCER EPIDEMIOLOGY. (3 cr; prereq 5330, 5340 or #) Potter, Robison

Epidemiologic aspects of cancer, including theories of carcinogenesis, incidence, site specific risk factors, and issues of cancer control and prevention.

5389. NUTRITIONAL EPIDEMIOLOGY. (3 cr; prereq 5330 or #) Elmer

Methodologic issues of exposure to nutrient intakes, biological basis for nutrition and disease relationships, studies of specific chronic diseases and nutritional intake, and analytic issues related to designing and interpreting studies using nutritional measures.

5390. SMOKING INTERVENTION. (3 cr; prereq epi or community hlth educ major) Lando

Impact of smoking on U.S. public health; overview of research on onset and prevention, factors maintaining dependence, cessation and intervention strategies, public health campaigns, public policies and second-hand smoking controversies, and international issues.

5391. INTRODUCTION TO BEHAVIORAL EPIDEMIOLOGY. (3 cr; prereq student in public hlth or med school or dentistry or pharmacy or grad student in epi or biostats or environ hlth or nursing or #) Staff

Theoretical, measurement, and research issues in behavioral epidemiology. Lifespan patterns in developing, changing, and maintaining behaviors related to major chronic diseases. Risk-related behaviors from epidemiologic perspective, using concepts of prevalence, incidence, risk, and trends.

Graduate Programs

5393. DESIGN AND ANALYSIS OF COMMUNITY TRIALS IN EPIDEMIOLOGY. (4 cr; prereq 5330, 5340, coursework in regression and analysis of variance or #) Murray

Design and analysis issues for epidemiologic studies evaluating effects of public health interventions applied at community level. Experimental and quasi-experimental designs and threats to validity that are important to these designs.

5394. MASS COMMUNICATION AND PUBLIC HEALTH. (3 cr, §Jour 5150; prereq credits in social or behavioral sci, PubH student or Jour grad student or #) Finnegan

Role, functions, and effects of mass media on public health; planned and unplanned effects; review of literature to understand how theories, models, and assumptions of mass communication research relate to public health.

5395. EPIDEMIOLOGY OF OBESITY. (3 cr; prereq public hlth student or grad student or #) Jeffery

Biological, psychological, and sociological determinants of obesity, role of obesity in acute and chronic disease, and implications of epidemiologic research for reducing obesity as public health problem.

5398. PUBLIC HEALTH POLICY AS A PREVENTION STRATEGY. (3 cr; prereq epi or community hlth educ or public hlth nutrition major or #) Forster

Philosophical, ethical, economic, political, and efficacy rationale for policy approach to prevention; historical and current application of prevention policy to public health problems.

5399. TOPICS IN EPIDEMIOLOGY. (1-4 cr; prereq basic epi, biometry or #)

One or more topics of current epidemiologic interest.

5404f. INTRODUCTION TO BIOSTATISTICS AND STATISTICAL DECISION. (4 cr; prereq HSRP&A student) Weckwerth

Variation; frequency distribution; probability; significance tests; estimation; trends; data handling; simple operations research applications. Statistical approach to rational administrative decision making. Lectures, lab exercises.

5409f. BIOSTATISTICS IN CLINICAL STUDIES.

(3 cr; prereq DDS or MD or DVM or PharmD or clinical nursing student) Keenan

Introduction to statistical treatment of data from dental, medical, and veterinary research. Tabular, graphical, and numerical descriptive methods; random sampling; principles of statistical inference; confidence intervals; statistical tests of hypotheses using t and chi-square distributions. Interpretation of statistical analyses in clinical literature.

5414f. BIOSTATISTICAL METHODS I. (4 cr, §5450; prereq MPH or public hlth grad student or #) Le

Basic quantitative methods for public health students, including tabular, graphical, and numerical descriptive methods; random sampling; principles of statistical inference; confidence intervals; statistical tests of hypotheses using t and chi-square distributions; interpretation of correlation and regression.

5415w. BIOSTATISTICAL METHODS II. (3 cr, §5452; prereq grade of B or better in 5409 or 5414 or 5450, MPH or hlth sci grad student or #) Zelterman
Continuation of basic statistical methods, including correlation, regression, analysis of variance and non-parametric tests. Introduction to use of computer packages for data analysis.

5420f. STATISTICAL COMPUTING I: USING STATISTICAL PACKAGES. (2 cr; prereq 5414 or §5414 or 5450 or §5450, health sci student, # for undergrads) Jeffries

Use of statistical computer package SAS for analysis of biomedical data. Data manipulation, description, and basic statistical analyses (t-tests, chi squares, simple regression).

5421w. STATISTICAL COMPUTING II: ADVANCED COMPUTATIONAL AND GRAPHICAL METHODS. (3 cr; prereq 5464, C or FORTRAN or #) Carlin

UNIX-Workstation-based computing and graphical methods for biostatistical analysis. Linear systems, numerical integration and differentiation, optimization, Monte Carlo methods, design and analysis of simulation studies. Familiarity with SAS and a high-level programming language.

5422s. STATISTICAL COMPUTING III: DATA COLLECTION AND MANAGEMENT. (3 cr; prereq 5420 or 5464, 5462) Connett, Neaton

Data collection methods, forms design, and data entry methods for clinical trials and epidemiological studies. Data editing methods, database design, and statistical report generation using NOMAD and SAS.

5450f,w,s. BIOSTATISTICS I. (4 cr, §5414; prereq Math 1111 or Math 1201, hlth sci student, # for undergrad) Jeffries, Kjelsberg, Thomas

Descriptive statistics; Gaussian probability models; point and interval estimation for means and proportions; hypothesis testing, including t-tests and chi-square tests; regression and correlation techniques; one-way analysis of variance; applications in health sciences using output from statistical packages.

5452w. BIOSTATISTICS II. (4 cr, §5415; prereq 5420, grade of B or better in 5450 or #) Jeffries

Analysis of variance and multiple regression for biological and health science data; estimation, testing, and prediction; underlying assumptions; model selection; applications.

5454s. BIOSTATISTICS III. (4 cr; prereq 5452, 5420 or equiv, #) Le

Analysis of categorical data; emphasizes log-linear models and inferences from observational data. Methods and applications of logistic regression and survival analysis, including Cox's proportional hazards model.

5456s. BIOSTATISTICS CONSULTING SEMINAR. (3 cr; prereq 5462, 5464, biostats student or #) Kjelsberg, Goldman

Roles and responsibilities of biostatistician as consultant and collaborator in health science research. Interpersonal communication. Consulting models and settings. Formulation of analysis problem.

5462w. CLINICAL TRIALS I. (3 cr; prereq 5452 or ¶5452 or 5465 or ¶5465, biostat or epi student or #) Neaton

Introduction and methodology of randomized clinical trials; design issues, case examples; operational aspects; elementary statistical methods and application to follow-up studies in medicine and public health.

5464. BIostatistical INFERENCE I. (4 cr, §5450; prereq Stat 5131 or ¶Stat 5131, biostat student or #)

Exploratory data analysis using SAS and S-Plus, ANOVA, and classical non-parametrics, multiple comparisons, and power and sample-size determinations.

5465. BIostatistical INFERENCE II. (4 cr, §5452; prereq Stat 5132 or ¶Stat 5132, biostat student or #)

Multiple regression, matrix notation, polynomials, diagnostics, splines, and ANOVA as regression.

5466. BIostatistical INFERENCE III. (4 cr, §5454; prereq Stat 5133 or ¶Stat 5133, biostat student or #)

Contingency tables, logistic regression, categorical outcome from cohort and case-control studies, and Poisson regression.

5470. TOPICS IN BIostatISTICS. (Cr ar; prereq #)

Selected readings with discussion based on these readings.

5605. PERINATAL HEALTH AND FAMILY PLANNING. (3 cr; prereq public hlth or grad student or #)

Perinatal and family planning issues, programs, services, and policies. Social, cultural, psychological, physical, environmental, economic, ethical, and political factors affecting family planning, pregnancy, and infant outcomes.

5606. HEALTH OF INFANTS AND YOUNG CHILDREN. (3 cr; prereq public hlth or grad student or #)

Major causes of mortality and morbidity, public health interventions, and public policies that prevent disease/injury and enhance health in infants and young children. American populations at risk. For students already well grounded in a health-related discipline.

5607. ADOLESCENT HEALTH: ISSUES, PROGRAMS, AND POLICIES. (3 cr; prereq public hlth or grad student or #) Leland, Story

Major public health issues and problems of adolescents in America; relationship between and among societal, political, economic, environmental, psychosocial, and cultural determinants that impact on adolescent health status and services.

5610. PRINCIPLES OF MATERNAL AND CHILD HEALTH. (3 cr; prereq public hlth or grad student or #) ten Bensel, staff

Introduction to current issues relating to health needs of families, mothers, and children, with emphasis on principles of primary care, health maintenance, preventive care, organization, and evaluation.

5613. CHRONIC ILLNESS AND CHILDHOOD DISABILITY. (3 cr; prereq public hlth or grad student or #) Patterson

In-depth look at the epidemiology, identification, management, follow-up, and prevention of chronic and handicapping conditions of children. Community programs for emotional, physical, and intellectual handicaps.

5614. FIELD EXPERIENCE IN MATERNAL AND CHILD HEALTH. (Cr ar; prereq MCH grad student) Staff

Field experiences selected by students to meet their career goals.

5616. RIGHTS OF CHILDREN AND YOUTH:

ABUSE AND NEGLECT. (4 cr) ten Bensel
Needs and rights of children and parents; neglect and abuse of children. Historical and legal aspects, identification and reporting procedures, family assessment and treatment modalities, follow-up processes, research, prevention, and implications for societal action.

5621. MATERNAL AND CHILD HEALTH SEMINAR. (1 cr; prereq maternal and child hlth grad student) Staff

Weekly discussion group allowing interaction between MCH students and faculty. Format decided by students; includes presentation of topics of student interest. MCH faculty members act as resource persons.

5623. PRINCIPLES OF MATERNAL AND CHILD HEALTH RESEARCH. (3 cr; prereq MCH student or #) Alexander

Methodological and theoretical issues related to MCH research. Facilitates student's development of master's project proposal.

5625. USE OF COMPUTERS IN PUBLIC HEALTH RESEARCH. (3 cr; prereq maternal and child hlth student, 5806 or equiv or #) Leland

Computer training for data analysis in public health quantitative research projects. Development of coding manual and data definition file; data entry, cleaning, and analysis; interpreting and reporting results.

5626. PERINATAL TOPICS: SECONDARY DATA ANALYSIS. (3 cr; prereq public hlth student, 5330,

5625, 5414 or 5450, 5806, 5621 or equiv, #) Alexander
Introduction to secondary data analysis. Investigation of research hypothesis using National Center for Health Statistics data files.

5627. ADOLESCENT HEALTH TOPICS: SECONDARY DATA ANALYSIS. (3 cr; prereq 5414 or 5450 or equiv, 5623, 5625 or equiv, 5806 or equiv, #) Leland

Introduction to secondary data analysis. Investigation of research hypothesis using National Center for Health Statistics data files.

5637. SEMINAR: CROSS-CULTURAL HEALTH ISSUES IN MINNESOTA. (3 cr; prereq hlth and

community professional) Eschwey, McIntosh
Lecture, discussion, readings, and group project in proposal writing. Health issues and "health culture" of Hmong, Hispanic, Black, and Native American communities in Minnesota. Focuses on cultural factors that influence health and health services.

Graduate Programs

5639. PREVENTION: THEORY, PRACTICE, AND APPLICATION IN PUBLIC HEALTH SERVICE.

(4 cr) Shanedling
Current issues and controversies concerning prevention and how it relates to health services. History, idea of prevention, terminology, life style intervention, programs and legislative issues, education, roles, and implications for societal action.

5641. VIOLENCE ACROSS THE LIFE CYCLE.

(1 cr)
Latest theories and practice. Follows ecological model: fetal, child, adolescent, spouse, and elder maltreatment; violence on television; and animal abuse. Emphasis on prevention programs.

5645. FAMILIES AND HEALTH. (3 cr; prereq student in public hlth or hlth sci or grad student in social or behavioral sciences or professional in hlth-related discipline or #) Patterson

Family theory and research on family's impact on health. Implications for primary and secondary prevention in public health and educational programs, clinical practice, and public policy.

5647. INDEPENDENT STUDY IN MATERNAL AND CHILD HEALTH. (Cr ar; prereq maternal and child hlth student or #) Staff

5648. TOPICS IN MATERNAL AND CHILD HEALTH. (Cr ar; prereq #)

Selected readings or individualized directed instruction.

5651. CRITICAL READINGS IN ADOLESCENT HEALTH SEMINAR. (2 cr) Resnick

Basic analytic tools for critical reading of peer-reviewed publications from variety of professional perspectives.

5655. SEXUAL ORIENTATION ISSUES FOR ADOLESCENTS. (3 cr; prereq BA or employment in educ or hlth or social service)

Adolescent sexuality and sexual orientation from perspective of individual identity; impact of community; response of youth-serving professionals toward gay/lesbian/bisexual youth and their families.

5660. GLOBAL ISSUES IN PUBLIC HEALTH: THE 21ST CENTURY. (3 cr; prereq public hlth or grad student or #)

Complex, global issues involving also the United States, including women's health, violence, new infections, environmental diseases.

5700.* FOUNDATIONS OF PUBLIC HEALTH ADMINISTRATION PRACTICE. (3 cr; prereq public hlth admin student or #) Block

Planning, organization, and administration of public health agencies at state level and how these agencies function in relation to public health at federal and local levels. Opportunity to interact with practicing public health administrators and specialists.

5701. PUBLIC HEALTH ADMINISTRATION II. (3 cr; prereq public hlth admin student or #) Staff

Issues, administrative problems, activities, structure of local and federal public health agencies.

5702. POLICY ISSUES IN PUBLIC HEALTH ADMINISTRATION. (3 cr; prereq public hlth admin student or #) Block

Policy development and implementation in public health-related agencies and organizations.

5707. INDEPENDENT STUDY: PUBLIC HEALTH ADMINISTRATION. (1-12 cr; prereq public hlth admin student or #) Staff

5711. PUBLIC HEALTH LAW. (4 cr; prereq public hlth student or #) Feinwachs

Basic concepts of the law, legislative process, legal bases for existence and administration of public health programs, legal aspects of current public health issues and controversies, and regulatory role of government in health services system.

5713. HMOs AND ALTERNATIVE DELIVERY SYSTEM MANAGEMENT II. (3 cr; prereq public hlth admin or hlth care admin student or #) Christianson

Management of HMOs, PPOs, and other new delivery systems. Quality assurance, legal and ethical concerns, financial aspects, marketing, and provider relations.

5727. HEALTH LEADERSHIP AND EFFECTING CHANGE. (3 cr, §HSU 5007; prereq public hlth student or grad student or #) Spradley

Application of broad theoretical base in planned change to solve managerial and organizational problems in students' roles as leaders in health professions.

5731. PUBLIC HEALTH PROGRAM PLANNING AND GRANT WRITING. (4 cr, §Nurs 5966; prereq public hlth admin student or nursing grad student or #) Staff

Knowledge and skills for planning health promotion and disease prevention programs and for writing grants to fund these programs. Uses PRECEDE-PROCEED Model as framework for program planning.

5732. REFORMING THE U.S. HEALTH CARE SYSTEM: COMPETITION, REGULATION, AND RATIONING. (3 cr; prereq public hlth or grad student or hlth-related professionals or #; offered alt yrs) Block

Impact of competition, regulation, rationing, and delivery of health services from perspective of patient, community, provider, and purchaser. Issues of quality, alternative delivery systems, behavior of providers, role of government and courts, ethics, and use.

5733. PUBLIC HEALTH INTERVENTIONS ACROSS THE LIFESPAN. (3 cr; prereq 5330, Nurs 8040 or #)

Synthesis of life cycle developmental approach and public health perspective with nursing and behavior change conceptual models to develop intervention models that are effective in addressing priority public health problems across the lifespan.

5734. ETHICAL DIMENSIONS OF PUBLIC HEALTH. (1 cr; prereq public hlth or grad student or #) Aroskar

Ethical issues and dilemmas that confront public health professionals and agencies. How ethics/values affect political, legal, economic, and cultural considerations.

5735. PUBLIC ETHICS/POLITICS AND PUBLIC HEALTH. (2-3 cr; prereq public hlth or grad student or #) Aroskar

Ethics/values related to decision making in public health interventions. Responsibilities of state in relation to health, politics as public ethics, and distributive justice in pluralistic society.

5736. THE ELDERLY: A HIGH RISK**POPULATION.** (3 cr, §Nurs 5782; prereq public hlth or grad student) Staff

Characteristics of people over 65 that place them at high risk for disability, institutionalization, and death. Health maintenance, rehabilitation, and alternatives to institutionalization.

5737. TOPICS: MULTIDISCIPLINARY**PERSPECTIVES ON AGING.** (4 cr, §AdEd 5440, §CPsy 5305, §PA 5414, §Soc 5960, §SW 5024)

Sociological, biological, and psychological aspects of aging; theories of aging; death and bereavement; issues and problems of older adults in the United States; human services and their delivery systems (health, nutrition, long-term care, education); public policy and legislation; environment and housing; retirement.

5738. TOPICS: ADULT HEALTH. (1-3 cr; prereq #)

Individualized directed instruction on selected problems and current issues in adult health.

5739. TOPICS: PUBLIC HEALTH**ADMINISTRATION.** (Cr ar; prereq public hlth admin student or #) Staff

Selected readings in public health administration. Discussion.

5742. MANAGEMENT OF HEALTHCARE**ORGANIZATIONS.** (3 cr; prereq hlth care admin student or #) Reiling

Role of hospital in delivery of health services and relationships with other elements of healthcare system. Problems of achieving results, governance, medical staff, and role of administrator.

5743. ETHICS IN HEALTHCARE**ADMINISTRATION.** (2 cr; prereq hlth care admin or public hlth admin student or #) Aroskar

Ethical perspectives in management of healthcare organizations; components of decision-making framework; application of framework to selected ethical issues; analysis of institutional mechanisms for dealing with ethical problems.

5744. PRINCIPLES OF PROBLEM SOLVING IN**HEALTH SERVICES ORGANIZATIONS.** (3 cr; prereq hlth care admin student or #) Dornblaser, staff
Lectures, seminars, and demonstrations on problem solving theory and technique. Management problem solving of cases. Solution of a management problem within health services organization and presentation of report.**5745. ADVANCED PROBLEM SOLVING PROJECT****IN HEALTH SERVICES ORGANIZATIONS.** (5 cr; prereq 5744) Dornblaser, staff
Student groups define, analyze, and solve significant senior management-level operational problems or health public policy problems in Twin Cities health services organizations.**5747. HUMAN RESOURCES MANAGEMENT.** (3 cr; prereq hlth care admin or public hlth admin student or #) Langan

Introduction to concepts in human resources management as applied to health services organizations. Relationship between human resources management and general management, nature of work, nature of human resources, compensation and benefits, personnel planning, recruitment and selection, training and development, employee appraisal and discipline, and union-management relations.

5749. LONG-TERM CARE ADMINISTRATION.**(3 cr; prereq hlth care admin or public hlth admin student or #) Grant**

Overview of research-based knowledge for administering and designing services and programs in long-term care organizations and hospitals.

5750. LONG-TERM CARE INDUSTRY. (3 cr; prereq

hlth care admin or public hlth admin student or #) Grant
Overview of organization, financing, and delivery of long-term care services to the aged. Demographic trends, financing structures, public policies, and solicited responses to long-term care issues.

5751. PRINCIPLES OF MANAGEMENT IN**HEALTH SERVICES ORGANIZATIONS.** (3 cr)

Veninga
Lectures and case studies on the role of healthcare services administrators, principles of management, and the administrative process.

5753. STRATEGIC MANAGEMENT IN THE**HEALTHCARE INDUSTRY.** (3 cr; prereq MHA

student or #) Goes
Seminar to evaluate application of organizational theory, organizational analysis, organizational behavior, and competitive analysis to providers, suppliers, and insurers in the healthcare industry.

5754. MARKETING HEALTH SERVICES. (3 cr;**prereq hlth care admin or public hlth admin student or #) Hillestad**

Managing marketing function: marketing planning, strategy, and management concepts. Identification of marketing problems and opportunities: construction, evaluation, and management of marketing plan.

5756. FINANCIAL ACCOUNTING IN HEALTH**ORGANIZATIONS.** (4 cr; prereq hlth care admin or

public hlth admin student or #) Tranter
Accounting principles and practices applicable to healthcare organizations with emphasis on hospitals and ambulatory care services; total financial requirements; cost-finding methodologies, third-party payor negotiation; internal control; internal and external financial reporting.

5757. MANAGERIAL ACCOUNTING IN HEALTH**ORGANIZATIONS.** (4 cr; prereq 5756, hlth care admin

or public hlth admin student or #) Portz
Budgeting for hospitals; operational, capital, and cash flow requirements for other healthcare organizations.

Graduate Programs

5758. STRATEGIC FINANCIAL PLANNING IN HEALTHCARE ORGANIZATIONS. (4 cr; prereq 5757, master of hlth care admin or public hlth admin student) Riley

Case studies and readings in the review and analysis of actual hospital financial statements, third-party payor costs reports, and other financial documents. Application of financial ratios to financial statement analysis.

5759. HEALTHCARE FINANCIAL MANAGEMENT (PRIVATE SECTOR EMPHASIS).

(4 cr; prereq 5756, 5757, MHA or public hlth admin or #; knowledge of spreadsheet software recommended) Connor

Principles of corporate finance and selected insurance concepts integrated and applied to healthcare with private sector emphasis. NPV, CAPM, capital and operating budgets, Medicare PPS and RBRVS, risk-adjusted capitation, healthcare reform.

5760. OPERATIONS RESEARCH AND CONTROL SYSTEMS FOR HOSPITALS. (3 cr, §HInf 5435; prereq 5404 or #) Potthoff

Decision-making framework for both operating and control systems in the hospital environment. Basic modeling techniques and examples of actual hospital applications.

5761. QUANTITATIVE METHODS APPLIED TO HEALTH ADMINISTRATION PROBLEMS. (3 cr; prereq basic stats) Weckwerth

Application of quantitative methods, including analysis of cyclicities, PERT, data handling systems, simple ANOVA, linear programming, cost-benefit analysis, and inventory control to solve health problems at administrative levels.

5762. INFORMATION TECHNOLOGY IN HEALTHCARE. (3 cr; prereq hlth care admin or public hlth admin or maternal and child hlth student or #) Potthoff

Aligning information technology (IT) with healthcare strategy, management processes, and operations. Analyzing organizational information needs; incorporating these needs into IT policy and planning; implementing IT policies.

5766. APPLIED FIELD RESEARCH I. (1 cr per sect; prereq hlth care admin student or #) Weckwerth
Under faculty supervision, students select topic of importance in healthcare administration and formulate research problem and approach for field study.

5767. APPLIED FIELD RESEARCH II. (2 cr; prereq MHA student or #) Weckwerth
Under faculty supervision, students investigate alternative methodological approaches to study of topic selected in 5766 and carry out field research project.

5768. APPLIED FIELD RESEARCH III. (2 cr; prereq 5767 or #) Weckwerth
With counsel of faculty adviser, students carry out research analysis of selected topic and prepare report on findings.

5770. TOPICS: HOSPITAL AND HEALTHCARE ADMINISTRATION. (Cr ar; prereq hlth care admin student or #) Staff

Selected readings in hospital and healthcare administration with discussion based on these readings.

5771. HEALTHCARE FINANCIAL MANAGEMENT (PUBLIC SECTOR EMPHASIS). (4 cr; prereq one college-level [3 cr] accounting course or #; knowledge of spreadsheet software recommended) Connor

Principles of finance and selected insurance concepts integrated into and applied to healthcare with public sector emphasis. NPV, public financing, capital and operating budgets, Medicare PPS and RBRVS, risk-adjusted capitation, and healthcare reform.

5772. HEALTH CARE ISNs. (3 cr; prereq hlth care admin student or #) Johnson

Growth and development of integrated health care systems based on an open-systems perspective of health organizations. Process of development and strategies of various organizational arrangements. Implications for roles of managers, trustees, and physicians.

5790. SOCIOLOGY OF MEDICINE AND HEALTHCARE: AN INTRODUCTION TO MEDICAL SOCIOLOGY. (4 cr, §Soc 5855) Litman

Social and psychological components of health and medical care. Organization and delivery of healthcare services, their problems and perspectives; focus on the patient, provider of care, and environment in which healthcare services are dispensed.

5791. PUBLIC HEALTH AND MEDICAL CARE ORGANIZATION. (3 cr; prereq public hlth or grad student) Resnick

Sociopolitical, economic, and moral/ethical issues confronting public health and medical care system in the United States. Trends in service provision, human resources, financing and health services organization, and implications for public health.

5792. HEALTH SERVICES ORGANIZATIONS IN THE COMMUNITY. (1 cr; prereq MHA student or #) Reiling

Lectures about and on-site visits to health services organizations; emphasis on role of organization and administrator.

5793. ECONOMIC ASPECTS OF HEALTHCARE. (3 cr; prereq intro microeconomics or #) Nyman
Economic analysis of America's healthcare sector, emphasizing problems of pricing, production, and distribution. Contributions of healthcare services to the nation's health.

5794. PUBLIC POLICY IN HEALTHCARE. (3 cr; prereq hlth care admin or public hlth admin student or #) Kralewski

Development and present status of selected public policy issues in social, economic, and political contexts. Alternative courses of possible public action reviewed and their outcomes assessed.

5796. LEGAL CONSIDERATIONS IN HEALTH SERVICES ORGANIZATIONS. (3 cr; prereq hlth care admin student or #) Feinwachs

Laws affecting administration of hospitals and other healthcare organizations; administrative law, corporate and business law, labor law, civil liability and tax-related issues. Legal issues relevant to the administrator, decision-making and planning process.

5806. PRINCIPLES OF PUBLIC HEALTH RESEARCH. (3 cr; prereq grad student or public hlth student in stats or vital stats or ¶) Garrard

Evaluation of public health research literature and planning for independent research projects. Formulation of research question, research design, sampling techniques, use of research concepts, and data analysis. Data collection techniques including questionnaires, interviews, and data analysis.

5852. PROGRAM EVALUATION IN HEALTH AND MENTAL HEALTH SETTINGS. (4 cr; prereq #) Garrard, Pirie

Overview of evaluation, models of evaluation, objectives of an evaluative study, sampling of subjects, methods of data collection, methodological designs, interpretation of data, preparation of final report, and ethical and political considerations.

5861. HEALTH INSURANCE. (3 cr; prereq intro course in microecon theory, grad student or #) Feldman, Nyman

Financing personal healthcare: theory of insurance, health insurance market, cost sharing, HMOs, PPOs, public and catastrophic health insurance, AIDS and insurance, the uninsured poor. Emphasis on public policy.

5862. COST-BENEFIT, COST-EFFECTIVENESS, AND DECISION ANALYSIS IN HEALTHCARE.

(3 cr; prereq 3-cr course in intermediate econ) Christianson

Applications of cost-benefit, cost-effectiveness, and decision analysis techniques in evaluating healthcare programs; government regulations; new technologies; diagnosis and treatment protocols. Strengths, limitations, and appropriateness of different approaches.

5863. QUALITY ASSURANCE. (2 cr) R L Kane, Lurie

History of approaches to assessing and assuring care quality. Recent activities concerning small area variation, outcomes, appropriateness, and effectiveness. Theory and specifics of alternative approaches and their interpretation.

5868. PRINCIPLES OF HEALTH SERVICES RESEARCH. (2 cr) R L Kane

Disciplinary contributions to health services; how health services research can influence policy; best case examples.

5870. SURVEY RESEARCH AND SAMPLE DESIGN IN HEALTH SERVICES RESEARCH.

(3 cr) Moscovice

General, technical, and theoretical context of survey research in health services research. Survey and sample design issues, with extensive use of case examples.

5881. TOPICS IN HEALTH SERVICES RESEARCH AND POLICY. (Cr ar; prereq #)

New course offerings, selected readings, or individualized directed instruction.

5900. PUBLIC HEALTH NUTRITION: PRINCIPLES AND PROGRAMS. (3 cr; prereq public hlth nutrition student or #) Krinke

Principles of public health nutrition, roles and functions of public health nutritionists, programs and delivery mechanisms for promoting nutritional status of populations. Students explore their beliefs and competencies in relation to principles and philosophy of public health nutrition.

5901. SEMINAR: PUBLIC HEALTH NUTRITION. (2 cr; prereq public hlth nutrition major or #)

Enhances critical thinking and problem-solving skills, increases understanding of current issues regarding nutritional health of public, and promotes interaction among faculty and students.

5902. MATERNAL AND INFANT NUTRITION.

(3 cr; prereq 3xxx nutrition course or equiv or #) Brown

Nutritional needs of childbearing women and infants, how to meet these through programs and services.

5905. HUMAN NUTRITION AND HEALTH. (3 cr;

prereq jr or sr or grad-level student) Brown

Science of human nutrition in relation to personal and community nutrition problems and concerns. Applied, introductory graduate-level course with labs.

5907. DIETARY ASSESSMENT. (2 cr; prereq public hlth nutrition major or #) Buzzard

Methods for assessing dietary intake of populations and individuals; appropriate uses of dietary assessment methods in various public health, clinical, and research settings; evaluation and interpretation of dietary data.

5908. ANTHROPOMETRIC ASSESSMENT OF NUTRITIONAL STATUS. (2 cr; prereq grad student,

5414 or 5450 or equiv) Himes

Anthropometry as used to assess nutritional status; taking basic measurements; practical experience in anthropometry; conceptual rationales and interpretation of anthropometric data.

5909. TOPICS: PUBLIC HEALTH NUTRITION.

(1-12 cr; prereq public hlth nutrition major or #) Staff

Faculty-supervised independent study in research topic.

5910. CRITICAL REVIEW OF RESEARCH IN PUBLIC HEALTH NUTRITION. (2 cr; prereq public hlth nutrition major or #, at least 1 grad course each in

research, biostats, epi) Himes

Application of principles of nutrition, epidemiology, and biostatistics to evaluation of scientific research in public health nutrition.

5914. NUTRITION INTERVENTION. (3 cr; prereq

nutrition course or #) Jeffery, Kushi

Selecting appropriate nutrition intervention strategies for health programs, applying them to target audiences, and evaluating their usefulness in relation to program objectives.

Graduate Programs

5932. NUTRITION: ADULTS AND THE ELDERLY. (3 cr; prereq 3xxx nutrition course or equiv or #) Krinke
Review of current literature and research on nutrient needs and factors affecting nutritional status of adults and the elderly.

5933. NUTRITION: HEALTH/DISEASE RELATIONSHIPS. (3 cr; prereq 5330 or equiv, FScN 5622 or MdBc 5201 or equiv or #) Kushi
Issues in nutrition and public health; biological and epidemiological bases for public health dietary recommendations. Relation of nutrition to heart disease, cancer, hypertension, obesity, and other conditions.

5934. ADMINISTRATIVE SKILL BUILDING. (3 cr) Splett
Processes that lead to administrative effectiveness; practical application in public health and human service programs. Community needs assessment, planning, budgeting, staffing, cost-effectiveness and cost-benefit analysis, decision making, and grant writing.

5935. CHILD AND ADOLESCENT NUTRITION. (3 cr; prereq grad-level student or #) Story
Current issues and literature. Major nutrition issues of youth; biological, cultural, and psycho-social factors influencing food behaviors; and strategies for improving nutritional health.

8150. RESEARCH: ENVIRONMENTAL AND OCCUPATIONAL HEALTH. (1-8 cr; prereq #) Staff
Opportunities to pursue research in the importance of environmental and occupational stresses on human health.

8185. ANALYSIS OF TOXICANTS. (3 cr; prereq #; offered alt yrs) Swackhamer
Application of principles of analytical chemistry to analysis of toxic chemicals in environmental samples, including air, soil, water, and tissue; survey of instrumental methods (gas and liquid chromatography, mass spectrometry, and atomic and molecular spectroscopy); interpretation of results; analytical quality control. Lecture, lab.

8191. RESEARCH: INJURY PREVENTION IN THE WORKPLACE, COMMUNITY, AND HOME. (1-8 cr; prereq #) Gerberich
Students develop independent and comprehensive research efforts relevant to injury prevention.

8192f, 8193w, 8194s. OCCUPATIONAL INJURY PREVENTION AND SAFETY RESEARCH SEMINAR. (1 cr per qtr; prereq environ hlth major or #) Gerberich, Maldonado
Facilitates student research in Occupational Injury Prevention and Safety Program (OIPSP) through interdisciplinary involvement of OIPSP engineering and public health students.

8261. MOLECULAR TOXICOLOGY. (3 cr; prereq 5262, Biol 5001, #)
Toxic actions and mechanisms of environmental chemicals at molecular level; current research in selective toxicity.

8264. HUMAN DISEASES CAUSED BY ENVIRONMENTAL AGENTS. (3 cr; prereq 5261, 5262, #) Greaves
Clinical presentation of disease; investigation of exposed populations and affected individuals.

8269. TOXICOLOGY SEMINAR. (1 cr; prereq 5262, 8261, #)
Evaluation of toxicological studies. Students present data from literature or their own research.

8330. RESEARCH: EPIDEMIOLOGY. (1-8 cr; prereq epi major) Staff
Opportunities offered by the School of Public Health and by various cooperating organizations for qualified students to pursue research work.

8331. FIELD PRACTICE IN EPIDEMIOLOGIC INVESTIGATIONS. (1-8 cr; prereq epi student) Staff
Supervised participation in epidemiologic investigations in the field under the auspices of official and voluntary health agencies.

8332. READINGS IN EPIDEMIOLOGY. (Cr ar; prereq epi major, #) Staff
Readings in current research articles on epidemiology.

8379. SEMINAR IN EPIDEMIOLOGY. (2 cr; prereq epi or physiological hygiene major) Staff
Discussion of selected current epidemiologic problems.

8389. SEMINAR: TOPICS IN EPIDEMIOLOGY. (3 cr; prereq epi or community hlth educ major; offered when feasible)

8420f. SURVIVAL ANALYSIS. (3 cr; prereq 5466 or equiv, Stat 5133) Le
Theory and applications of statistical methodologies in survival analysis, including estimation of survival curves and proportional hazards models. Application of parametric and non-parametric techniques in clinical trials and other health studies.

8421w. ANALYSIS OF CATEGORICAL DATA. (3 cr; prereq 5466 including SAS, Stat 5133) Waller
Analysis of categorical data with applications to clinical treatment evaluation, epidemiology, and other public health areas. Topics include log-linear, logit, and linear logistic models; power and robustness studied by exact and approximate methods.

8422w. MODERN NON-PARAMETRICS. (3 cr; prereq public hlth or grad student, 5466, Stat 5133 or #) Louis
Classical non-parametric inference, exact tests and confidence intervals for discrete data, robust estimates, the jackknife, bootstrap and cross-validation. Includes substantial computing, study of wide variety of models and applications, and formal development sufficient for understanding statistical structures and properties.

8430f. SEQUENTIAL ANALYSIS. (3 cr; prereq 8420, Stat 5133, FORTRAN, biostat student or #) Goldman, Grambsch, Louis
Design and analysis of clinical trials using sequential methods. Use of Monte Carlo methods for studying operating characteristics of sequential tests; illustrations include various types of data. Wald and likelihood ratio theory; specific problems with testing binomial proportions and normal means.

8431w. BAYES AND EMPIRICAL BAYES

METHODS. (3 cr; prereq theoretical stats or #) Carlin
Overview of Bayesian approaches to statistical inference and empirical Bayes methods for point and interval estimation. Computation and data analysis, including asymptotic methods, Monte Carlo methods, the Gibbs sampler, and biostatistical applications.

8432s. BIOASSAY AND SCREENING. (3 cr; prereq

theoretical stats or #; offered alt yrs) Louis
Properties of progressive disease models, including lead time produced by screening and length-biased sampling. Relates population screening and rodent bioassay models. Estimation approaches and study designs, including sequential methods. Examples include screening for breast cancer and cervical cancer.

8433s. ANALYSIS OF LONGITUDINAL DATA.

(3 cr; prereq Stat 5131-5132-5133 or equiv, Stat 8311-8312 or equiv or #; offered alt yrs) Grambsch, Thomas
Methods for analyzing longitudinal data, repeated measurement of a continuous variable over time or space. Multivariate analysis of variance, time series approaches, and Laird-Ware two-stage model for random effects. Emphasis on normal theory linear models.

8434. ADVANCED SURVIVAL ANALYSIS. (3 cr;

prereq 8420, Stat 5133 or equiv; offered alt yrs) Grambsch
Martingale methods and counting process theory as applied to survival data, including martingale foundations, statistical tests for comparing survival among groups, Cox proportional hazards model, diagnostics and analysis of residuals, multivariate survival data, and extensions to event history analysis.

8435f. SEMINAR IN CATEGORICAL DATA. (3 cr;

prereq Stat 5133, PubH 8421 or Stat 5421 or Stat 8431 or equiv course in categorical data or #) Zelterman
Topics of current research interest in analysis of categorical data. Readings from recently published statistical methodology.

8436s. SPATIAL BIOSTATISTICS. (3 cr; prereq 8420,

8421, experience with statistical computing packages such as BMDP or SAS, programming experience with FORTRAN or C) Waller
Introduction to statistical methodologies for analyzing spatial data. Tests for spatial autocorrelation, spatial prediction through kriging, random spatial processes, and tests for disease clustering.

8449. TOPICS IN BIOSTATISTICS. (Cr ar; prereq

5450, #) Staff
Special topics for advanced students.

8450. RESEARCH IN BIOSTATISTICS. (Cr ar) Staff

Opportunity for qualified students to pursue research work.

8750. SEMINAR: ALTERNATIVE PATTERNS OF

HEALTHCARE. (4 cr; prereq HSRP&A or MHA student or #) Litman
Alternative approaches to organization, financing, and delivery of ambulatory care, long-term care, maternal and child care, and mental health.

8760. TOPICS: HOSPITAL AND HEALTHCARE

ADMINISTRATION. (3 cr; prereq HSRP&A student) Staff
Independent study under tutorial guidance of selected problems and current issues in health and healthcare.

8761. READINGS IN THEORY AND PRINCIPLES

OF HOSPITAL AND HEALTHCARE
ADMINISTRATION. (3 cr; prereq HSRP&A student or #) Staff

8762w. CONTEMPORARY PROBLEMS OF

HOSPITAL AND RELATED HEALTH SERVICES.
(3 cr) Weckwerth
Current concepts, problems, principles, and future developments in health and healthcare.

8763. EXTERNAL FORCES AFFECTING HEALTH

SERVICES DELIVERY. (3 cr; prereq HSRP&A student or #) Weckwerth
Development of concepts, models, and principles of financing, social policy making, organizing, and human resource development for health services delivery, including written papers, oral presentations, and cross examination.

8764. RESEARCH APPLICATIONS TO HEALTH

SERVICES DELIVERY. (3 cr; prereq 8763)
Weckwerth
Tutorial guidance and supervised course development covering research design, application, analysis, and presentation in health services delivery.

8765. SEMINAR: ORGANIZATION AND

MANAGEMENT THEORY IN HEALTHCARE.
(3 cr; prereq advanced stats, HSRP&A PhD student or #) Goes
Organizational, managerial, and administrative theories applied to contemporary health services research problems.

8770s. SEMINAR: HEALTH AND HUMAN

BEHAVIOR. (3 cr; prereq HSRP&A student or 5790 or Soc 5855 or #) Litman
Sociology of health and healthcare; social and personal components of behavior in sickness and in health; community health; and the relationship of social and cultural factors in organization and delivery of healthcare services.

8780. ADVANCED STATISTICAL METHODS IN

HEALTHCARE RESEARCH. (3 cr; prereq 1 qtr each of applied and theoretical stats) Weckwerth
Survey and analysis of application of nonparametric statistics to healthcare research.

8782. RESEARCH PRACTICUM. (3 cr per qtr [max 6

cr]; prereq HSRP&A student or #) Litman, Weckwerth
Field experience in healthcare research. Supervised independent and team research on selected topics and problems in the field of healthcare.

8790.* SEMINAR: POLITICAL ASPECTS OF

HEALTHCARE. (3 cr; prereq HSRP&A student or #; offered winter of odd yrs) Litman
Interrelationships between government, politics, and healthcare; the political and social basis of health legislation and community decision making in provision and modification of health services.

Graduate Programs

8796. TOPICS IN HEALTH ECONOMICS. (3 cr; prereq MHA student or #) Dahl
General principles of health economics applied to current issues in health. Implications for health policy derived and discussed.

8801. SEMINAR: HEALTH SERVICES POLICY. (3 cr; prereq HSRP MS or HSRP&A PhD student or #) Kralewski, Moscovice
Overview of policy science. Evolution of health services policy in the United States, alternative policy-making models, and substantive policy areas.

8803. LONG-TERM CARE: PRINCIPLES AND POLICIES. (3 cr; prereq grad-level course in hlth care policy or #) R A Kane
Long-term care policy for functionally impaired persons, particularly the elderly. Team-taught from healthcare and social services perspective; grounded in research literature on evidence of program effects. Innovative programs addressing current disconnections.

8810-8811-8812+. SEMINAR: RESEARCH STUDIES IN HEALTHCARE. (4 cr; prereq HSRP MS or HSRP&A PhD student, Stat 5121, Stat 5122, Stat 5302 or # for 8810, 8810 or # for 8811, 8811 or # for 8812) Dowd, Finch
Review and appraisal of design, measurement, analysis, and findings of contemporary studies. Development and articulation of research proposal.

8813. MEASUREMENT OF HEALTH-RELATED SOCIAL FACTORS. (3 cr, §SAPH 8840; prereq intro stat course, understanding of simple correlations or #) Choi
How social factors such as innovativeness, compliance, religiosity, and stress are measured and tested for reliability and validity. Relationships between theory, concepts, variables, data.

8820. HEALTH ECONOMICS II. (3 cr; prereq 8761, 1 qtr calculus, 1 qtr linear algebra or #) Manning
Application of microeconomic theory to healthcare decisions of consumers and producers under different assumptions about market structure and behavior.

8821. HEALTH ECONOMICS III. (3 cr; prereq 8820 or #) Feldman
Examines application of microeconomic theory to health services research through selected reading from published and unpublished health economics literature.

8861. TOPICS IN THEORY AND PRINCIPLES OF HEALTH SERVICES RESEARCH, POLICY, AND ADMINISTRATION. (3 cr; prereq HSRP&A student or #)

8880. DIRECTED RESEARCH. (1-8 cr; prereq HSRP&A PhD student, #)
Guided research in health services research, policy, and administration.

8900. SEMINAR IN ADVANCED LIFE CYCLE NUTRITION. (3 cr; prereq 5902 or 5935 or 5932 or equiv) Staff
Methodological issues of applied human nutrition investigation, current status of knowledge, and implication of research results to public health policies, programs, and future research.

Quaternary Paleocology

Regents' Professor: Margaret B. Davis (ecology, evolution, and behavior); Eville Gorham (ecology, evolution, and behavior)

Professor: Subir K. Banerjee (geology and geophysics); Dwight A. Brown (geography); Edward J. Cushing (ecology, evolution, and behavior); Guy E. Gibbon (anthropology); Kerry R. Kelts (geology and geophysics); Richard H. Skaggs (geography); Peter S. Wells (Center for Ancient Studies); Herbert E. Wright (*emeritus*: geology)

Associate Professor: Robert C. Bright (ecology, evolution, and behavior; Bell Museum), *director of graduate studies*; Emi Ito (geology and geophysics); Janet D. Spector (anthropology)

Adjunct Associate Professor: Kenneth L. Cole (forest resources)

Assistant Professor: R. Lawrence Edwards (geology and geophysics); Katherine Klink (geography)

Course of Study—Minor in Quaternary paleocology, applicable to master's (M.A. and M.S.) and doctoral programs.

Curriculum—This minor offers a formal, structured interdisciplinary graduate curriculum for students specializing in Quaternary paleocology. The program focuses on the acquisition of skills that will permit the student to gather and interpret a wide variety of paleoecological data.

The minor program is developed by consultation among the student, the major adviser, and the director of graduate studies for Quaternary paleocology. Students with sufficient background and previous course experience equivalent to one or more courses within the curriculum may apply to the steering committee for waiver of appropriate requirements.

Prerequisites for Admission—Admission to the Quaternary paleocology graduate minor is contingent on prior admission to a Graduate School degree-granting program.

Special Application Requirements—Students already in residence at the University of Minnesota may apply by sending a letter of application to the director of graduate studies as well as a letter of recommendation from their current adviser. Students applying for admission to the University for the first time should send a letter of application to the director of

graduate studies as well as a copy of their University application documents, which are addressed to a University department.

Applications of new students are normally due by March 1 for consideration for acceptance into the minor for the following year. Resident students may apply any time.

Requirements for the Minor—Both doctoral and master's students are required to have introductory ecology (Biol 5041) or its equivalent. Doctoral students must take at least five of the courses listed below (at least three from the core courses) with the credits totaling 20 or more. Master's students must take at least three of the courses listed below (at least two from the core courses) with the credits totaling 12 or more. All students are required to maintain academic standards in accordance with Graduate School and department standards.

Language Requirements—None specific to the minor program.

For Further Information and Applications—Contact the Quaternary Paleoecology Graduate Program, University of Minnesota, 300 Bell Museum of Natural History, 10 Church Street S.E., Minneapolis, MN 55455 (612/624-1852).

Core Courses

- EEB 5004. EARTH SYSTEM: GEOSPHERE/BIOSPHERE INTERACTIONS
- EEB 5008. QUATERNARY ECOLOGY
- EEB 5016. ECOLOGICAL PLANT GEOGRAPHY
- Geo 5261. GLACIAL GEOLOGY
- Geo 8262. QUATERNARY PALEOECOLOGY AND CLIMATE

Soil 5515. SOIL DEVELOPMENT, CLASSIFICATION, AND GEOGRAPHY

A course in general climatology

An additional course in biogeography

Elective Courses

Climatology

- Geog 5423. CLIMATE MODELS AND MODELING
- Soil 5241. MICROCLIMATOLOGY
- Soil 5424. APPLIED CLIMATOLOGY

Paleoecological Methods

EEB 8014. PALEOECOLOGICAL METHODS

Geo 5155. VERTEBRATE PALEONTOLOGY II

PBio 8301. POLLEN MORPHOLOGY AND QUATERNARY PALYNOLOGY

Systematics

EEB 5129. MAMMALOLOGY

EEB 5136. ICHTHYOLOGY

Ent 5020. INSECT TAXONOMY

PIPa 5206. BIOLOGY OF FUNGI

Community Ecology

EEB 5014. ECOLOGY OF VEGETATION

Ecosystem Ecology

EEB 5608. ECOSYSTEMS: FORM AND FUNCTION

Limnology

CE 8505. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS

EEB 5601 or Geo 5601. LIMNOLOGY

EEB 5621. LIMNOLOGY LABORATORY

Geology

Geo 5255. GLACIOLOGY

Geo 5311. GEOCHEMICAL PROCESSES

Geo 5321. ISOTOPE GEOLOGY

Geo 5541. GEOMAGNETISM

Geo 5651. SEDIMENTOLOGY

Geog 5441. QUATERNARY LANDSCAPE EVOLUTION

Archaeology

Anth 5176. ENVIRONMENTAL ARCHAEOLOGY

Graduate Programs

Recreation, Park, and Leisure Studies

See Kinesiology and Leisure Studies.

Religious Studies (RELS)

Professor: Josef L. Altholz (history); Frederick M. Asher (art history); Bernard S. Bachrach (history); Ayers L. Bagley (social and philosophical foundations of education); Roland A. Delattre (American studies); Caesar E. Farah (history); Jasper Hopkins (philosophy); Theofanis G. Stavrou (history); James D. Tracy (history); Tzvee Zahavy (Classical and Near Eastern studies)

Associate Professor: William W. Malandra (Classical and Near Eastern studies); Jonathan Paradise (Classical and Near Eastern studies); Riv-Ellen Prell (anthropology); Philip H. Sellow (Classical and Near Eastern studies); Gayle G. Yates (American studies)

Course of Study—Minor in religious studies, applicable to master's (M.A. and M.S.) and doctoral programs.

Curriculum—The interdisciplinary graduate minor in religious studies is for master's and doctoral students in fields such as history, classics, English, anthropology, philosophy, and American studies and is shaped to suit the particular needs and interests of the student. Courses are selected in consultation with the director of graduate studies from RELS 5xxx courses as well as appropriate 8xxx courses in related fields.

Prerequisites for Admission—Admission to the religious studies graduate minor is contingent on prior admission to a master's or doctoral degree-granting program within the Graduate School.

Special Application Requirements—Students who wish to plan or declare a graduate minor in religious studies should contact the director of graduate studies in the Department of Classical and Near Eastern Studies, which provides the administrative home for the minor. The director of graduate studies must approve the applicant's proposed course of study and sign the student's degree program form.

Minor Requirements—Master's students must complete at least 12 graduate credits in approved courses in at least two areas of study. Doctoral students must complete at

least 20 graduate credits in approved courses in at least three areas of study and have a religious studies faculty member on their preliminary examination committees.

Language Requirements—None specific to the minor program.

For Further Information and Applications—Contact the director of graduate studies, Department of Classical and Near Eastern Studies, University of Minnesota, 330 Folwell Hall, 9 Pleasant Street S.E., Minneapolis, MN 55455 (612/625-5353).

5031. TRADITIONAL RELIGIONS OF INDIA. (4 cr, §1031, §3031, §SoAS 3031, §SoAS 5031) Malandra
Historical survey of India's pre-Islamic religious traditions with emphasis on Hinduism and Buddhism (Theravada and Mahayana). Religion in context of history, society, ideological systems, literature, and visual arts.

5032. BUDDHISM IN EAST ASIA. (4 cr, §EAS 5032; prereq jr or sr or #)
Origins of Buddhism in India, its spread and acculturation in China and Japan. Doctrines and practices, major sectarian divisions.

5036. RELIGIONS OF ISLAM. (4 cr, §3036, §MELC 3036, §MELC 5036) Farah
Evolution of Islam in historical context; institutions that made for diversity and continuity: traditions, law, and observances of the faith; sectarian movements; philosophical and theological trends; modern developments: reformist, revolutionary, and militant.

5071. GREEK AND HELLENISTIC RELIGIONS. (4 cr, §ANE 3071, §Clas 5071) Sellow
Greek religion of archaic, classical, and Hellenistic periods; eclipse of city-state and "failure of nerve"; mystery religions and impact of Eastern cults; ancient myths and need for allegory; ruler worship; Gnosticism; Judaism in Greek world; Dead Sea Scrolls.

5072. THE NEW TESTAMENT. (4 cr, §3072, §Clas 3072, §Clas 5072) Sellow
Early Jesus movement in its social and historical setting; origins in Judaism; traditions about Jesus; Paul, his controversies, and his interpreters; questions of authority, religious practice, and structure in early communities; apocryphal literature and emergence of scriptural canon. Contemporary methods of New Testament study. Ancient sources studied as evidence for constructing critical history and in an attempt to appreciate their narrative structures; other literary techniques.

5073. ROMAN RELIGION AND EARLY CHRISTIANITY. (4 cr, §3073, §Clas 3073, §Clas 5073) Sellev

Etruscans; republican religion; appeal of non-Roman cults; ruler worship; Christians in Asia Minor, Egypt, and the West; popular piety, Christian and non-Christian; Rabbinic Judaism; varieties of Christianity in second and third centuries; influence of Greco-Roman culture on emerging church; Constantine and Julian.

5101. RELIGION AND AMERICAN CULTURE.

(4 cr, §AmSt 5101) Delatire
Representative profile of past and present religion in America, organized around a theme or problem.

5111. INTERPRETATION OF MYTH. (4 cr, §Hum 5711; prereq jr or sr or #)

Structure and function of myths. Myth as social charter, ideological system, and literary form. Readings in classic theories of myth and primary sources from India, Iran, Mesopotamia, Greece, Africa, North and South America.

5112. INTERPRETATION OF RITUAL. (4 cr; prereq jr or sr or #)

Structure and function of rituals. Ritual as symbolic communication, religious action, and technique of social restructuring. Sacrifice; initiation; funeral; sacred dance. Theoretical and primary readings.

5151. RELIGIOUS ETHICS IN AMERICA. (4 cr; prereq jr or sr or #) Delatire

Representative range of contemporary approaches and traditions, with special attention to selected issues and historical background of major options.

5412. HINDUISM. (4 cr, §3412, §SALC 3412, §SALC 5412) Junghare

Development of Hinduism; sectarian trends, modern religious practices, myths and rituals, pilgrimage patterns and religious festivals, interrelationship of Indian social structure and Hinduism.

5413. BUDDHISM. (4 cr, §3413, §SALC 3413, §SALC 5413)

Historical account of Buddhist religion: its rise, development, various schools, and common philosophical concepts. Focuses on Indian Buddhism, compares it with Hinduism, and discusses its demise and revival on Indian subcontinent.

5414. COMPARATIVE RELIGIONS OF SOUTH ASIA. (4 cr, §3414, §SALC 3414, §SALC 5414; 3413 or SALC 3412 recommended)

Compares and contrasts basic philosophical concepts, literatures, ideologies, and ritualistic practices of Hinduism, Buddhism, and Jainism with those of Islam and Sikhism.

5505. ANCIENT ISRAEL: BACKGROUND OF THE BIBLE. (4 cr, §ANE 3505, §ANE 5505; prereq grad student or #)

Hellenistic period. Period of Ezra and Nehemiah, Samaritans, apocalyptic and other eschatological types; Maccabean period; Sadducees, Pharisees, Zealots, Christians, Qumran, wisdom literature; Philo, Josephus; Jewish rights during Roman Empire. Evaluation of sources for historical reliability. Knowledge of Hebrew not required.

5508. ISLAM: IRAN TO INDIA. (4 cr, §3508, §MidE 3508, §MidE 5508)

Islam as a faith; formation of Perso-Islamic civilizations; historical, religious, and cultural developments from Samanids to the revolution; Islam in South Asia; configuration of Indo-Islamic heritage; Sufi orders; syncretic and revivalist movements; challenges of modernity; contemporary Islam in India and Pakistan.

5521. PHILOSOPHY OF RELIGION. (4 cr, §Phil 5521; prereq 8 cr philosophy)

Grounds and sanctions of religion according to various philosophies.

5890. SEMINAR IN RELIGIOUS STUDIES. (5 cr for undergrads, 3 cr for grad students; prereq sr major or #)

Conceptual and methodological issues in contemporary religious studies.

5960. TOPICS IN RELIGIOUS STUDIES. (4 cr; prereq #)

5970. DIRECTED STUDIES. (3-5 cr per qtr; prereq #, Δ, □)

8970. DIRECTED STUDIES. (2-5 cr; prereq Δ)

Rhetoric and Scientific and Technical Communication

SCIENTIFIC AND TECHNICAL COMMUNICATION

Professor: Billie J. Wahlstrom, *head*; James E. Connolly; Alan G. Gross; Mary M. Lay; Earl E. McDowell; Victoria M. Mikelonis-Paraskov; L. David Schuelke; W. Keith Wharton

Associate Professor: Ann H. Duin, *director of graduate studies*; J. Michael Bennett; Richard W. Ferguson; Laurie S. Hayes; Arthur E. Walzer

RHETORIC AND SCIENTIFIC AND TECHNICAL COMMUNICATION

Professor: Karlyn K. Campbell (speech-communication); Shirley N. Garner (English); Michael F. Graves (curriculum and instruction); Alan G. Gross (rhetoric); Mary M. Lay (rhetoric); Earl E. McDowell (rhetoric); Victoria M. Mikelonis-Paraskov (rhetoric); Marshall S. Poole (speech-communication); Donald J. Ross, Jr. (English); L. David Schuelke (rhetoric); Robert L. Scott (speech-communication); Richard A. Swanson (vocational and technical education); Elaine E. Tarone (English as a second language); Billie J. Wahlstrom (rhetoric)

Associate Professor: Ann H. Duin (rhetoric), *director of graduate studies*; Christopher M. Anson (English); William A. Babcock (journalism and mass communication); John H. Beatty (ecology, evolution, and behavior); J. Michael Bennett (rhetoric); Lillian S. Bridwell-Bowles (English); Rita Copeland (English); Richard W. Ferguson (rhetoric); Laurie S. Hayes (rhetoric); Helen E. Longino (women's studies); Gregory C. Sales (curriculum and instruction); Thomas M. Scanlan (rhetoric); Arthur E. Walzer (rhetoric)

Assistant Professor: Simon R. Hooper (curriculum and instruction)

Graduate Programs

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—Scientific and technical communication, M.S. (Plan A and Plan B); rhetoric and scientific and technical communication, M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Two emphases are available in the scientific and technical communication (STC) master's program: theory and research in scientific and technical communication, and theory and practice in scientific and technical communication. Emphases in the master's and doctoral programs in rhetoric and scientific and technical communication (RSTC) are rhetorical theory, history, and criticism; culture and communication (international studies, gender studies, and science and technology studies); STC pedagogical theory and research; and STC communication management theory and research.

Prerequisites for Admission—All STC master's applicants are required to have a bachelor's degree from an accredited college or university; 30 credits in science, technology, mathematics, and/or engineering; 12 credits in advanced communication courses such as writing/editing, oral communication, visual communication, organizational communication, and communication theory; and 8 credits in computer science or management information systems, or demonstrated equivalent experience. All RSTC master's and doctoral applicants must have completed 12 credits in writing/editing or communication and 12 credits in science. The *Graduate Studies Handbook* detailing prerequisites is available from the department.

Special Application Requirements—Three letters of recommendation, scores from the General Test of the Graduate Record Examination, two writing samples, and a professional objective statement. Nonnative speakers of English are required to take the Test of English as a Foreign Language (TOEFL) and have satisfactory scores. The letters of recommendation and writing

samples may be used to support an application for financial aid. Admission to the M.S. program may begin in any quarter. M.A. and Ph.D. students will be admitted only in the fall quarter. Forms and instructions should be requested from the department. Students who wish to be considered for teaching assistant or research assistant positions should apply by February 1.

Master's Degree Requirements—The minimum requirement is 44 credits (normally 10 courses). For the M.S. degree with an emphasis on theory and research (Plan A), coursework must include Rhet 5180, 5500, 8110, 8210, 8510; 8 credits in a related field; 16 thesis credits; and additional rhetoric credits, totaling a minimum of 44 credits. For the M.S. degree with an emphasis on theory and practice (Plan B), coursework must include Rhet 5180, 8110, 8210, 8510; 8 credits in a related field; 8 credits in Rhet 8180 or 4 credits in Rhet 8181; and additional rhetoric credits, totaling 44 credits.

All M.A. students must take two courses in the rhetorical theory, history, and criticism core; one course in the culture and communication core; two courses from either the STC pedagogical theory and research core or two courses from STC communication management theory and research core; 8 credits in a related area; 16 thesis credits for Plan A or 8 project credits for Plan B; and additional rhetoric credits, totaling a minimum of 44 credits.

Doctoral Degree Requirements—Ph.D. students are required to earn 68 credits beyond the master's degree. This includes two courses in the rhetorical theory, history, and criticism core; Rhet 8100; one course in culture and communication (international studies core); 18 credits in a minor field or supporting program; and 36 dissertation credits. Students are required to demonstrate competency in a foreign language(s), a programming language(s), and/or statistics appropriate for dissertation research.

Language Requirements—For the master's degree, none. For the doctoral degree, see Doctoral Degree Requirements above.

For Further Information and Applications—Contact the Department of Rhetoric, University of Minnesota, 201 Haecker Hall, 1364 Eckles Avenue, St. Paul, MN 55108 (612/624-4761; fax 612/624-3617).

Rhet 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Rhet 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Rhet 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Rhetoric (Rhet)

5100. TECHNICAL COMMUNICATION: SPECIAL PROBLEMS. (Cr ar; prereq #, Δ) Staff
Supervised reading, research, and work on advanced technical communication projects not covered in regularly scheduled courses.

5105. CORPORATE VIDEO FOR TECHNICAL COMMUNICATORS. (4 cr; ¶3105)
Video production, including video team roles, production technology, and the development process. Students apply rhetorical principles in analyzing video, develop a treatment, write a script, and prepare an annotated bibliography on a video-related topic.

5165. STUDIES IN ORGANIZATIONAL COMMUNICATION, CONFLICT, AND CHANGE. (4 cr; prereq fr comm req or equiv or grad student) Schuelke

Roles of internal and external organizational communication, conflict-problem identification, and change processes. Contemporary theory and research in organizational development; problem identification and diagnosis. Change processes and applications to actual organizational settings.

5170. MANAGERIAL COMMUNICATIONS. (4 cr; prereq fr comm req or equiv or grad student) Wharton
Analyzing manager's position in organizational communication network. Possible forms, contexts, and functions of manager's communication. Emphasis on assessing and developing personal competence and confidence in managerial communication. Lectures, discussions, readings, experiential exercises, and field research.

5180. INTERNSHIP IN SCIENTIFIC AND TECHNICAL COMMUNICATION. (2-6 cr; prereq STC major or grad student, #, Δ) Staff
On-the-job experience at the University or in industry or government.

5257. SCIENTIFIC AND TECHNICAL PRESENTATIONS. (4 cr; prereq 1222, 3562 or grad student or #) Connolly, Schuelke
Presentations for specific situations related to technical or scientific topics. Audience analysis and adaptation, techniques of support and visualization, organization for clarity and accuracy, and techniques for interpreting and answering questions. Students make and evaluate technical and scientific presentations. Emphasis on seminar reports and professional conference papers.

5258. INTERVIEWING: DYNAMICS OF FACE-TO-FACE COMMUNICATION. (4 cr) McDowell
Improving intrapersonal and interpersonal skills in interviewing situations. Participation in appraisal, reprimand, complaint, persuasion, and problem-solving techniques; counseling interviews; and a research interview project. Equal emphasis on interviewer and interviewee roles.

5400. COMMUNICATION PROGRAM PLANNING AND EVALUATION. (4 cr; prereq jr or sr or grad student or work exper in communication) Schuelke
Examples, materials, and resources for planning, budgeting, and assessing organizational communication programs.

5500. RESEARCH IN COMMUNICATION STRATEGIES. (4 cr) McDowell
Introduction to research design and methodology in communication. Emphasis on application of various research methods to particular communication strategies or settings.

5531. SCIENTIFIC AND TECHNICAL COMMUNICATION COURSE DEVELOPMENT: PHILOSOPHY AND METHODOLOGY. (4 cr; prereq 3562, STC sr or STC or RSTC grad student or #; A-F only) Lay
Theories and methodologies as they relate to composition and scientific and technical communication. Emphasis on learning to teach first-year college students written or oral persuasive strategies. Students practice assignment and course development, justification, and evaluation.

5532. SCIENTIFIC AND TECHNICAL COMMUNICATION COURSE DEVELOPMENT: MENTORED TEACHING. (2 cr; prereq 5531, STC or RSTC grad student or #; A-F only) Lay
Under faculty mentor, students teach course units, prepare and evaluate course assignments, conduct conferences with student writers or speakers, and help oversee education within actual course.

5533. SCIENTIFIC AND TECHNICAL COMMUNICATION COURSE DEVELOPMENT: TEACHING SEMINAR. (1 cr; prereq 5532, STC or RSTC grad student or #; A-F only) Lay
Students share observations and solve teaching problems, usually concurrent with first teaching assignments.

5540. TOPICS IN SCIENTIFIC AND TECHNICAL COMMUNICATION. (Cr ar; prereq #)
Topics announced in *Class Schedule*.

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5560. EDITING FOR TECHNICAL COMMUNICATION. (4 cr; prereq STC premajor or major or grad student)
Introduction to editorial process; editor-writer relationship; copyediting; preparing scientific and technical documents; handling format, visuals, and quantitative materials.

5572. PROCEDURES AND POLICIES MANUAL. (3 cr; prereq STC major or pre-major, fr comm req, 3562 or grad student or #) Ferguson
Problem analysis, process management, gathering information, writing procedures, verification, constructing finished manual.

5573. GRANT PROPOSAL. (3 cr; prereq STC major, fr comm req, 3562 or grad student or #) Betsinger, Mikelonis-Paraskov
Writing the grant proposal, including establishing credibility, problem statement, program objectives, plan of action, evaluation, budget presentations, and proposal summary. Serves both real and hypothetical situations.

5575. NEWSLETTER. (3 cr; prereq STC major or pre-major, fr comm req, 3562 or grad student or #) Mikelonis-Paraskov
Newsletter design and production. Writing and editing newsletter articles. Hands-on experience in typography, graphic design, formatting, layout, and distribution procedures. Students produce a newsletter using Macintosh desktop publishing.

5581. DOCUMENT DESIGN. (4 cr; prereq 3562, STC or sr or grad student; A-F only) Duin
Designing a document to meet user's need, completing draft, and evaluating effectiveness. Forms and software documentation (user guides, reference manuals, tutorials, and input sheets) for databases, decision aids, computer-aided instruction, on-line programs, or visual displays. Mandatory lab time as part of project team of programmers, subject-matter specialists, and communication specialists.

5600. TRANSFER OF TECHNOLOGY. (4 cr; prereq work exper in scientific/technical comm or #) Schuelke
Methods of transferring scientific and technical knowledge and practice. Review of research in diffusion and transfer methods at different technical levels. Tools, methodologies, and assessment procedures for managing program. Assessment and design plan.

5680. GENDER AND THE RHETORIC OF SCIENCE AND TECHNOLOGY. (4 cr; prereq 1101 or equiv) Lay
How cultural gender roles and biological sex attributes influence communication within scientific and technical communities. Communication strategies of professional writers, scientists, and technologists.

5700. RHETORICAL THEORY: PERSUASION AND THE LITERATURE OF SCIENCE. (4 cr; prereq grad student, Q3700; A-F only) Gross, Walzer
Introduction to principles and history of rhetorical theory and criticism. Emphasizes classical theories, especially of Plato and Aristotle. Practice of rhetorical criticism of contemporary communication, including scientific communication. Contemporary scholarship in rhetoric of scientific and technical communication.

8100. RESEARCH METHODS IN RHETORIC AND SCIENTIFIC AND TECHNICAL COMMUNICATION. (3 cr; prereq STC or RSTC grad student or #) Gross, Lay, Wahlstrom
Nature of professionalism and of research in the field.

8110. THEORY AND RESEARCH IN AUDIENCE ANALYSIS. (3 cr; prereq STC or RSTC grad student or #) Ferguson
Review of research on human learning and understanding. Theories of audience analysis and preparation of written messages to reach defined audiences. Applications to problem-solving strategies in technical communication.

8120. READING AND WRITING PROCESSES AND THE TECHNICAL COMMUNICATOR. (4 cr; prereq 5160 or #) Duin
Theories of and processes involved in critical reading and writing in the workplace. Case studies of reading/writing processes of technical communicators and design of documents based on greater understanding of these processes. Potential effects of promoting higher-level reading and writing processes in the workplace.

8180. DESIGN PROJECT. (4 cr per qtr [8 cr req]; prereq STC Plan B grad student) Staff
Extended problem-solving situation in business, government, or industry in which student acts as consultant to explore a problem, identify possible solutions, introduce solution, and apply it. Scheduled workshops provide guidance, support, and research findings.

8181. STC CAPSTONE PROJECT. (4 cr; prereq STC Plan B student, #) Staff
Independent study course for synthesizing coursework, internship, and related area. Student plans, develops, and presents written and oral report describing the synthesis.

8210. THEORY AND RESEARCH IN MEDIA SELECTION. (3 cr; prereq STC or RSTC grad student or #) Duin, Wahlstrom
To assist technical communication problem solvers in decision making. Survey of media available for transmitting messages between communication sources and receivers and analysis of factors that influence media choices.

8258. INFORMATIONAL RESEARCH INTERVIEWING IN SCIENTIFIC AND TECHNICAL COMMUNICATION. (3 cr; prereq STC or RSTC grad student or #; A-F only) McDowell
Fundamentals of information-gathering and information-giving interviewing techniques, including interviewing process and types of interview guides and schedules, openings and closings, and sequences. Types of informational interviews: orientation, journalistic, probing, survey, and focus group.

8500. QUALITATIVE RESEARCH: STRATEGIES IN TECHNICAL COMMUNICATION. (4 cr; prereq STC or RSTC grad student or #) McDowell, Schuelke
Qualitative methods of communication research, including qualitative observation and analysis, unobtrusive methods, focus group research, and organizational climate assessment. Students develop, conduct, and report on systematic qualitative research project.

8510. THEORY AND PRACTICE IN DESIGNING MESSAGES. (3 cr; prereq STC or RSTC grad student or #) Mikelonis-Paraskov, Schuelke

Through case studies, how purpose and situation shape written discourse. Students develop and carry out strategies for delivering specific information to specific audience for specific purpose.

8515. TOPICS IN THE RHETORIC OF SCIENCE AND TECHNOLOGY: THEORY, HISTORY, CRITICISM. (3 cr; prereq 5700 or Spch 5611 or equiv) Gross

Relationship between rhetorical theory and practice of science and technology. Topics specified in *Class Schedule*.

8525. TOPICS IN CULTURE AND COMMUNICATION. (3 cr per qtr [max 9 cr]; prereq STC or RSTC grad student or #)

Topics, which vary, are drawn from international studies, gender studies, and science and technology studies. See *Class Schedule*.

8556. SEMINAR IN SCIENTIFIC AND TECHNICAL COMMUNICATION PEDAGOGY: THEORY AND RESEARCH. (3 cr; prereq 5531, 5532, 5533 or equiv; offered alt yrs)

Composition pedagogy research and theories that inform scientific and technical communication classroom and workplace. Students design, conduct, and evaluate research in a scientific and technical communication instructional setting.

Russian Area Studies

Professor: John S. Adams (geography); Anatoly Liberman (German); Thomas S. Noonan (history); Herbert L. Pick, Jr. (child development); Richard Rudolph (history); Theofanis Stavrou (history); Carol Urness (Bell Library); Rudolph Vecoli (history); Immigration History Research Center)

Associate Professor: Iraj Bashiri (Institute of Linguistics and Asian and Slavic Languages and Literatures); Irina Corten (Institute of Linguistics and Asian and Slavic Languages and Literatures); Gary R. Jahn (Institute of Linguistics and Asian and Slavic Languages and Literatures); Leonard A. Polakiewicz (Institute of Linguistics and Asian and Slavic Languages and Literatures); Miranda Beaven Remnek (Slavic bibliographer, University Libraries)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degree Offered—M.A. (Plan A and Plan B).

Curriculum—A wide range of courses are offered that deal with various aspects of the interdisciplinary study of the Russian area: language and literature, history, geography, political science, and economics.

Coursework consists of a prescribed selection of core courses in the various disciplines, courses in an area of specialization, and one seminar.

Prerequisites for Admission—A bachelor's degree from an accredited university or college is required.

Special Application Requirements—The following must be forwarded directly to the department: three letters of recommendation, a copy of one or more papers representative of current level of scholarly development, and a statement of the student's purpose. Scores from the General Test of the Graduate Record Examination are required.

Prospective students should contact the department for further information. Students are admitted each quarter.

Degree Requirements—Plan B students must take required courses in Russian literature (Russ 5421-5422), Russian history (two courses), and social science (Geog 5181 or equivalent, Pol 5471); take four further courses in one of the three areas of specialization (Russian history, Russian literature, or Soviet studies)—a list of acceptable courses is available from the department office; take one methodologies seminar (RAS 8061); demonstrate third-year-level proficiency in Russian by passing a special examination or earning a B or higher in specific coursework; and pass a final oral examination. Plan A students must fulfill these same requirements, except that they may take one less course in their area of concentration.

Plan A students must submit a thesis. Plan B students must submit three research papers (Plan B papers). Plan A theses and Plan B research papers should display familiarity with all the relevant bibliography on the topic, an awareness of the major issues, sustained analysis, substantial research in Russian language sources, and the use of other research and language tools where appropriate. Plan A theses and Plan B research papers must be read and approved by two members of the department's graduate faculty.

Graduate Programs

For Further Information and Applications—Contact Russian Area Studies, Area Studies Programs, University of Minnesota, 214 Social Sciences Building, 267 19th Avenue S., Minneapolis, MN 55455 (612/625-8543).

RAS 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Russian (Russ)

5104. INTRODUCTION TO LITERARY ANALYSIS. (4 cr; prereq 3103 or ¶3rd-yr Russian) Jahn
Reading and analysis of selected poetry and prose; rudiments of studying Russian literature.

5105. READINGS IN RUSSIAN POETRY AND PROSE. (4 cr; prereq 3106 or equiv) Jahn
Masterpieces of modern Russian poetry and prose, in the original. Lectures and discussions primarily in Russian. Students expected to have high-intermediate or advanced standing in Russian.

5106. CONTEMPORARY RUSSIAN LITERATURE AND CULTURE. (4 cr; prereq 3 yrs Russian, # for native speakers) Corten
Current cultural and social issues in Russia through analysis of literary works and texts and Russian newspapers and periodicals. Taught in Russian.

5211. MODERN RUSSIAN LITERATURE IN TRANSLATION. (4 cr) Corten
Literary merit as well as cultural and political significance of the important works of Soviet Russian literature (1917 to present) by officially accepted and dissident authors.

5401. DOSTOEVSKY IN TRANSLATION. (4 cr) Jahn
An analytic approach to the novels.

5404. TOLSTOY IN TRANSLATION. (4 cr) Jahn
Novels, stories, and dramas.

5407. STORIES AND PLAYS OF ANTON CHEKHOV IN TRANSLATION. (4 cr) Polakiewicz
An intrinsic approach to the prose works and major plays.

5409. THE 19TH-CENTURY RUSSIAN NOVEL IN TRANSLATION. (4 cr) Polakiewicz
The Russian realistic novel from its origin to its decline; social, political, and intellectual circumstances that led to its emergence as the dominant genre of the "Age of Realism" in Russia.

5421. LITERATURE: MIDDLE AGES TO DOSTOEVSKY IN TRANSLATION. (4 cr, §3421) Jahn
Russian literature from about 1,000 A.D. through mid-19th century, emphasizing writers of first half of 19th century.

5422. LITERATURE: TOLSTOY TO THE PRESENT IN TRANSLATION. (4 cr, §3422) Corten
Russian literature from mid-19th century to present: Realism, Modernism, Socialist Realism, and other developments since 1917, with view to language evolution and change.

5601. TRANSLATING FICTION FROM RUSSIAN TO ENGLISH. (4 cr; prereq 3 yrs college-level Russian or equiv, #) Corten
Stylistic study of selected passages from 19th-century Russian classics and artistically suitable ways of rendering them in English. Individual projects translating modern Russian short stories into English with view to possible publication.

5970. DIRECTED READINGS. (1-5 cr per qtr; prereq upper div or grad student, #)

Russian Area Studies (RAS)

8061. SCOPE AND METHODS OF RUSSIAN AREA STUDIES. (4 cr)
Subfields, problems, and methodologies.

Area Studies (Area)

5950. TOPICS IN RUSSIAN AREA STUDIES. (4 cr)
Topics in various disciplines of social sciences and humanities.

5970. DIRECTED STUDIES. (1-15 cr per qtr; prereq #, Δ, CLA approval)
Guided individual reading or study.

5990. DIRECTED RESEARCH. (1-15 cr per qtr; prereq #, Δ, CLA approval)

Central Asian Studies (CAS)

5311. MEDIEVAL SAGES: IRAN AND CENTRAL ASIA. (4 cr; prereq some background in Iranian or Central Asian or Islamic studies) Bashiri
Intellectual life of the region from rise of the Ghaznavids (1000 A.D.) to fall of the Timurids (1500 A.D.).

5541. RUSSIA AND CENTRAL ASIA. (4 cr)
Rise and fall of Mongol Empire, formation of Chaghatai Khanate and Golden Horde. Russian expansion into Central Asia and rivalry with Britain leading to the "Great Game." Russia and republics during Soviet period and after.

5601. FICTION: IRAN AND CENTRAL ASIA. (4 cr, §MELC 5601) Bashiri
Social, political, and religious thought of Iranian and Central Asian fiction writers since beginning of 20th century, emphasizing themes of tradition, modernization, women's rights, and secularization.

5900. READINGS IN AN IRANIAN LANGUAGE. (1-4 cr per qtr [12 max cr], §Pers 5900; prereq Pers 3013 or #) Bashiri
Premedieval and medieval Iranian texts. Topics specified in *Class Schedule*.

5990. DIRECTED RESEARCH. (Cr ar; prereq #)

Polish (Plsh)

5900. TOPICS. (4 cr)
Topics specified in *Class Schedule*.

5970. DIRECTED READINGS. (1-4 cr per qtr; prereq #, Δ, CLA approval)

Slavic (Slav)

5900. TOPICS IN RUSSIAN AND EAST EUROPEAN STUDIES. (4 cr per qtr [max 12 cr])
Topics specified in *Class Schedule*.

8601-8602†. INTERDISCIPLINARY SEMINAR IN SLAVIC AREA STUDIES. (4 cr per qtr; prereq grad in Russian area studies or #)

Required of graduate students in Russian area studies.
Topic varies yearly. Must be completed in same academic year.

Required Distribution Courses

(Offered through other departments)

Geog 5181. RUSSIA AND ENVIRONS. (4 cr) Adams

Pol 5471. POLITICS OF RUSSIA AND THE COMMONWEALTH OF INDEPENDENT STATES. (4 cr; prereq 3051 or non-pol sci grad student or #)
Davidheiser

Scandinavian Studies (Scan)

Professor: Nils Hasselmo; Poul Houe; Anatoly Liberman (German); Göran Stockenström

Associate Professor: Kaaren Grimstad; William Mishler; Mariann Tiblin (Wilson Library)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan B only) and Ph.D.

Curriculum—The master's program is offered in Scandinavian studies. Students in the master's program emphasize one of the three Scandinavian languages and literatures, while acquiring a thorough general knowledge of the other two. An M.A. program may also include Finnish. The program gives the student the opportunity to explore areas of personal interest. Students in the Ph.D. program concentrate on topic areas chosen in consultation with their adviser and the department's graduate faculty.

Prerequisites for Admission—Prospective students usually hold a bachelor's degree in Scandinavian or have some formal study of Scandinavian languages and literature at the undergraduate level. Applicants whose preparatory work shows gaps that can be remedied may be asked to complete supplemental work before admission.

Special Application Requirements—Three letters of recommendation from individuals qualified to discuss the applicant's academic performance, a complete set of transcripts (in addition to those sent to the Graduate School), Graduate Record Examination scores, a copy of one or more papers representative of the applicant's current level of scholarly development, and a statement of professional goals are required. Students generally are admitted in the fall quarter only. Applications for the Graduate School Fellowship and teaching assistantships must be received by January 15.

Master's Degree Requirements—Students are expected to acquire a thorough knowledge of the Scandinavian or Finnish languages and literatures through seminars and courses and through the aid of a department reading list. Specific requirements include a knowledge of Old Norse equivalent to the two quarters offered by the department, two courses in literary criticism, a course in the history of the Scandinavian languages, and two courses outside the Scandinavian program. A written and an oral final examination are required.

Doctoral Degree Requirements—Generally, no more than 44 credits beyond the M.A. are required. Additionally, applicants must earn at least 18 credits in a minor or supporting program outside the Scandinavian program. In consultation with an advisory committee, the doctoral student in Scandinavian languages and literature develops four research topics or fields of inquiry. One of these topics is the projected thesis topic. Students must complete two courses in literary criticism (which may be taken as part of the master's program) and demonstrate competence in the history and development of the Scandinavian languages.

Language Requirements—For the master's degree, a reading knowledge of one modern language in addition to the Scandinavian languages or Finnish is required. Finnish or Icelandic is acceptable if the primary language is a Scandinavian one; any modern Scandinavian language if Finnish is the

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primary one. For the doctoral degree, two non-Scandinavian languages, one of which must be German or French, are required in addition to the Scandinavian languages and Old Norse.

Minor Requirements for Students

Majoring in Other Fields—The approval of the director of graduate studies is a prerequisite for minor work in the field. Coursework usually consists of no more than 12 credits for an M.A. minor and an additional 12 credits for a Ph.D. minor.

For Further Information and

Applications—Contact the Department of German, Scandinavian, and Dutch, University of Minnesota, 205 Folwell Hall, 9 Pleasant Street S.E., Minneapolis, MN 55455 (612/625-2080; fax 612/624-8297).

Courses identified by the §§ symbol do not require knowledge of the Scandinavian languages except for majors in Scandinavian. Courses in Scandinavian area studies are offered on a regular basis. For further information, see art history, geography, history, political science, and sociology.

Scan 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Scan 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5201. §§SCANDINAVIAN LITERATURE FROM THE LATE MIDDLE AGES TO THE ENLIGHTENMENT. (4 cr; prereq reading knowledge of a Scandinavian language for Scandinavian grads) Houe
Representative literary works from the 14th century to Bellman and Holberg.

5202. SCANDINAVIAN LITERATURE FROM ROMANTICISM TO THE MODERN BREAKTHROUGH. (4 cr; prereq reading knowledge of a Scandinavian language for Scandinavian grads) Houe
Romantic and early realistic authors.

5421. FINNISH FOLKLORE: THE KALEVALA. (4 cr; offered alt yrs)
Finnish national epic from a folkloristic point of view. Reading in translation.

5501. §§SCANDINAVIAN MYTHOLOGY. (4 cr) Grimstad
Scandinavian myths based on the Poetic Edda and Prose Edda. All readings in translation.

5502. §§THE ICELANDIC SAGA. (4 cr) Grimstad
The saga literature, its origins and development. Readings in translation.

5511. SKALDIC POETRY: ITS METHOD. (4 cr; prereq a reading knowledge of Old Norse; offered when feasible) Liberman

5512. §§THE POETIC EDDA. (4 cr; prereq reading knowledge of Old Norse) Grimstad
Poems from the Poetic Edda (texts in Old Norse).

5611. §§SCANDINAVIAN LITERATURE IN ITS EUROPEAN CONTEXT: REALISM. (4 cr; offered alt yrs) Stockenström
Breakthrough of realism in Scandinavian literature in its European context. Representative European literary texts from the 19th century—dramas, novels, and criticism—read in translation.

5613. §§CONTEMPORARY SCANDINAVIAN LITERATURE. (4 cr) Mishler
Major trends after 1945. Readings in translation for nonmajors.

5614. §§THE DRAMA OF IBSEN AND STRINDBERG. (4 cr) Stockenström
Later plays viewed in context of modern art and theatre with emphasis on different methods of visualizing the landscape of the soul on stage.

5615. §§IBSEN AND THE BEGINNINGS OF THE MODERN DRAMA. (4 cr) Stockenström
The plays of Ibsen; his role as the founder of modern European drama. Readings in translation for nonmajors.

5616. §§STRINDBERG AND THE DRAMA IN REVOLT AND TRANSITION. (4 cr) Stockenström
Strindberg as master of the naturalistic drama and as the father of modernity in European and American theatre.

5617. §§SCANDINAVIAN LITERATURE IN ITS EUROPEAN CONTEXT: SYMBOLISM. (4 cr; offered alt yrs) Stockenström
Representative European literary texts from late 19th and early 20th centuries—dramas, novels, and criticism—read in translation.

5618. §§MODERN SCANDINAVIAN DRAMA. (4 cr) Stockenström
Scandinavian plays from the 20th century.

5619. §§SCANDINAVIAN POETRY SINCE 1890. (4 cr; prereq grad student, reading knowledge of a Scandinavian language) Houe, Mishler
Representative poets since 1890.

5631. §§NINETEENTH-CENTURY SCANDINAVIAN NOVEL. (4 cr) Houe, Mishler
Development from beginnings to end of 19th century. Readings in translation for nonmajors.

5632. §§TWENTIETH-CENTURY SCANDINAVIAN NOVEL. (4 cr) Houe, Mishler
Novels of Hamsun, Strindberg, Lagerkvist, others. Readings in translation for nonmajors.

5670. §§TOPICS IN SCANDINAVIAN STUDIES.

(4 cr per qtr)

Topics announced before first class meeting. Readings in English for nonmajors. Meets with 3670.

5701-5702. OLD NORSE LANGUAGE AND LITERATURE.

(4 cr per qtr) Grimstad

Acquisition of a reading knowledge of Old Norse; linguistic, philological, and literary study of Old Norse language and literature.

5703. OLD NORSE: SAGA READING AND ANALYSIS.

(4 cr; prereq 5702; offered alt yrs) Grimstad

(Continuation of 5702) Prose narrative in Old Norse; its literary content.

5704. HISTORY OF THE SCANDINAVIAN LANGUAGES.

(4 cr)

Scandinavian languages from the early Middle Ages to the present; cultural history. Readings in translation for nonmajors.

5711. STRUCTURE OF THE SCANDINAVIAN LANGUAGES.

(4 cr; prereq introductory course in linguistics or #)

Syntax and phonology of standard Danish, Norwegian, and Swedish. Readings in translation for nonmajors.

5970. DIRECTED STUDIES.

(1-15 cr; prereq #, A, CLA approval)

Topics not covered by regular courses. Readings in Scandinavian literature in the original.

8201. PROSEMINAR IN SCANDINAVIAN BIBLIOGRAPHY.

(4 cr; required of all grad majors)

Discussion of problems and approaches by staff members representing different specialties.

8202. PROSEMINAR IN LITERARY METHODOLOGY.

(4 cr; required of all grad majors)

8501. SEMINAR: MEDIEVAL SCANDINAVIAN LANGUAGES AND LITERATURE.

(3-4 cr; offered when feasible)

8601. SEMINAR: SCANDINAVIAN NOVEL.

(3-4 cr; offered when feasible)

8611. SEMINAR: SCANDINAVIAN DRAMA.

(3-4 cr; offered when feasible)

8621. SEMINAR: SCANDINAVIAN POETRY.

(3-4 cr; offered when feasible)

8631. SEMINAR: SCANDINAVIAN CRITICISM.

(3-4 cr; offered when feasible)

8702. PHILOLOGICAL PROSEMINAR II: INTRODUCTION TO PHILOLOGY WITH SPECIAL EMPHASIS ON METHODS.

(2-4 cr)

8970. RESEARCH IN SCANDINAVIAN LANGUAGES AND LITERATURE.

(1-6 cr [may be repeated for cr])

Guided research for advanced graduate students.

8975. SEMINAR: SCANDINAVIAN IMMIGRANT LANGUAGES AND LITERATURE.

(4 cr per qtr; prereq reading knowledge of one Scandinavian language, grad student; offered when feasible)

Scientific and Technical Communication

See Rhetoric and Scientific and Technical Communication.

Scientific Computation (SciC)

Regents' Professor: L. E. Scriven (chemical engineering and materials science)

Professor: Donald G. Truhlar (chemistry), *director of graduate studies;* Norma M. Allewell (biochemistry/ biological sciences); Jan Almlöf (chemistry); Ronald E. Anderson (sociology); James R. Chelikowsky (chemical engineering and materials science); H. Ted Davis (chemical engineering and materials science); Avner Friedman (mathematics); W. David Kelton (operations and management science); Mitchell B. Lusk (mathematics); Suhas V. Patankar (mechanical engineering); Linda R. Petzold (computer science); Youcef Saad (computer science); Ahmed Sameh (computer science); George R. Sell (mathematics); Charles C. S. Song (civil and mineral engineering); Harlan W. Stech¹ (mathematics and statistics); Tayfun E. Tezduyar (aerospace engineering and mechanics); David D. Thomas (biochemistry/medical school); Clark D. Thornborson¹ (computer science); Luke Tierney (statistics); Paul R. Woodward (astronomy); David A. Yuen (geology and geophysics)

Associate Professor: J. Bernardo Cockburn (mathematics); Lynne K. Edwards (educational psychology); Efi Foufoula-Georgiou (civil and mineral engineering); Larry G. Hutchinson (linguistics); Daniel J. Kersten (psychology); Vipin Kumar (computer science); John L. Nieber (agricultural engineering); Michael R. Taaffe (operations and management science); Ahmed H. Tewfik (electrical engineering); Vaughan R. Voller (civil and mineral engineering)

Assistant Professor: Michael A. Altmann (laboratory medicine and pathology); Sumru G. Altug (economics); Phillip J. Barry (computer science); Graham V. Candler (aerospace engineering and mechanics); Jeffrey J. Derby (chemical engineering and materials science); David M. Ferguson (medicinal chemistry)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A only) and Ph.D.

Curriculum—The graduate degree program in scientific computation encompasses coursework and research on the fundamental principles for using intensive computation to support research in the physical, biological, and social sciences and engineering.

¹ University of Minnesota, Duluth

Graduate Programs

Emphasis is on research issues, state-of-the-art methods, and applying these methods to outstanding problems in science, engineering, and other fields that use scientific computation, numerical analysis and algorithm development, symbolic and logic analysis, high-performance computing tools, supercomputing and heterogeneous networks, and visualization. A handbook for prospective major students that describes the program and degree requirements in detail is available from the program.

Prerequisites for Admission—Both prospective graduate students and current graduate students in other programs may apply. Applicants fill out a form provided by the program as well as applicable Graduate School forms. A bachelor's degree in a field that uses scientific computation is required for admission. Applicants without such a degree who expect to obtain one before the date on which admission in the graduate program is sought may also apply.

Special Application Requirements—Three or more letters of recommendation and official transcripts for all previous undergraduate and graduate work are required for all applicants. Students are admitted each quarter.

Master's Degree Requirements—M.S. students must complete at least 28 course credits plus 16 thesis credits.

Doctoral Degree Requirements—Ph.D. students must complete at least 47 course credits plus 36 thesis credits. Students are required to pass written and oral preliminary examinations.

Language Requirements—None.

Minor Requirements for Students Majoring in Other Fields—Coursework consists of core and supplementary courses. Core courses for the minor include both SciC courses and pre-approved courses in other departments, a complete list of which is provided in the program's brochure. The minimum requirement for a *doctoral minor* is 18 graduate-level quarter credits, with at least 12 of these (at least four courses)

selected from the minor core curriculum. The minimum requirement for a *master's minor* is 9 graduate-level quarter credits, with at least 6 of these (at least two courses) selected from the minor core curriculum. Students may use up to two courses from their major field for a doctoral minor or one course from the major field for a master's minor, provided that no rule exists prohibiting this in the major field and other courses are used to satisfy the major requirement. Prospective minor students may request from the program a handbook that describes in detail the requirements for the minor and provides a list of pre-approved core courses.

For Further Information and Applications—Contact the Graduate Program in Scientific Computation, Minnesota Supercomputer Institute, University of Minnesota, 2027 SCC, 1200 Washington Avenue South, Minneapolis, MN 55414 (612/624-8859; fax 612/624-8861; e-mail duvall@msi.umn.edu).

SciC 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

SciC 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

SciC 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Core Courses

8001f. PARALLEL AND HIGH-PERFORMANCE COMPUTING. (4 cr; prereq undergrad degree in field using sci comp)

Interdisciplinary overview of computer science aspects of scientific computation, both hardware and techniques. Parallel computing, architectures, programming, and algorithms; restructuring compilers; graphics and visualization; data structures; non-numerical algorithms; networks; operating systems; databases.

8002w. ADVANCED NUMERICAL METHODS.

(4 cr; prereq undergrad degree in field using sci comp) Interdisciplinary overview emphasizing computational aspects. Approximation methods for partial differential equations, numerical linear algebra, sparse matrix techniques, iterative methods, solution of eigenvalue problems, and case studies.

8003s. MODELING, OPTIMIZATION, AND STATISTICS. (4 cr; prereq undergrad degree in field using sci comp)

Interdisciplinary overview. Nonlinear equations and optimization, statistics, control theory, modeling, and simulation.

8011. SCIENTIFIC VISUALIZATION. (3 cr; prereq undergrad degree in field using sci comp)

Basic issues, 3D graphics, representation of scientific data, modeling, visualization hardware, user interface techniques, commonly used algorithms and techniques for visualization, animation, examples of successful visualizations.

8012. SYMBOLIC COMPUTING AND ITS APPLICATIONS. (4 cr; prereq undergrad degree in field using sci comp)

Applications to large-scale problems in science, engineering, and other fields involving scientific computation; interaction of symbolic and numerical computing. Parallelism in symbolic computing. Illustrations with packages such as REDUCE or MAPLE.

8013. COMPUTATIONAL ASPECTS OF FINITE ELEMENT METHODS. (4 cr, §AEM 8601; prereq undergrad degree in field using sci comp or IT grad student)

Fundamental concepts and techniques. Preprocessing: grid generation and refinement, data structures. Postprocessing: visualization. Parallel implementation of finite element techniques. Examples from structural analysis, thermal analysis, and/or fluid dynamics.

8090. TOPICS IN SCIENTIFIC COMPUTATION. (1-4 cr; prereq #)

Interdisciplinary topics.

8010f.s. SUPERCOMPUTER RESEARCH SEMINAR. (1 cr per qtr [may be repeated for cr, max 4 cr])

Series of seminars by visiting lecturers.

Social and Administrative Pharmacy (SAPh)

Professor: Judith M. Garrard; Laël C. Gatewood; Theodor J. Litman; Peter C. Morley; Stephen W. Schondelmeyer; Lawrence C. Weaver (*emeritus*); Vernon E. Weckwerth; Darwin E. Zaskie

Associate Professor: Ronald S. Hadsall, *director of graduate studies*; Paul W. Abramowitz; Daniel M. Canafax; Thomas Choi; Robert J. Cipolle; James C. Cloyd; Courtney V. Fletcher; Cynthia R. Gross; Henry J. Mann; Linda M. Strand

Assistant Professor: John M. Coster; Charles E. Daniels; Jinnet Fowles

Adjunct Assistant Professor: Bruce E. Scott

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Students are prepared for research and related activities investigating relationships between biological and physical factors in social settings that involve the drug

use process. This flexible interdisciplinary program uses the resources of the University's many health and social science departments. Programs include courses and offerings from public health, management, sociology, psychology, and public affairs.

Prerequisites for Admission—Although the majority of students in the program are pharmacists, a pharmacy education is not required.

Special Application Requirements—Applicants must complete a department supplementary application form in addition to the Graduate School forms. The supplementary form along with three letters of recommendation should be sent directly to the department. Graduate Record Examination scores are required.

Master's Degree Requirements—Core department courses are required. For the Plan B option, a project and at least one Plan B paper are required. Degree requirements are flexible to accommodate many career objectives in the drug use area. For specific requirements see the descriptive department brochure. A final oral examination is required.

Doctoral Degree Requirements—Core department courses are required in addition to selected studies in other departments. Before emphasizing the Ph.D. thesis, students must pass three written preliminary examinations on subjects chosen from an extensive list. In addition to Graduate School requirements, students must make an oral presentation to a meeting of department faculty and graduate students on the rationale for the thesis and the proposed methodology.

For specific requirements see the descriptive department brochure.

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—For the master's degree minor, 9 credits are required. For the Ph.D. minor, two quarters of the department seminar and 16 credits of other coursework in the department are required.

For Further Information and Applications—Contact the Department of Pharmacy Practice, College of Pharmacy, University of Minnesota, 7-115 Health Sciences Unit F, 308 Harvard Street S.E., Minneapolis, MN 55455 (612/624-2112).

SAPh 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

SAPh 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

SAPh 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

8100. SEMINAR. (1 cr per qtr) Staff

8200. RESEARCH PROBLEMS. (Cr ar) Staff

8255. DRUG MARKETING. (3 cr; offered alt yrs)

Hadsall

Historical development of distributive systems, underlying economic principles, marketing channels, agencies, institutions, functions, policies, and practices as they relate to the pharmaceutical industry.

8420. SOCIAL AND BEHAVIORAL ASPECTS OF PHARMACY PRACTICE. (3 cr) Staff

Historical development of the profession, its growth and development, with emphasis on the forces of education, professionalization, attitude modification, and the changes occurring as a product of legal and organizational forces in society.

8500, 8501, 8502. PHARMACY AND ITS ENVIRONMENT. (3 cr per qtr; offered alt yrs) Hadsall,

Morley, Schondelmeyer, Strand

Cultural foundations of pharmacy. Development of present state of pharmacy practice. Social-psychological factors in drug use, abuse, or nonuse by the patient and practitioner. Role of the pharmacist as health practitioner—within the profession, in relation to other health practitioners, and in relation to the general public.

8610. BEHAVIORAL AND SOCIAL RESEARCH METHODOLOGIES IN THE HEALTH SCIENCES. (3 cr) Gross

Survey of research methodologies for studying social and behavioral aspects of health care. Development of strategies for selecting and modifying existing research tools for particular purposes. Ethics of doing research on humans.

8611. RESEARCH DESIGN. (3 cr; prereq 8610) Gross

Survey of behavioral and social measures and development of skills in research design. Students present their own research designs and measurement tools for class critique and conduct at least a pilot study.

8612. RESEARCH SEMINAR. (2 cr) Staff

Research issues, ideas, design, findings, and interpretations presented by students and faculty for discussion.

8810. SOCIAL PSYCHOLOGY OF HEALTH CARE. (3 cr) Staff

Assessment of social psychological aspects of health care delivery. Topics include behavioral and social aspects of pain and suffering, emotions, disease and recovery, responses to drugs and other therapies, patients' continuity with prescribed therapies, relationships between the health care professional and the patient, and relationships among members of various health care professions.

8840. SOCIAL MEASUREMENT. (3 cr, §PubH 8813) Choi

Essential methodological techniques in social research measurement and theory construction. Explaining and establishing the correspondence between unobservable concepts (such as innovativeness, compliance, religiosity, stress, power) and their empirical indicators. Methods, techniques such as factor analysis, issues in reliability, validity, and scale construction. Computer analysis of data (brief introductory session presented for those who have not used a computer). Measurement, theory construction, and their interrelationship: assessing reliability and validity of the measurement of concepts used in theoretical propositions, showing how propositions are derived from theory, ways of constructing a theory, and appropriateness of theories.

Note—The following courses are described under Hospital Pharmacy in this bulletin:

SAPh 8210, 8220, 8301, 8400, 8700, 8701, 8702, 8703.

Social and Philosophic Studies of Education

Professor: Ayers L. Bagley, *director of graduate studies;* John J. Cogan; Roland A. Delattre; Glenn L. Hendricks; Darrell R. Lewis; Karen Seashore Louis; Marion Lundy-Dobbert; Tim L. Mazzoni; Josef A. Mestenhauer

Associate Professor: Arthur M. Harkins; Jean A. King; Robert E. Orton; R. Michael Paige; Patrick J. Starr; Caroline S. Turner

Senior Fellow: Richard B. Heydinger; Dean Honetschlager

Lecturer: Timothy J. Delmont

Other: Carol Boyer; Gerald A. McIntosh

Course of Study—The graduate minor in social and philosophic studies of education (SPSE) serves M.A. and doctoral students in relevant fields such as American studies, anthropology, education, English, history, philosophy, political science, sociology, and women's studies.

Curriculum—The graduate minor provides a multidisciplinary foundation for the study of education from the perspectives of history, philosophy, and the social sciences. The

minor program is shaped to suit the particular needs and interests of the student at either the master's or doctoral level. Courses are selected in consultation with a faculty member in SPSE in the Department of Educational Policy and Administration (EdPA) from a list of courses at the 5xxx and 8xxx levels both in EdPA and in related fields.

Prerequisites for Admission—Admission to the SPSE graduate minor is contingent upon prior admission to a master's or doctoral degree-granting program within the Graduate School. Interested students should consult with a faculty member in SPSE in the Department of Educational Policy and Administration.

Special Application Requirements—Students who wish to plan or declare a graduate minor in SPSE should contact the director of graduate studies in the Department of Educational Policy and Administration, which provides the administrative home for the graduate minor. The director of graduate studies in this department must approve the applicant's proposed course of study and indicate that approval by signing the student's Degree Program form.

Minor Requirements—M.A. students must complete at least 12 graduate credits in SPSE-approved courses divided between two areas of study. Doctoral students must complete at least 18 graduate credits in SPSE-approved courses divided between two areas of study and have a faculty member in SPSE on their preliminary examination and final oral examination committees.

Language Requirements—None specific to the minor program.

For Further Information and Application—Contact the Department of Educational Policy and Administration, University of Minnesota, 275 Peik Hall, 159 Pillsbury Drive S.E., Minneapolis, MN 55455 (612/624-1006; fax 612/624-3377).

Distribution Requirements—For the M.A. minor, at least two courses from each of Areas I and II; for the doctoral minor, at least three courses from each of Areas I and II.

AREA I—HISTORY AND PHILOSOPHY OF EDUCATION

EdPA 5101. HISTORICAL FOUNDATIONS OF MODERN EDUCATION. (3 cr)

EdPA 5102. EDUCATION IMAGERY IN EUROPE AND AMERICA. (3 cr)

EdPA 5155. HISTORY OF WESTERN EDUCATIONAL THOUGHT. (3 cr)

EdPA 5156. HISTORY OF IDEAS IN AMERICAN EDUCATION. (3 cr)

EdPA 5170. AMERICAN PRAGMATISM AND EDUCATION. (3 cr)

EdPA 5182. COMPARATIVE PHILOSOPHIES OF EDUCATION. (3 cr)

EdPA 5245. ETHICS, MORALITY, AND VALUES IN EDUCATION. (3 cr)

EdPA 8261. SOCIAL AND PHILOSOPHICAL FOUNDATIONS OF EDUCATION. (Cr ar)

Phil 5324. ETHICS AND EDUCATION. (4 cr)

WoSt 5103. FEMINIST PEDAGOGY. (4 cr)

AREA II—SOCIAL SCIENCES AND EDUCATION

EdPA 5131. COMPARATIVE EDUCATION. (3 cr)

EdPA 5171. ANTHROPOLOGY AND EDUCATION. (4 cr)

EdPA 5174. ETHNOGRAPHIC RESEARCH METHODS. (4 cr)

EdPA 5175. SYSTEMS THINKING FOR INNOVATIVE PROFESSIONALS. (3 cr)

EdPA 5176. ETHNOGRAPHIC RESEARCH SKILLS LABORATORY. (2 cr)

EdPA 5190. SOCIOLOGY OF EDUCATION. (4 cr)

EdPA 5202. POLITICS OF EDUCATION. (3 cr)

EdPA 5209. EDUCATION IN FUTURE SOCIAL SYSTEMS. (3 cr)

EdPA 5211. SOCIAL DESIGN AND EDUCATIONAL FUTURES. (3 cr)

EdPA 5280. INTRODUCTION TO THE ECONOMICS OF EDUCATION. (4 cr)

EdPA 8170. SEMINAR: RESEARCH METHODS IN ANTHROPOLOGY AND EDUCATION. (1-3 cr)

EdPA 8268. SEMINAR: SOCIAL AND EDUCATIONAL FUTURES. (1-6 cr)

EdPA 8340. POLICY SYSTEMS IN EDUCATION. (3 cr)

Graduate Programs

Social Work (SW)

Professor: Jean K. Quam, *director*; Michael Baizerman; Jerome Beker; Richard S. Bolan; Neil F. Bracht; Geraldine K. Brookins; Jeffrey Edleson; C. David Hollister; Rosalie Kane; David J. Klaassen; Dario Menanteau-Horta; Susan S. Meyers; Rama Pandey (*emeritus*); Esther Wattenberg (*emeritus*); Shirley Zimmerman

Associate Professor: Irl E. Carter; Jane F. Gilgun; Linda Jones; Helen Q. Kivnick; Donald E. Maypole¹; Ronald Rooney; Byron Schneider; Mark S. Umbreit

Assistant Professor: Sandra Beeman; Mark G. Frenzel; Nancy Lee Leland; Ronald L. Pitzer; Oliver J. Williams

Instructor: Nancy Johnston, *director of graduate studies*; Nancy Abramson; Maura Sullivan

Other: Sonia Davila-Williams; D. Michael Graham; Gloria M. McGee; James R. Reinardy

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S.W. and Ph.D.

Curriculum—Concentrations in the master's program include practice in two areas: 1) direct practice, and 2) human services management. Three dual programs are also available: M.S.W./master of public health, M.S.W./master of arts in public affairs, and M.S.W./M.Plan. in planning. The doctoral program prepares students for advanced levels of scholarship and research and provides intellectual leadership for the profession; it does not provide advanced training for clinical practice. The program emphasizes interdisciplinary study and development of analytic skills to accommodate the diverse interests of individual students.

Prerequisites for Admission—Applicants to the M.S.W. program must present 39 quarter credits in the social sciences, e.g., sociology, political science, economics, psychology, history, and anthropology. Applicants must also have completed one course each in statistics and human biology. One year of paid or volunteer social work experience is required of all applicants who do not have a bachelor's degree in social work. Doctoral applicants must have earned the master's degree in social work from a school of social work accredited by the Council on Social

Work Education, and must have a superior academic record. Significant experience in social work practice is preferred.

Special Application Requirements—Three letters of recommendation, a complete set of transcripts (in addition to that required by the Graduate School), an example of written work, a personal statement, and a department application form are required of all applicants. Graduate Record Examination (GRE) scores are not required for admission to the master's program, but are required from applicants who wish to be considered for nomination for a Graduate School Fellowship. GRE scores are required for admission to the doctoral program. The application deadline is January 15 for the master's program and February 15 for the doctoral program. Beginning students in either program are admitted fall quarter only.

Master's Degree Requirements—The master's degree requires the equivalent of two years of graduate study. A weekend studies option is available through Continuing Education and Extension. A part-time program of up to four years is available in both weekday and weekend studies options. A total of 75 credits is required for the two-year M.S.W. degree; a 66-credit advanced standing program is available to graduates of undergraduate social work programs accredited by the Council on Social Work Education. All credits must be completed within five years of the date of the earliest course students wish to apply to their M.S.W. program. A maximum of 38 quarter credits may be transferred toward the 75-credit M.S.W. degree from the following sources with the approval of the School of Social Work: up to 30 credits of graduate-level coursework from Continuing Education and Extension at the University of Minnesota; up to 12 credits of work at graduate level and quality completed as an adult special student at the University of Minnesota; up to 38 credits from another regionally and professionally accredited school of social work, if the student was registered as a graduate student in the

¹ University of Minnesota, Duluth

program; and up to 12 credits of non-social work electives taken as a graduate student at another university.

For the 66-credit program, a maximum of 33 quarter credits may be transferred from the following sources with the approval of the School of Social Work: 33 credits completed as a graduate student in another accredited M.S.W. program; up to 30 credits of graduate-level coursework from Continuing Education and Extension at the University of Minnesota; and up to 12 credits of non-social work electives taken as a graduate student in another university.

Doctoral Degree Requirements—Programs are designed by the student and adviser to develop appropriate skills in research and scholarship. Required components of the program are seminars in research methods, statistics, social welfare history, social policy, and social work practice, theory and model development, and teaching. The doctoral program gives preference to applicants with at least two years of post-master's degree work.

Language Requirements—None.

For Further Information and Applications—Contact the School of Social Work, University of Minnesota, 400 Ford Hall, 224 Church Street S.E., Minneapolis, MN 55455 (612/624-5888).

SW 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

SW 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Core M.S.W. Degree

5111. CONTEMPORARY POLICY AND PROGRAMS IN SOCIAL WELFARE. (3 cr for grad students, 4 cr for undergrads; prereq grad standing or 12 cr social sciences)

Framework for analysis of concepts and principles in social policy for social welfare programs and services.

5211. ADVANCED THEORIES OF HUMAN GROWTH AND CHANGE. (3 cr for grad students, 4 cr for undergrads; prereq grad standing or 12 cr social sciences)

Socio-psycho-biological factors associated with individual and group development as applied to social work practice.

5349. SOCIAL WELFARE IN AMERICA. (3 cr for grad students, 4 cr for undergrads, §Hist 5349)
Social services, public policies, and profession of social work—colonial era to present. Dependency, deviancy, crime, social security, public health, social reform, functions of public and voluntary institutions (charities, settlements).

5601. ETHNOCULTURAL CONCEPTS IN SOCIAL WORK PRACTICE. (3 cr for grad students, 4 cr for undergrads)

Relation of ethnocultural concepts to development of social welfare policies and services and social work practice. Critical examination of commonalities of principle and cross-ethnic issues and practices among the four major ethnic minority groups of color (American Indian, Asian American, Black, and Hispanic). Contribution of each to effective interpersonal and intragroup relationships in social service delivery system.

8010. FIELD INSTRUCTION I. (4 cr or cr ar [max 12 cr required]; hrs ar)

8020. FIELD INSTRUCTION II. (4 cr or cr ar [max 12 cr required]; prereq 8010)

Field practice in social work process under direct supervision.

8030. FIELD INSTRUCTION IN SOCIAL WORK III. (Cr ar; prereq 8020)

Field experience in social work under direct supervision.

8400. SOCIAL WORK METHODS I. (3 cr; prereq ¶8010)

Development of conceptual understanding of, and skill in, the social work process using ecological and problem-solving models as approaches for analysis. Ethics, assessment, interview skills, goal-setting.

8401. SOCIAL WORK METHODS II. (3 cr; prereq 8400, ¶8010)

Further development of conceptual understanding of, and skill in, using various roles and interventions in working with individuals, families, and groups.

8402. SOCIAL WORK METHODS III. (3 cr; prereq 8400, 8401, ¶8010)

Issues and interventions in social work macro-practice, including organizational structure and analysis, community organizing, and working in task groups.

8901. SOCIAL WORK RESEARCH METHODS. (3 cr)

Logic, methods, and techniques of scientific inquiry in social work. Nature and functions of theory, models, assumptions, problem formulation, causal analysis, conceptualization, operationalism, and hypothesis formulation.

8902. DIRECT PRACTICE EVALUATION. (3 cr; prereq 8901 or equiv)

Students design evaluations that incorporate current evaluation methods and principles derived from research, theory, practice wisdom, and their own experience. Evaluation methods include single-system designs, event analysis, client-focused evaluations, and practitioner-focused evaluations.

Graduate Programs

8903. PROGRAM EVALUATION. (3 cr; prereq 8901 or equiv)

Conceptual, methodological, political, psychological, and administrative factors related to conduct and consequences of social work program evaluation. Social programs as cause and effect models, types and strategies of evaluation, and appraisal of selected social work research literature.

Other Social Work Courses

5010. SEMINAR: SPECIAL TOPICS. (Cr ar) Topics specified in *Class Schedule*.

5020. PUBLIC HEALTH/SOCIAL WORK INTEGRATIVE SEMINAR. (3 cr, §PubH 5020; prereq MSW/MPH student or other grad public hlt or social work student)

Socializes students to integrated, synthesized PHSW philosophy, roles, functions, knowledge, and skills for practical application to major contemporary social health problems. Expansionistic, social epidemiological, conceptual problem analysis, and community intervention.

5024. MULTIDISCIPLINARY PERSPECTIVES ON AGING. (4 cr, §AdEd 5440, §CPsy 5305, §HSU 5009, §PA 5671, §PubH 5737, §Soc 5960) Multidisciplinary introduction to aging and the aging process.

5025. INTERNATIONAL SOCIAL WELFARE. (3 cr; prereq 1001, 3984 or #) Role of international social welfare in meeting basic human needs and promoting human rights, social justice, and peace; theories, models, and strategies of social welfare in different economic and political systems; emphasis on Third World.

5026. MEDIATION AND CONFLICT RESOLUTION. (3 cr) Development of mediator skills for making informed decisions regarding appropriateness of mediation in relation to conflicts frequently confronting social work practitioners, such as divorce, neighborhood disputes, conflicts between parents and adolescents, conflicts between spouses, and crime victims and offenders.

5027. PEACE AND JUSTICE AS SOCIETAL VALUES. (3 cr) Direct, structural, and cultural violence; connection between peace and justice; role of personal empowerment, alternative institutions, and nonviolent action; global-national-local strategies for action.

5028. SOCIAL WORK IN THE SCHOOLS. (3 cr) Applying social work methods and skills in school setting. Emphasizes developing clinical skills, consultation, advocacy, and use of community resources as a school social worker.

5030. CHILD ABUSE PREVENTION: DIRECTED FIELD EXPERIENCE AND INTEGRATIVE SEMINAR. (3 cr per qtr; prereq 5301, 5302, 5303) Two-quarter sequence arranged by program adviser for the child abuse prevention specialization.

5100. YOUTH IN THE WORLD. (3 cr, §YoSt 5100) Theoretical and conceptual framework for understanding adolescence, adolescents, and youth in context of everyday life, e.g., in school, at play, in the community, at home.

5102. SURVEY OF WOMEN AND PUBLIC POLICY. (3 cr, §WoSt 5502, §PA 5441; prereq 5111, WoSt 1001 or #) Social and economic problems and policy issues of special significance to women in United States.

5123. FINANCIAL MANAGEMENT IN PUBLIC AND NONPROFIT ORGANIZATIONS. (3 cr, §PA 5123) Design, installation, and use of accounting and control systems; public accounting standards and practices; financial administration; debt management; controllership and post auditing; financial reporting; contract and procurement management systems.

5212. SOCIAL WORK WITH OLDER ADULTS. (3 cr) Introduction to social work knowledge, skills, and values for working with older adults. Theories on and attitudes toward aging, nature and limitations of gerontological social work, forces shaping delivery system and context of practice, major biopsychosocial dimensions in practice, different models of intervention. Emphasizes cultural competence in working with ethnic groups and special populations.

5234. CLINICAL PRACTICE WITHIN A HOSPITAL AND HEALTH-CARE SETTING. (3 cr) Focused, practice-oriented learning environment that builds upon previous experiential and academic learning.

5301. CHILD ABUSE PREVENTION I: RESEARCH AND THEORY. (3 cr; prereq admission to child abuse prevention specialization) Prevention of child abuse and neglect; conceptual framework for developing primary and secondary preventive interventions.

5302. CHILD ABUSE PREVENTION II: PROGRAM DEVELOPMENT, IMPLEMENTATION, AND EVALUATION. (3 cr; prereq 5301) Prevention of child abuse and neglect; skills for program design, implementation, and evaluation for children at risk.

5303. CHILD ABUSE PREVENTION III: STRATEGIES FOR POLICY AND SYSTEMS CHANGE. (3 cr; prereq 5302) Prevention of child abuse and neglect; understanding social policy and systems change for children at risk.

5312. SEMINAR: DIRECT WORK WITH ADOLESCENTS. (3 cr, §YoSt 5312) Direct work with troubled and at-risk adolescents in wide range of settings in which social workers are typically involved. Emphasizes young people in groups in the "life space," in everyday life, rather than in one-to-one, office-based interactions.

5404. SOCIAL WORK PRACTICE IN CHILD WELFARE. (3 cr)

Advanced survey of child welfare policies; use of multi-systemic interventions; impact of poverty, race, ethnicity, and gender on policy and practice; current developments in family preservation, relative placement, foster care, adoptions, and Indian Child Welfare; role of social work in child protection services.

5414. FUNDAMENTALS OF SOCIAL GROUP WORK. (4 cr for undergrads, 3 cr for grad students; prereq 3005)

Principles of social group work practice applicable to both task and treatment groups. Small group as a social process to achieve task and treatment goals. Sociophilosophic orientation, theoretical frames of reference, application of structure, task and process variables, use of member-to-member interactions, group goal setting, and professional relationships with groups, individual members, and systems external to small groups.

5424. SOCIAL WORK WITH INVOLUNTARY CLIENTS. (3 cr, §8424)

Analysis of involuntary transactions experienced by social workers in variety of settings. Theory, ethics, and strategies for intervention.

5425. BRIEF TREATMENT AND THE TASK-CENTERED MODEL. (3 cr)

Theory and practice of brief treatment approaches to social work practice. Various time-limited models explored and contrasted, focusing on task-centered practice, a model that is both time-limited and empirically based. Emphasizes theoretical base and application of model in variety of social work situations.

5498. CHILD DEVELOPMENT AND SOCIAL POLICY. (3 cr, §PA 5498)

Intersection of developmental conceptual orientations with policies that affect children and families. Basic developmental, psychological, and social research that either currently informs, or should inform, effective policy formulation for optimal development of children and youth. Analysis of demographic, historical, and social trends that underlie assumptions that drive policies directed at women and children.

8104. CHILD WELFARE AND THE LAW. (3 cr; prereq 8121, 8402 or equiv)

Social work practice in juvenile court: child abuse and neglect reporting laws, risk assessment, reasonable efforts, case plan, custody proceedings, permanency planning, termination of parental rights, child testimony, social worker testimony, adoption laws.

8121. SOCIAL POLICY AND DELIVERY SYSTEMS FOR FAMILY AND CHILDREN'S SERVICES. (3 cr; prereq 5111)

Application of theoretical social policy framework to goals, tasks, organization, and delivery arrangements of programs serving social welfare of families and children.

8122. HEALTH/MENTAL HEALTH POLICY. (3 cr; prereq 5111)

Political, economic, and policy issues pertinent to social work practitioners.

8150. SPECIAL TOPICS IN SOCIAL POLICY. (Cr ar)**8301. INTRODUCTION TO HUMAN SERVICES MANAGEMENT THEORY AND PRACTICE.** (3 cr)

Principles and practices of management and administration, with emphasis on social work settings.

8305. COMMUNITY DEVELOPMENT. (3 cr)

Process by which groups and individuals within a community work together to fulfill community needs through social services; principles of working with unfunctional and local organizations.

8307. ADVANCED TRAINING IN HUMAN SERVICES MANAGEMENT. (3 cr)

Skill development and practice in personnel management, resource development, and strategic planning.

8311. ISSUES AND INTERVENTIONS IN CHILD SEXUAL ABUSE. (3 cr, §5311)

Major issues and interventions involved in child sexual abuse. Development of knowledge and skills in working with sexually abused children and their families. Perceptions of victims, perpetrators, mothers, and other family members; interviewing; justice system; child protection.

8350. PLANNED SOCIAL CHANGE. (3 cr)

Analysis of systems in social work practice for social change, including human needs, policy planning, programming, management, and community participation.

8406. SUPERVISION AND CONSULTATION IN SOCIAL WORK PRACTICE. (3 cr; prereq 8401, #)

Principles and practices of first-line supervision in direct practice systems—administration, education, and support. Principles and methods of consultation and staff development.

8407. STRATEGIES OF FAMILY INTERVENTION. (3 cr; prereq 8401 or #)

Seminar in methods of and strategies for helping families cope with family problems.

8408. DIRECT WORK WITH CHILDREN AND THEIR FAMILIES. (3 cr; prereq 8121, 8402 or equiv)

Research, theory, and practice in child welfare settings: research and theory on attachment, resilience, and vulnerability; child protection investigation and interviewing; work with maltreated children and their families; AIDS, crack, and cocaine babies; child placement; and foster care.

8421. SOCIAL WORK PRACTICE: PSYCHOPATHOLOGY AND INTERVENTION. (3 cr, §5421)

Roles and intervention strategies of social workers in variety of service settings. Problems frequently presented, treatment alternatives, interdisciplinary practice, and ethical issues.

Graduate Programs

8422. SOCIAL WORK PRACTICE WITH PERSONS WITH SERIOUS AND PERSISTENT MENTAL ILLNESS. (3 cr, §5422; prereq 8402 or 66 cr MSW student)

Specialized training and conceptual framework for understanding serious and persistent mental illness as individual and social problem. De-institutionalized, community-based care and consumer issues.

8424. SOCIAL WORK WITH INVOLUNTARY CLIENTS. (3 cr; prereq 8401)

Analysis of involuntary transactions experienced by social workers in variety of settings. Theory, ethics, and strategies for intervention.

8425. TASK-CENTERED PRACTICE. (3 cr; prereq 8401)

Theory and practice of time-limited, empirically based approaches drawing primarily from task-centered approach. Emphasis on instruction: practice and feedback on specific task-centered skills.

8426. INTERVENTION WITH BATTERED WOMEN AND THEIR FAMILIES. (3 cr, §5426)

Current theories, research, and social work practice concerning battered women and their families.

8427. FAMILY-CENTERED, HOME-BASED SERVICES. (3 cr)

!Problems of concern to families; empowering parents and providing them with support. For both academic and practice arenas. Family-oriented content specific to FCHBS area. For applying family-centered principles to students' practice settings.

8450. SPECIAL TOPICS: PRACTICE WITH INDIVIDUALS, FAMILIES, AND GROUPS. (1-4 cr; prereq 8401 or #)

8970. DIRECTED STUDY. (Cr ar; prereq #)

Independent study under tutorial guidance.

8990. RESEARCH PROJECTS. (Cr ar [max 6 cr])

Opportunity to pursue, individually or in small groups, a line of empirical research inquiry of interest to the student and relevant to the field of social work. Translates content from the introductory courses into a research design and study to broaden and deepen research knowledge and skills. Projects may be conducted in conjunction with field learning experiences or other coursework.

Doctoral Courses

8130. SEMINAR: HISTORY OF SOCIAL WORK. (3 cr per qtr; prereq 5349 or Hist 5349)

Ways in which social movements and key individuals have influenced the development, current status, and future prospects for social welfare, social services, and social work.

8180. SOCIAL POLICY FORMULATION AND ANALYSIS. (3 cr; prereq PhD student or #)

Formulation and analysis of various theoretical perspectives and conceptual frameworks and their application to social policy issues and problems, and social welfare systems and programs.

8461. THEORY AND MODEL DEVELOPMENT IN SOCIAL WORK. (3 cr; prereq MSW or #)

Conceptual paradigms for development and testing of practice innovations in social work.

8701. SOCIAL WORK TEACHING METHODS.

(3 cr; prereq PhD student or 2nd-yr MSW student or #)

Pedagogical theory and curriculum content bases for social work instruction. Introduction to scholarship and service roles assumed by social work faculty.

8702. SOCIAL WORK TEACHING SEMINAR. (1 cr per qtr [2-qtr regis required]; prereq soc wk PhD student or #)

Teaching methods and issues related to effective teaching in social work programs. Must be taken during same academic year as teaching experience requirement.

8703. FACULTY ROLE: SCHOLARSHIP, TEACHING, AND SERVICE. (3 cr, §FPCH 8703)

Rooney

Interdisciplinary orientation to faculty roles. Skills for developing scholarly focus, carrying out academic and grant writing, facilitating, learning, performing service, and managing time and priorities.

8991. RESEARCH SEMINAR. (3 cr; prereq PhD student)

8992. RESEARCH SEMINAR. (3 cr; prereq 8991, PhD student)

Continuation of 8991.

Youth Studies (YoSt)

5100. YOUTH IN THE WORLD. (3 cr, §SW 5100)

Theoretical and conceptual framework for understanding adolescence, adolescents, and youth in context of everyday life, e.g., in school, at play, in the community, at home.

5120. INDEPENDENT STUDY IN YOUTH STUDIES. (Cr ar [max 12 cr]; prereq #)

Independent reading or research under faculty supervision.

5130. SPECIAL TOPICS IN YOUTH STUDIES.

(3-5 cr [max 15 cr]; prereq #) Staff

Review of research and discussion. Topics announced in *Class Schedule*.

5132. EXPERIENTIAL LEARNING. (3 cr; prereq CPsy 5303 or #)

Purposes and models of experiential learning in schools and youth-serving agencies. Development, implementation, and evaluation of such programs.

5133. YOUTH AND HEALTH. (3 cr; prereq 5331, Soc 1001, CPsy 5303, PubH 3004 or #)

Medical and health status of youth. Age-specific morbidity data regarding youth. Introduction of youth development concepts for use in sociomedical and sociohealth problem analysis and program development.

5200. YOUTH POLICY: ENHANCING HEALTHY DEVELOPMENT IN EVERYDAY LIFE. (3 cr)

Differs from typical approaches in which policy is problem-focused and directed at "risk reduction." This model is grounded in youth's everyday life.

5201-5202-5203. YOUTH WORK PRACTICE: INTERNSHIP AND SEMINAR. (4 cr per qtr; prereq acceptance into YoSt collateral)

Two-hour seminar and 8 to 10 hours of fieldwork each week. Students reflect on and integrate knowledge about youth with ongoing experience in work with youth.

5230. WORK WITH YOUTH: INDIVIDUAL. (3 cr per qtr; prereq Soc 1001, Psy 1001, CPsy 5303 or #)

Basic assumptions underlying work with youth. Emphasis on how adolescents learn to get along with themselves. Special issues and concerns of adolescents and of persons who work with them.

5231. WORK WITH YOUTH: FAMILY. (3 cr per qtr; prereq 5230, FSoS 5200 or #)

Theories and techniques of therapy for adolescents and their families. Emphasis on practical methods of structural change; developing effective communication and problem-solving systems.

5232. WORK WITH YOUTH: GROUP. (3 cr; prereq 5230)

Basic assumptions underlying work with youth. Special concern for adolescents: how they learn to get along with themselves, their role in the family, relationships with peers and on the job.

5312. SEMINAR: DIRECT WORK WITH ADOLESCENTS. (3 cr, §SW 5312)

Direct work with troubled and at-risk adolescents in wide range of settings in which social workers are typically involved. Emphasizes young people in groups in the "life space," in everyday life, rather than in one-to-one, office-based interactions.

5330. CHILD AND ADOLESCENT PSYCHOLOGY FOR PRACTITIONERS. (3 cr; prereq courses in educational psychology, child or adolescent psychology)

Applying theory and research about children and adolescents, including how findings can be used and how theories can facilitate understanding behavior of young people.

5331. YOUTH AGENCIES, ORGANIZATIONS, AND SERVICE SYSTEMS. (3 cr; prereq two courses in sociology/anthropology, work exper in youth agency or organization)

Major forms of youth agencies, organizations, systems. Sociopolitical structures, legitimacy, ideologies, goals, programs, services. Staff, legal and ethical issues, youth participation.

5401. COMMUNICATING WITH ADOLESCENTS ABOUT SEXUALITY. (3 cr; prereq 6 cr social sciences, exper in youth work or #)

Sexual development and experience; emphasis on effective communication between adults and youth. Sexual patterns, variations, roles, power, exploration, education.

5711. INTRODUCTION TO CONSULTATION IN YOUTH WORK. (3 cr; prereq at least two courses in sociology and/or anthropology, major in human services profession, paid or voluntary exper in youth or other human services organization)

Major conceptual models for understanding consultation; their use in analyzing program development, research, program evaluation, and clinical cases. Role of consultant and consultee; ethical issues in consultation. Does not focus on how to do consultation.

Sociology (Soc)

Professor: David A. Ward, *chair*; Robert K. Leik, *director of graduate studies*; Ronald R. Aminzade; Ronald E. Anderson; Dennis D. Brissett¹ (medicine); William Brustein; David Cooperman; George A. Donohue (*emeritus*); Bertram L. Ellenbogen (*emeritus*); Barry C. Feld (law); Robert Fulton; Joseph Galaskiewicz; Arthur L. Johnson (*emeritus*); David Knoke; Candace Kruttschnitt; Barbara Laslett; Theodor J. Litman (public health); Karen S. Louis (educational policy and administration); Carl Malmquist; Margaret M. Marini; Donald G. McTavish; Dario Menanteau (rural sociology); Jeylan T. Mortimer; Joel I. Nelson; Ira L. Reiss; Joel B. Samaha (history); Mark Snyder (psychology); Richard E. Sykes (speech-communication)

Associate Professor: Rose M. Brewer (Afro-American and African studies); Robert E. Kennedy; Joachim J. Savelsberg; Stephan P. Spitzer

Assistant Professor: Yanjie Bian; Jeffrey P. Broadbent; Michael D. Finch (public health); Jane D. McLeod; Jennifer L. Pierce

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Studies in social organization, social psychology, sociological theory, and statistics and research methodology provide background for more advanced work organized around the following substantive foci: law, criminology, and deviance; social self and life course; organizations and occupations; historical and comparative; family, gender, and human sexuality.

Although these are the main substantive areas, individual programs can be developed in other specialties such as death education, gerontology, and rural sociology. Training for students interested in both academic and applied employment is generally available.

¹ University of Minnesota, Duluth

Graduate Programs

Prerequisites for Admission—A background in basic sociology, usually consisting of the equivalent of 18 quarter credits in undergraduate work, including 9 quarter credits of social science statistical methods, or an M.A. degree in sociology or a closely related field is required. Individuals who have completed fewer than 18 credits may be admitted but are generally required to complete background coursework in theory and statistics during their first year of residence.

Special Application Requirements—Applicants are evaluated on their general ability, knowledge of basic skills, creativity, and potential for contribution to the field. In addition to the Graduate School application, applicants must submit the following: Graduate Record Examination scores; a complete set of transcripts in addition to that required by the Graduate School; an application for department support (if desired); a sample of written work, usually a term paper, written in English; three letters of recommendation; and a statement of professional objectives. The department accepts new students for fall admission only. The final application deadline for admittance is March 1. For maximum fellowship support, the final application deadline is January 1.

Master's Degree Requirements—The department requires a general academic program consisting of approximately two years of coursework (including the same required core courses as for the Ph.D.), written papers or thesis, and a final oral examination.

Doctoral Degree Requirements—The program consists of a period of concentrated coursework (or its equivalent), extensive preparation in an area of specialization, a significant research experience, preparation in a special research technique, and a doctoral dissertation.

Language Requirements—For the master's degree, none. For the doctoral degree, expertise in a foreign language may be used to fulfill department requirements in comparative sociology.

Minor Requirements for Students Majoring in Other Fields—Six courses in sociology, including two 8xxx courses, are required. Courses should be chosen equally from two of the department's subfields.

For Further Information and Applications—An informational brochure covering specific admission and degree requirements is available from the Graduate Secretary, Department of Sociology, University of Minnesota, 909 Social Sciences Building, 267 19th Avenue South, Minneapolis, MN 55455 (612/624-2093; fax 612/624-7020).

Soc 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Soc 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Soc 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Law, Criminology, and Deviance

5101. SOCIOLOGY OF LAW. (4 cr; prereq 3101-3102 or #; 5705 recommended) Cooperman, Savelsberg
Sociological analysis of law and society. Examination, through historical and cross-cultural materials, of social forces involved in the creation of legal norms (both civil and criminal), procedures of enforcement, and impact of law on social change.

5102. CRIMINOLOGY. (4 cr; prereq 3101-3102 or #) Kruttschnitt, Savelsberg, Ward
Nature and types of crime, problems in measurement of incidence and trends, and review of sociological theories of crime causation. Implications for crime prevention and control.

5104. COMMUNITY-BASED CORRECTIONS. (4 cr; prereq 3102 or #) Ward
Theories behind and structures of diversion, probation, parole, and other community corrections programs that are alternatives to imprisonment.

5105. CONTEMPORARY CORRECTIONS. (4 cr; prereq 3101-3102 or #; 5161, 5162 recommended) Ward
Advanced study of correctional organizations including prisons and jails; probation and parole, department and community corrections. Penal policies and practices in the United States compared with advanced penal systems in other countries.

5107. COMPARATIVE CRIMINOLOGY AND CRIMINAL JUSTICE SYSTEMS. (4 cr; prereq 3102 or #) Savelsberg, Ward
Theories of crime causation and operation of criminal justice agencies in other countries.

5108. CURRENT ISSUES IN CRIME CONTROL.

(4 cr; prereq 3102 or #) Kruttschnitt, Savelsberg
Selected current criminal justice policies examined from the perspective of courts, legislature, community, and interest groups; impact of policy changes on society and social control agencies.

5109. DOMESTIC CRIMINAL VIOLENCE. (4 cr; prereq 3101-3102 or #)

Survey of research on family violence within criminological framework. Definition of domestic violence; empirical and theoretical approaches to study of domestic violence; response of social control agencies.

5111. SOCIOLOGY OF DEVIANT BEHAVIOR.

(4 cr; prereq 3101, 3102 or #)
Nature of deviant behavior, social process associated with careers of deviants, and relationship of deviancy to problems of social control.

5114. THE SOCIAL CONTROL OF WOMEN OFFENDERS. (4 cr; prereq 3102 or #; offered alt yrs) Kruttschnitt

Historical and current explanations for female criminality; current trends in women's participation in crime and their treatment in the legal system.

5125. POLICING IN AMERICAN SOCIETY. (4 cr; prereq 3101-3102 or #: 5161, 5162 recommended; offered when feasible) Sykes, Ward**5135. WHITE-COLLAR CRIME.** (4 cr; prereq 3101-3102 or #: 5161, 5162 recommended; offered alt yrs) Savelsberg

Types of white-collar crime, broadly construed; roots in American society; responses offered by theoreticians and amateur and professional politicians.

5142. JUVENILE JUSTICE LAW AND ORGANIZATION. (4 cr; prereq 3101-3102 or #: 5161, 5162 recommended; offered alt yrs) Malmquist

Sociological perspective on historical evolution of the juvenile court; organizational relationships between court, police, and other agencies; policies on serious offenders and status offenders; processes of intake, diversion, pre-trial detention, waiver to adult court, and sentencing; conflicts over due process and treatment objectives; current movements to abolish juvenile justice.

5147. SOCIOLOGY OF MENTAL DISORDERS. (4 cr; prereq 1001 or #) Malmquist, McLeod, Spitzer
Social definitions and origins of mental illness, its epidemiology, patterns of reaction to mental illness including sociological analysis of mental health programs and their effectiveness. Social policy implications of mental health definitions.**5148. CRIMINAL PSYCHOPATHOLOGY.** (4 cr; prereq sr or grad student; offered alt yrs) Malmquist
Psychiatric and psychological aspects of antisocial and criminal behavior as related to issues faced in courts and criminal justice system.**5149. KILLING.** (4 cr; prereq sr or law or grad student) Kruttschnitt

Sociological, legal, and psychological aspects of diverse types of killing. "Normal" killings contrasted with pathological types. Mentally disturbed, sexual, gang, and terrorist killings and killings within families.

5161. CRIMINAL LAW IN AMERICAN SOCIETY. (4 cr) Samaha

Purposes and basic principles of criminal law; proper limits of criminal sanction; suggested reforms in existing criminal law.

5162. CRIMINAL PROCEDURE IN AMERICAN SOCIETY. (4 cr) Samaha

Examination and assessment of the state's power to intrude into lives of citizens and deprive them of life, liberty, and property in enforcing criminal law. Arrest, search, and seizure powers, pre-trial practices, and prisoners' rights. Suggested limits on discretionary power of police, prosecutors, judges, and corrections authorities.

8105. SEMINAR: CRIMINAL POLICY. (3 cr; offered when feasible) Ward**8148. LAW, SOCIETY, AND THE MENTAL HEALTH SYSTEM.** (3 cr; prereq grad student, 5148 or #; offered alt yrs) Malmquist

Intensive survey of psychopathology, with reference to criminal behavior and the criminal justice system.

Social Self and Life Course**5205. SYMBOLIC INTERACTION.** (4 cr; prereq 3201 or 5201 or equiv or #) Spitzer

Methods of acquiring knowledge in social psychology; outstanding pieces of research. Social psychology of small groups, mass behavior, and making of political and economic choices. Current thinking and research in this field in light of concepts and theories presented in introductory courses in social psychology.

5211. SOCIAL PROCESSES IN SMALL GROUP SETTINGS. (4 cr; prereq 3201 or 5201 or #; offered alt yrs) Anderson, Leik

Small group research and theory focusing on both lab and nonlab investigation of interpersonal exchange, communication structures, status and power relations, coalition formation, reference groups, role differentiation, group uniformity, social influence, and problem-solving behavior. Lab arranged.

5215. SELF-CONCEPT IN THEORY AND RESEARCH. (4 cr; prereq jr or sr or grad student, 16 cr social sci and/or educ or #; offered alt yrs) Spitzer

Major sociological theories and assessment methodologies characterizing study of the self; application to and findings in topical areas such as crime and delinquency, mental illness, socialization, aging, drug abuse, group processes, and policy evaluation.

5524. THE CROSS-CULTURAL CONSTRUCTION OF SEXUALITY. (4 cr; prereq 8 cr sociology or #; offered alt yrs) Reiss

See Family, Gender, and Human Sexuality for description.

Graduate Programs

5555. POPULATION THEORY. (4 cr; prereq 3551 or #; offered when feasible) Kennedy

5561. DEMOGRAPHIC METHODS. (4 cr, §PubH 5460; prereq 3551 or #) Kennedy
Demographic measures and concepts of fertility, mortality, and migration. Stable population methods and demographic estimates from incomplete data.

5855. SOCIOLOGY OF MEDICINE AND HEALTH CARE: AN INTRODUCTION TO MEDICAL SOCIOLOGY. (4 cr, §PubH 5790; prereq jr or sr or grad student) Litman, McLeod
Social factors associated with incidence in physical and mental illness and its treatment. Social organization of medical institutions. Public needs and medical services. Sociology of aging; social problems of the aged.

5938. AGING AND THE LIFE COURSE. (4 cr; prereq 3937 or 5937, 3201, 3401 or 5201, 5401 or equiv or #; offered alt yrs) McTavish
Theories of aging, age stratification, generational change; organization and individual level. Lecture and discussion.

5954. SOCIOLOGY OF GENDER. (4 cr; prereq 3401 or #; offered alt yrs) Brewer, Laslett, Marini, Pierce
Historical, contemporary, and feminist perspectives on social organization and construction of gender roles and relationships. How gender shapes and is shaped by elements of social organization such as family, economy, ideology, and the state.

5956. SOCIOLOGY OF DEATH. (4 cr; prereq jr or sr, 8 cr sociology or #) Fulton
Issues and problems that mortality presents in contemporary society.

8215. THEORIES OF SOCIAL PSYCHOLOGY. (4 cr; prereq #) Marini, Mortimer, Spitzer, Sykes
Review of current social psychological theories in important areas such as attitudes, communication, interaction and small groups, with the intent of integrating these materials according to a superordinate theoretical perspective.

8524. SEMINAR: SOCIOLOGY OF HUMAN SEXUALITY. (3 cr; offered alt yrs) Reiss
See Family, Gender, and Human Sexuality for description.

8551. SEMINAR: PROBLEMS IN POPULATION RESEARCH. (3 cr; offered when feasible) Kennedy

8855. SEMINAR: HEALTH AND HUMAN BEHAVIOR. (3 cr, §PubH 8770; prereq 5855 or #; offered alt yrs) Litman, McLeod
Social ecology of health; social and personal components of illness; health and the community; social and cultural aspects of health care services.

8956. DEATH, GRIEF, AND BEREAVEMENT. (3 cr; prereq #; offered alt yrs) Fulton
Issues and problems that mortality presents to contemporary society.

Occupations and Organizations

5311. SOCIOLOGY OF CONFLICT. (4 cr; prereq 3401 or 5401 or equiv or #) Cooperman, Savelsberg
Theoretical, empirical study of group conflict. Methods and models. Animal conflict. Aggression and conflict. Types of conflict: feuds, community, ecologies of urban conflict, racial, internal war, revolution. Conflict and social organization: relation of stratification, industrial and social change to conflict.

5401. SOCIAL ORGANIZATION. (4 cr [no cr for sociology majors], §3401; prereq 8 cr sociology, anthropology, economics, political science or psychology) Galaskiewicz, Knoke, Nelson, Savelsberg
Theories of social structure, social stratification, community structure, status groups, nature of social power, social control processes, aspects of formal organizations, and rational actor models for decentralized social processes.

5405. SOCIAL STRATIFICATION AND MOBILITY. (4 cr; prereq 3401 or 3405 or 5401 or any 3xxx sociology course or equiv; some stats recommended; offered alt yrs) Brewer, Fulton, Nelson
Form and content of hierarchical arrangements. Relationship of hierarchical arrangements to problems of social order and individual behavior.

5411. FORMAL ORGANIZATIONS. (4 cr; prereq 3401 or 5401 or equiv or 8 cr sociology, anthropology, psychology, political science or economics; offered alt yrs) Galaskiewicz, Knoke
Sociological analysis of formal organizations. Theories of structure of and behavior in corporations and bureaucracies. Corporate structure explored from standpoint of role expectations, transaction costs, and structural responses to organizational failures. Power, conflict, and bargaining in organizational decision making. Course content varies.

8411. SEMINAR: CURRENT TOPICS IN THE STUDY OF ORGANIZATIONS. (3 cr; prereq 5411; offered when feasible) Knoke, Galaskiewicz

8415. THEORIES OF SOCIAL ORGANIZATION. (4 cr; prereq #) Galaskiewicz, Knoke, Nelson, Savelsberg
Survey of social organization; presentation and critical analysis. Major social organizational concepts, theoretical perspectives, and current theoretically relevant literature.

Historical and Comparative

5301. SOCIAL MOVEMENTS IN A CHANGING SOCIETY. (4 cr; prereq 3401 or 5401 or equiv or #) Aminzade, Broadbent, Brustein
Origins and organization of social movements. Dilemmas and challenges facing movement organizations. Strategies and tactics of protest movements. Relationship between social movements and political institutions, including parties, the state, and the mass media. Role of social movements in dynamics of social change.

5305. ENVIRONMENTAL SOCIOLOGY. (3 cr; prereq 1001 or environmental course or #)
Interaction between social and natural systems, especially societal causes of increasing pollution and ecosystem destruction. Culture, social relations, politics, and economics as causes and potential solutions.

5415. COMPARATIVE SOCIAL STRUCTURE. (4 cr; prereq 20 cr sociology, economics or political science or #; offered when feasible) Cooperman, Nelson

5481. COMPARATIVE ASIAN DEVELOPMENT. (4 cr, §EAS 5481; prereq sociology of development, Asian-related courses or #; offered when feasible)
Broadbent

5524. THE CROSS-CULTURAL CONSTRUCTION OF SEXUALITY. (4 cr; prereq 8 cr sociology or #; offered alt yrs) Reiss
See Family, Gender, and Human Sexuality for description.

5755. SOCIAL STRUCTURE AND POLITICAL BEHAVIOR. (4 cr; prereq 5401 or 5401 or equiv or #) Aminzade, Broadbent, Brustein
Alternative theoretical perspectives on power, the state, political parties, and political change. Relationship between socio-economic structures and political behavior. Nature and social origins of democratic and authoritarian forms of the state. Distribution of power in contemporary United States, Western Europe, and/or East Asia.

5954. SOCIOLOGY OF GENDER. (4 cr; prereq 3401 or #; offered alt yrs) Brewer, Laslett, Marini, Pierce
See Social Self and Life Course for description.

8477, 8478. RESEARCH SEMINAR: HISTORICAL SOCIOLOGY. (4 cr per qtr; prereq #) Aminzade, Laslett
8477: General theoretical and methodological issues in historical sociology. Student submits proposal outlining research to be undertaken in 8478. 8478: Research project carried out under supervision of instructors; submission of research paper.

8755. SEMINAR: RESEARCH IN POLITICAL SOCIOLOGY. (4 cr; prereq 5755 or #; offered alt yrs) Aminzade, Broadbent, Brustein
Problems of research in political sociology and political economy; theory and methodology for explaining relationships at micro and macro levels. Individualized research projects.

8794. DEMOCRACY: THEORY AND PRACTICE. (4 cr; prereq #) Aminzade, Broadbent
Recent theory and research on origins and character of democratic institutions, focusing on comparative/historical research on citizenship, representation, party systems, and dynamics of change in democratic political systems.

Family, Gender, and Human Sexuality

5505. FAMILY DEVELOPMENT. (5 cr; prereq 1001, 3201 or 5201 or equiv, CPsy 1301 or #) Leik
Natural history of families; how they form, function, and achieve distinctive identities. Developmental growth of children and parents in interaction in seven stages of the family life cycle, from engagement planning to family dissolution.

5524. THE CROSS-CULTURAL CONSTRUCTION OF SEXUALITY. (4 cr; prereq 8 cr sociology or #; offered alt yrs) Reiss
How society shapes sexual customs. How sexuality is influenced by a society's beliefs concerning jealousy, gender roles, and normality. Comparison and explanation of U.S. sexual customs and those in Western and non-Western societies.

5954. SOCIOLOGY OF GENDER. (4 cr; prereq 3401 or #; offered alt yrs) Brewer, Laslett, Marini, Pierce
See Social Self and Life Course for description.

8501. SEMINAR: CONTEMPORARY RESEARCH ON MARRIAGE AND THE FAMILY. (4 cr; offered when feasible) Laslett, Reiss

8524. SEMINAR: SOCIOLOGY OF HUMAN SEXUALITY. (3 cr; offered alt yrs) Reiss
Social criticism of society's traditional handling of sexuality. Recent scientific work on AIDS, rape, teenage pregnancy, and child sexual abuse; how they may be reduced by a more pluralistic conceptualization of sexuality.

Social Theory

5701. ANALYTICAL SOCIAL THEORY. (4 cr; prereq 8 cr social sci or #) Cooperman
Standards for evaluating sociological explanations. Main types of sociological theory: systems, theories of conflict, exchange, network, interpretive. Current issues in theoretical analysis.

5703. SOCIAL LIFE AND CULTURAL CHANGE. (4 cr; prereq 8 cr social sci or #) Cooperman, Donohue, Fulton, Marini
Theories of social change; methodological problems. Comparative social thought and structure of antiquity as basic data for analysis.

5705. BACKGROUND OF MODERN SOCIAL THOUGHT. (4 cr; prereq 8 cr social sci or #) Brustein, Laslett, Marini
Selections from original texts by Marx, Weber, Durkheim, Freud, and Gilman. Division of labor, social cohesion and social control, gender and social reproduction, class relations and social organization of production, norms and values, history.

5711. ELEMENTS OF SOCIOLOGICAL ANALYSIS. (4 cr; prereq 8 cr social sci or #) Broadbent, Cooperman, Leik
Premises upon which social theories are developed. Construction of social theories.

8701. SEMINAR: CLASSICAL SOCIOLOGICAL THEORY. (4 cr; prereq 8711, 8725 or #) Broadbent, Cooperman, Laslett, Marini, Savelsberg
Considered on individual, small group, organizational, and societal levels. Theorists such as Marx, Simmel, Durkheim, Weber, Gilman, Merton, Parsons, Mead, and Blumer.

Graduate Programs

8702. SEMINAR: CONTEMPORARY SOCIOLOGICAL THEORY. (4 cr; prereq 8701 or #) Aminzade, Broadbent, Brustein, Cooperman, Laslett, Marini, Pierce, Savelsberg
Considered on individual, small group, organizational, societal, and world-system levels. Social exchange, rational choice, expectation states, feminist, organizational ecology, network, and conflict theories. Examples of empirical research testing these theories.

8711. SEMINAR: PRINCIPLES OF SOCIAL SCIENCE. (4 cr; prereq 1st-yr soc grad student or #) Aminzade, Broadbent, Cooperman, Knoke, Laslett, Marini, Savelsberg
Goal of science and how it is furthered by theory and empirical research. Process by which a cumulative body of knowledge is developed; usefulness of that knowledge for improving human welfare.

8725. SEMINAR: THEORY CONSTRUCTION. (4 cr; prereq 8711 or #) Broadbent, Cooperman, Knoke, Marini
Structure of scientific theories and basic tools for developing and critiquing them. Types of theoretical statements, use of symbolic logic, concept formation, operationalization, confirmation status, determinacy of predictions, generalization, testability.

Methodology

5801. COMPUTER METHODS IN SOCIAL RESEARCH. (4 cr; offered alt yrs) Anderson
Basic concepts of information processing for social science research; elementary computer programming; practice in the use of computers for data analysis in social science; selected problems of computer usage in sociology.

5812. CONTENT ANALYSIS METHODS. (4 cr; prereq 3803 or equiv or #; offered alt yrs) McTavish
Content analysis methods used in social science research emphasizing computer-based developments. Theory, concept and dictionary formation, interview and data preparation procedures, contextual and conceptual computer analysis, interpretation, integration into quantitative and qualitative research.

8714. COMPARATIVE SOCIOLOGY: PERSPECTIVES IN THEORY AND RESEARCH. (3 cr; offered when feasible) Broadbent, Cooperman, Savelsberg

8812. DATA ANALYSIS I. (4 cr; prereq 3801, 3802, 3803 or 5021 or #) Knoke, Leik, Marini, McLeod, McTavish
Multivariate techniques based on general linear model: multiple correlation and regression, analysis of variance, analysis of covariance, canonical correlation, discriminant analysis, exploratory and confirmatory factor analysis, logistic regression, and structural equation modeling. Application using computers.

8813. DATA ANALYSIS II. (4 cr; prereq 8812 or #) Knoke, Leik, Marini, McLeod, McTavish
Methods of categorical data analysis, including log linear analysis and other discrete variable techniques. Event history, time-series, longitudinal data, and network analysis. Application using computers.

8814. SEMINAR: DESIGN OF SOCIOLOGICAL RESEARCH I. (4 cr; prereq 1st-yr soc grad student or #) Bian, Marini, McLeod, McTavish
Multiple objectives of social research and how they inform research design. Choice of unit of analysis, role of comparison, natural vs. controlled experiments, observational research, archival research, cross-sectional vs. over-time designs, ethical issues.

8815. SEMINAR: DESIGN OF SOCIOLOGICAL RESEARCH II. (4 cr; prereq 8814 or #) Anderson, McLeod
Measurement and quantitative and qualitative data collection and management. Review of approaches; validity; reliability; settings in which different types of data are collected and preserved; documentary sources; ethical issues; coding; content analysis; data storage, management, and retrieval.

8817-8818. SOCIOLOGICAL RESEARCH PRACTICUM. (5 cr per qtr; offered alt yrs) Anderson, McLeod, Pierce
Direct experience with variety of research techniques.

8821. SEMINAR: DESIGN OF QUALITATIVE RESEARCH. (3 cr; prereq #)
Techniques of qualitative field research. Participant observation, ethnography, in-depth interviewing, grounded theory.

8822. SEMINAR: ANALYSIS OF QUALITATIVE RESEARCH. (3 cr; prereq 8821, #)
Techniques for analyzing qualitative data, grounded theory, naturalistic inquiry, data presentation techniques.

8831. MEASUREMENT. (3 cr; prereq 3803 or equiv; offered when feasible) Anderson, Leik

Other Areas

5960. TOPICS IN SOCIOLOGY. (1-5 cr per qtr; prereq 1001)
Special, one-time offerings for juniors, seniors, and graduate students; topics specified in *Class Schedule*.

5970. DIRECTED STUDY. (1-5 cr per qtr; prereq #)
Guided individual readings or study.

8090. TOPICS. (Cr ar; prereq #)
Topics announced in *Class Schedule*. May also be taken as directed study (general seminar) by arrangement with an instructor in the department.

8955. SEMINAR: TEACHING SOCIOLOGY ON THE COLLEGE LEVEL. (3 cr; prereq 2nd- or 3rd-yr sociology grad student or #) Aminzade, Kennedy, Spitzer
Purposes; new developments. Relevant learning theories; opportunity to develop a plan for teaching a course, either individually or as part of a team.

Soil Science (Soil)

Professor: H. H. Cheng, *head*; Peter H. Graham, *director of graduate studies*; Raymond R. Allmaras; James L. Anderson; Donald G. Baker; Paul R. Bloom; Charles E. Clapp; Terence H. Cooper; Robert H. Dowdy; Samuel D. Evans; David F. Grigal; Satish C. Gupta; Gary L. Malzer; Jean A. Molina; Gyles W. Randall; George W. Rehm; Donald C. Reicosky; Mark W. Seeley; Ward B. Voorhees

Associate Professor: Deborah L. Allan; William C. Koskinen; John A. Lamb; Dennis R. Linden; John F. Moncrief; Robert C. Munter; Edward A. Nater; Pierre C. Robert; Carl J. Rosen; Michael P. Russelle; Michael J. Sadowsky; Michael A. Schmitt

Assistant Professor: John M. Baker; James C. Bell; David R. Huggins; Clive F. Reece

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Areas of concentration include genesis and classification, chemistry and fertility, microbiology and biochemistry, physics, and agricultural climatology. The course of study varies with the requirements of the area of concentration and the interests of the student. The minor, supporting, or related fields are usually selected in some allied field such as agronomy, botany, chemistry, microbiology, biochemistry, physics, geology, economics, forestry, agricultural engineering, or atmospheric science.

Prerequisites for Admission—The academic background normally required includes standard courses in college physics, chemistry (including quantitative analysis and organic or biochemistry), geology, microbiology, and mathematics, including one course in calculus, and an introductory course in soil science. For agricultural climatology, additional courses in mathematics, physics, meteorology, and engineering may be substituted. Candidates for the Ph.D. degree are normally required to have completed an acceptable master's degree thesis.

Special Application Requirements—A statement of career goals and three letters of recommendation evaluating the applicant's

potential for graduate study should accompany applications to both the M.S. and Ph.D. programs. Submission of Graduate Record Examination scores is required of all native English speakers; students whose native language is not English are expected to have ranked in the top 20 percent of their class. Students may be admitted in any quarter.

Master's Degree Requirements—Students must complete a minimum of 20 course credits in the major (excluding 5114) plus 16 master's thesis credits. Soil science coursework must include at least one core course in three of the five areas of concentration: soil chemistry-fertility, soil genesis-classification, soil physics, soil microbiology/biochemistry, and agricultural climatology. A seminar presentation and one colloquium are also required. A final oral examination is required.

Doctoral Degree Requirements—Students must complete or have completed at least one core course in three of the main areas of soil science listed under the M.S. degree requirements, two additional seminars, and two additional colloquia, plus 36 doctoral thesis credits. One of the required seminars outlines the proposed thesis research. A final oral examination is required.

Language Requirements—None.

For Further Information and

Applications—Contact the Department of Soil Science, University of Minnesota, 439 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108 (612/625-1244; fax 612/625-2208).

Soil 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Soil 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Soil 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5020. ENVIRONMENTAL IMPACT ASSESSMENT. (3 cr; prereq jr or sr, 16 crs science, AgEc 3610 or #)

Cooper
Roles of government agencies, consultants, and private citizens in assessment process. Steps in writing an environmental impact statement (EIS). Case studies, writing additional components of EIS, and preparing an EIS for a small local project.

Graduate Programs

5022. INTRODUCTORY SOIL SCIENCE FOR TEACHERS.

(4 cr, §1020; prereq one course in college chemistry, education degree, #) Cooper
Physical, chemical, and microbiological properties of soil. Using soil classification system to understand use of soil survey information for land use planning. Soil fertility concepts used in environmental planning and conservation decisions.

5104. COMPUTER APPLICATIONS IN SOIL SCIENCE.

(2 cr; prereq 1020 or 3125 or equiv, #) Robert
Practical problem-solving methods. Applications in soil climatology, chemistry-fertility-microbiology, genesis-inventory, and physics. Use of spreadsheets, relational databases, geographic information systems, and simulation models. Hands-on experience in computer lab. No computer programming experience required.

5114. SPECIAL PROBLEMS IN SOILS. (1-7 cr per qtr; prereq 3125, #, Δ)
Independent study.

5183. WATER RELATIONS, MINERAL NUTRITION, AND TRANSLOCATION IN HIGHER PLANTS.

(4 cr; prereq PBio 3131 or equiv) Allan, Markhart
Transport processes in plants, including water and nutrient absorption and distribution, effects of and adaptations to water and nutrient stress, functions of mineral nutrients, and translocation of photosynthates.

5210. ENVIRONMENTAL BIOPHYSICS.

(3 cr; prereq Math 1251, Phys 1041 or #) Reece
Physical micro-environment and energy/mass exchange processes among soils, plants, animals, and atmosphere. Calculating energy (sensible, latent, radiation) and mass (H₂O, CO₂, trace gases) transfer using mathematical models and energy budget analyses. Lecture and recitation.

5211. ENVIRONMENTAL INSTRUMENTATION.

(2 cr; prereq 5210, 5240 or #) Reece
Measuring environmental variables and analyzing energy and mass exchange based on such measurements. Principles of operation of environmental instruments and sources of measurement errors. Hands-on use of instruments. Lab and lecture/recitation.

5232. SOIL PHYSICS.

(4 cr; prereq Math 1142 or equiv or #) Gupta
Basic physical laws governing processes occurring in soils and their quantification. Physical basis for water, air, and heat transport processes. Lectures, lab demonstrations, and problem-solving help sessions.

5241. MICROCLIMATOLOGY.

(3 cr, §5240; prereq Math 1111 or 10 cr physics or #) D Baker
Meteorology and climatology in relation to soil-atmosphere interface with emphasis on microclimate; physical processes taking place within microclimate; modification of microclimate by human activities, including agricultural practices; meteorological instruments and use of weather data.

5310. SOIL CHEMISTRY.

(3 cr; prereq Chem 3100 or #) Bloom
Chemical processes in soil; composition of soil minerals and organic matter, solubility equilibria, adsorption/desorption, ion exchange, formation of soluble complexes, oxidation/reduction, acidity, alkalinity. Solution of problems related to environmental degradation, plant nutrition, and soil genesis.

5311. SOIL CHEMISTRY LABORATORY.

(2 cr; prereq ¶5310)
Lab exercises illustrate principles discussed in 5310. Techniques include pH, atomic adsorption spectrophotometry, ion specific electrodes, colorimetry, redox potential, and titration techniques.

5360. SOIL CLAY MINERALOGY. (3 cr; prereq sr standing or grad student; offered alt yrs) Nater
Structural chemistry, and origin and identification of crystalline and noncrystalline soil clay minerals. Extent, importance, and pedologic implications.

5361. SOIL CLAY MINERALOGY LABORATORY.

(1-4 cr; prereq ¶5360, #)
Individual lab assignments emphasizing techniques of clay mineral identification and analysis. Emphasis on X-ray diffraction methods. Electron optical, thermal, selective dissolution, FTIR spectroscopic, and other methods of analysis.

5424. APPLIED CLIMATOLOGY.

(3 cr, §Geog 5424; prereq 5240 or Geog 3421 or #) D Baker
For advanced undergraduates and beginning graduate students with background in principles of climatology or microclimatology. Sources of climatic data, methods of analysis, and selected set of specific applications focusing on agricultural and environmental management problems.

5510. FIELD STUDY OF SOILS FOR ENVIRONMENTAL ASSESSMENT.

(4 cr; prereq 1020 or 3125 or #) Cooper
Field observation and identification of morphological characteristics of soils. Interpretation of soil profiles for environmental assessment. Identification of soil landscapes and influence of soil-forming factors on soil morphology. Lectures and field laboratories.

5515. SOIL DEVELOPMENT, CLASSIFICATION, AND GEOGRAPHY.

(4 cr; prereq 3125 or #) Nater
Soil profile characteristics; influence of parent material, climate, topography, vegetation, and time on soil development, system of soil classification, and geographical distribution of soil orders.

5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION.

(3 cr; prereq 1020 or 3125 or #) Grigal
Formation, properties, and management of peatlands important to crop, forestry, and energy production in Minnesota and world. Lectures.

5555. WETLAND SOILS. (4 cr; prereq 1020 or 3125 or #)

Morphology, chemistry, hydrology, and formation of mineral and organic soils in wet environments. Soil indicators of wet conditions and techniques for identifying hydric soils for wetland delineations. Field trips and delineation exercise; emphasizes peatlands and wetland benefits, preservation, regulation, and mitigation.

5560. INTERPRETATION OF LAND RESOURCES. (3 cr; prereq 5510 or #) Anderson, Bell

Techniques for preparing soil maps of varying scales. Information from soil maps and accompanying reports evaluated for use in agriculture, engineering, waste treatment, forestry, and land planning. How soil survey and geographic information systems can be used to fullest in land resource interpretation.

5600. PRINCIPLES OF WASTE MANAGEMENT. (4 cr, §NRES 5600; prereq Biol 1009 or Chem 1051, Stat 3011 or #) Halbach

Issues, problems, and solutions in remedying waste stream generated by current society. Waste stream dynamics, MSW and yard waste composting, WTE incineration operation, ash disposal, recycling, landfill requirements, direct land disposal requirements, regulatory trends, and case studies.

5605. MICROBIAL ECOLOGY. (3 cr, §MicB 5611; prereq 5610 or Biol 5013 or MicB 5105 or #) Sadowsky
Interrelationship of microorganisms with terrestrial, aquatic, and organismal environments; survey of bacterial, fungal, and algal components of ecosystems; evolution and structure of microbial communities; population interactions within ecosystems; quantitative and habitat ecology; biogeochemical cycling; and biotechnological approaches to study of microbial ecology.

5610. SOIL BIOLOGY. (4 cr; prereq sr or grad student) Graham

The soil environment, its biological population. Role of living organisms in soil-plant environment and mineral transformations of agronomic importance (carbon, nitrogen, phosphorus, sulfur, heavy metals). Effects of soil microflora on soil fertility and plant nutrition. Lectures and recitation.

5611. SOIL BIOLOGY LABORATORY. (1 cr, ¶5610)

Techniques include counting microbes in soil, purification and classification of soil microorganisms, role of earthworms in nutrient cycling, nodulation and N_2 fixation, serology.

5710. ADVANCED FOREST SOILS. (3 cr [4 cr with paper]; prereq 1020 or 3125) Grigal

Factors affecting tree growth; estimation, modification, and management effects on site productivity; regeneration.

8000. SUPERVISED TEACHING EXPERIENCE.

(2 cr, §Agro 8000, §Hort 8000; prereq #) Allan
Classroom or extension teaching experience in Department of Agronomy and Plant Genetics or Horticultural Science or Soil Science; participation in teaching topic discussions to strengthen skills and develop personal teaching philosophy.

8111f,w,s. COLLOQUIA IN SOIL SCIENCE. (1 cr; prereq major or minor in soil sci or #)

Methodologies or rapidly developing areas of research not treated in existing courses. Lectures and discussions; some topics include visits to field sites and other laboratories.

8112. COLLOQUIA IN SOIL SCIENCE II. (1-2 cr; prereq major or minor in soil sci or #)

Methodologies or rapidly developing areas of research not treated in existing courses. Lectures and discussions; some topics include visits to field sites and other laboratories.

8124.* RESEARCH PROBLEMS IN SOILS. (2-5 cr; hrs ar)

Individual fieldwork lab in special problems in an area of soils other than that of the student's major thesis. Arrangements must be made in advance.

8128.* SEMINAR: SOILS. (1 cr)

Reports and discussion of significant ideas in soil science, including completed and planned research.

8250. ADVANCED SOIL PHYSICS. (3 cr; prereq 5232, differential equations or #) Gupta

Methods of measuring or estimating thermal and hydraulic characteristics of soils. Scaling soil hydraulic parameters. Numerical and analytical solutions of heat and water flow equations. Spatial and temporal variability in soil physical properties. Predicting soil mechanical behavior during tillage and compaction.

8330. ADVANCED SOIL CHEMISTRY. (4 cr; prereq physical chem or #; offered alt yrs) Bloom

Using physical chemistry principles for studying chemical processes in soil; chemistry of carbonates, dissolution/precipitation equilibria, oxidation/reduction, kinetics, adsorption/desorption, ion exchange and speciation of ions in solution. Lectures and discussion of current literature.

8400. ADVANCED TOPICS IN SOIL FERTILITY.

(3 cr; prereq 3416 or equiv; offered alt yrs) Allan
Soil testing, plant tissue analysis, application of amendments, models, and decision-making tools.

8630. CURRENT TOPICS IN BIOLOGICAL**NITROGEN FIXATION.** (2 cr; prereq 5605 or 5610 or #; offered alt yrs) Graham

Selected topics including inoculant production and control; ecology of *Rhizobium* in the soil; legume-*Rhizobium* specificity; competition; C and N nutrition of legumes; and environmental factors affecting BNF.

South Asian and Middle Eastern Languages and Cultures

Professor: Indira Y. Junghare, *chair and director of graduate studies*; Frederick M. Asher (art history); David Kopf (history); Joseph E. Schwartzberg (geography)

Associate Professor: Iraj Bashiri (Slavic and Central Asian languages and literatures); William W. Malandra (Classical and Near Eastern studies); Rocky V. Miranda (linguistics); Daniel D. Reisman (Classical and Near Eastern studies); Martin W. Sampson (political science)

Assistant Professor: Paul W. Staneslow

Librarian: Donald C. Johnson

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—South Asian Languages: M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Concentrations are Hindi, Marathi, Sanskrit, and Urdu. Programs focus on languages, literatures, cultural traditions, and contemporary problems of South Asia (countries of the Indian subcontinent and Himalayan borderlands).

Special Application Requirements—See the General Information section of this bulletin for Graduate School requirements.

Master's Degree Requirements—For the South Asian languages major, three years of study in one South Asian language or demonstration of equivalent level of proficiency is required. Besides language courses, Plan A requires two seminars and two non-language courses. Plan B requires two seminars and three courses on culture, history, literature, or religion, depending on the student's academic goals and subject to approval of the adviser. The final examination is oral.

Doctoral Degree Requirements—Four years of study in the language of concentration or demonstration of an equivalent level of proficiency and two years of study in a second South Asian (or related) language are required. The student is expected to enroll in seven non-language courses related to her or his academic goals. The student should have had at least one year in academic residence at Minnesota before taking the preliminary written and oral examinations.

Language Requirements—None for admission; for master's and doctoral programs, see above.

For Further Information and Applications—Contact the Department of South Asian and Middle Eastern Languages and Cultures, University of Minnesota, 188 Klæber Court, 320 16th Avenue S.E., Minneapolis, MN 55455 (612/624-4118).

SALC 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

SALC 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

SALC 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Hindi (Hndi)

5131-5132-5133. INTERMEDIATE HINDI. (5 cr per qtr; prereq 1103 or 5103 or #) Staneslow

5161-5162-5163. ADVANCED HINDI. (4 cr per qtr; prereq 3033 or 5133 or #) Junghare, Staneslow
Reading and discussion of short stories and other literature.

5701. STRUCTURE OF HINDI. (4 cr; prereq 3031 or 5131 or #) Junghare, Staneslow
Intensive examination of structure of Hindi language with attention to syntactic and semantic structure.

5710. TOPICS IN HINDI LANGUAGE AND LITERATURE. (5 cr) Junghare, Staneslow
Specialized topic in either the linguistic structure of Hindi or Hindi literature. Topic varies with student and faculty interest.

8990. RESEARCH. (Cr ar; prereq #)

Marathi (Mar)

5101, 5102, 5103. BEGINNING MARATHI. (5 cr per qtr, §1101, 1102, 1103) Junghare

5970. DIRECTED READINGS. (Cr ar) Junghare

8990. RESEARCH. (Cr ar; prereq #)

Sanskrit (Skt)

5131-5132-5133. BEGINNING SANSKRIT. (5 cr per qtr) Malandra

5161-5162-5163. ADVANCED SANSKRIT. (4 cr per qtr; prereq 5133) Junghare, Malandra

5201-5202-5203. INTERMEDIATE SANSKRIT. (5 cr per qtr; prereq 5133) Malandra

5320. READINGS IN PHILOSOPHICAL TEXTS. (4 cr [may be repeated for cr]); prereq 5133) Junghare, Malandra
Readings in representative texts.

South Asian and Middle Eastern Languages and Cultures

5710. TOPICS IN SANSKRIT LANGUAGE AND LITERATURE. (5 cr) Junghare, Malandra

Specialized topics in the linguistic structure of Sanskrit or Sanskrit literature. Topic varies quarterly.

8990. RESEARCH. (Cr ar; prereq #)

Urdu (Urdu)

5131-5132-5133. INTERMEDIATE URDU. (5 cr per qtr; prereq 1103 or Hindi 1103, 5103 or #) Barker

5161-5162-5163. ADVANCED URDU. (4 cr per qtr; prereq 3033, 5133 or #) Barker

South Asian Languages and Cultures (SALC)

5011. INDO-ARYAN LINGUISTICS. (4 cr) Junghare, Miranda

Phonological, morphological, and syntactic developments; Indo-European, Old Indo-Aryan, Middle Indo-Aryan, Hindi, and other major modern Indo-Aryan languages.

5031. TRADITIONAL RELIGIONS OF INDIA. (4 cr, §3031, §ReIS 3031, §ReIS 5031)

Historical survey of India's pre-Islamic religious traditions with emphasis on Hinduism and Buddhism (Theravada and Mahayana). Religion in context of history, society, ideological systems, literature, and visual arts.

5036. THE RELIGION OF ISLAM. (4 cr, §3036,

§ReIS 1036, §ReIS 3036, §ReIS 5036) Barker
Evolution of Islam in historical context; institutions that made for diversity and continuity; traditions, law, and observances of the faith; sectarian movements; philosophical and theological trends; modern developments: reformist, revolutionary, and militant.

5090. INSTRUCTION IN SOUTH ASIAN LANGUAGES. (Cr ar; offered when feasible) Staff

5201. ANCIENT INDIAN LITERATURE IN TRANSLATION. (4 cr) Malandra

Literary achievements of Indian civilization from ancient period.

5202. MODERN INDIAN LITERATURE IN TRANSLATION. (4 cr) Junghare

Literary achievements of Indian civilization from modern period.

5203. COMPARATIVE INDIAN LITERATURE IN TRANSLATION. (4 cr) Junghare

Comparative Indian literature of modern period.

5232. EARLY BUDDHISM, CASTE, AND CHAUVINISM. (4 cr, §Hum 5232, §ReIS 5232; prereq jr or sr or grad student or #)

Polemics and intellectual/social implications of early Buddhists rejecting caste traditions of Indian religions, which led to conversion of non-Hindus and missionary expansion of Buddhism.

5411. INTRODUCTION TO INDIAN PHILOSOPHY. (4 cr, §3411) Junghare

Major concepts; principal schools of Indian philosophy; traditional and contemporary views.

5412. HINDUISM. (4 cr, §3412, §ReIS 3412, §ReIS 5412; 1504 or 3411 or ReIS 1031 or # recommended) Junghare

Development of Hinduism; sectarian trends, modern religious practices, myths and rituals, pilgrimage patterns and religious festivals, and interrelationship of Indian social structure and Hinduism.

5413. BUDDHISM. (4 cr, §3413, §ReIS 3413, §ReIS 5413) Junghare

Historical account of Buddhist religion in terms of its rise, development, various schools, and common philosophical concepts. Focuses on Indian Buddhism, compares it with Hinduism, and discusses its demise and revival on Indian subcontinent.

5414. COMPARATIVE RELIGIONS OF SOUTH ASIA. (4 cr, §3414, §ReIS 3414, §ReIS 5414; 3412 or ReIS 3413 recommended)

Compares and contrasts basic philosophical concepts, literatures, ideologies, and ritualistic practices of Hinduism, Buddhism, and Jainism with those of Islam and Sikhism.

5500. PROBLEMS IN INDIAN PHILOSOPHY. (4 cr, §Phil 5801; prereq 5 cr phil, 4 cr Indian phil or religion or #)

Emphasizes analyses of mind and knowledge.

5531-5532. CULTURAL HISTORY OF NORTH INDIA: 1000-1707. (4 cr per qtr; prereq Indian

civilization course, medieval Indian history course or #) India in Muslim period; developments in Indian Islam; analysis of such syncretic movements as Sikhism.

5710. SEMINAR IN SOUTH ASIAN LANGUAGES AND LITERATURES. (Cr ar) Staff

5833. INDIA'S GODS AND GODDESSES. (4 cr, §Hum 5833, §ReIS 5833; prereq Hum 1211 or ReIS 1031 or SoAs 1504 or equiv, jr or sr or #) Staff

Societies give shape to their gods/goddesses and are in turn shaped by these mythological constructs. Indian history examined by following development of deities Krishna, Shiva, and Kali. Interactions of region, gender, class, in manifestations of art, drama, literature, ideology.

5940. TOPICS PROSEMINAR. (1-4 cr)

Selected topics in language, literature, or civilization.

5960. TOPICS IN SOUTH ASIAN LANGUAGES AND CULTURES. (4 cr)

Topics specified in *Class Schedule*.

5970. DIRECTED STUDIES. (Cr ar; prereq #, Δ, □)
Guided individual reading or study.

5990. DIRECTED RESEARCH. (Cr ar; prereq #, Δ, □)

8710. SEMINAR: SOUTH ASIAN LANGUAGES AND LITERATURE. (Cr ar; prereq #) Staff

Graduate Programs

8720. SEMINAR: INTERDISCIPLINARY STUDY OF SOUTH ASIAN TOPICS. (5 cr; prereq #) Staff
Selected Indian topics: language problems, social structure, social and cultural change, law, and religion as seen from variety of disciplinary perspectives in both social sciences and humanities.

8730. TEACHING SOUTH ASIAN LANGUAGES AND LITERATURE. (4 cr; prereq #) Staff
Fundamentals of language instruction as applied to South Asian languages and literature. Instruction in materials preparation and teaching or specific languages to a controlled group.

8990. RESEARCH. (Cr ar; prereq #)

Middle Eastern Languages and Cultures (MELC)

The following courses relating to the Middle East are applicable to student programs focusing on those features of South Asia that overlap with the Middle East (e.g., the Arab world, Iran, Turkey). Some of these courses are also applicable to the M.A. program in Arabic.

5001. INTRODUCTION TO RESEARCH IN ARABIC STUDIES. (4 cr, §Arab 5001)
Survey of most important research bibliographies in Arabic and Islamic studies. Bibliographic references in English and possibly in Arabic if sufficient interest.

5311. MEDIEVAL SAGES: IRAN AND SOVIET CENTRAL ASIA. (4 cr, §CAS 5311, §SCAS 5311; prereq some background in Iranian or Central Asian or Islamic studies) Bashiri
Intellectual life of the region from rise of the Ghaznavids (1000 A.D.) to fall of the Timurids (1500 A.D.).

5501. MODERN ARABIC POETRY. (4 cr, §3301, §Arab 3301, §Arab 5501)
Free verse movement and its major trends: post-romantic, social realist, symbolist, resistance, prose poem. Leading poets: al-Mal'ika, al-Sayyab, al-Bayati, Andunis, Hawi, Al-Khal, al-Fayturi, Abd-al-Sabur, Darwish, Sayigh, Jabra, al-Maghut. Cultural and historical context. Theoretical and critical essays. All readings in English.

5502. THE ARABIC NOVEL IN TRANSLATION. (4 cr, §3302, §Arab 3302, §Arab 5502)
Novel as new literary genre in Arabic literature. Trends: realist, psychological, existentialist, feminist, post-modernist/fantastic/experimentalist. Major novelists: Mahfouz Ghanem, Salih, Jabra, Kanafani, El Saadawi, al-Shaykh, Munif, Habibi, al-Qa'id, al-Ghitany, Khoury. Cultural and historical context. Discursive writing and theoretical and critical essays. All readings in English.

5503. ARABIC DRAMA. (4 cr, §3303, §Arab 3303, §Arab 5503)
Drama as new genre in modern Arabic literature, influenced by European drama. Relation with traditional dramatic forms in Arabic literature and culture. Trends: "theater of the mind," social realist, existentialist, absurdist, experimentalist, epic, verse drama. Major playwrights: al-Hakim, Abd-al-Sabur, Diyab, Salem, Faraj, Idris, al-Maghut, al-'Ani, Wannus, al-Madani. Cultural and historical context. Theoretical and critical essays. All readings in English.

5505. SURVEY: THE MIDDLE EAST. (4 cr, §Hist 3505) Farah
Cultural, religious, and scholarly achievements of Middle Eastern peoples from pre-Islamic times to present.

5508. ISLAM: IRAN TO INDIA. (4 cr, §RelS 5508, §RelS 5508) Staff
Islam as a faith; formation of Perso-Islamic civilizations; historical, religious, and cultural developments from Samanids to revolution; Islam in South Asia; configuration of Indo-Islamic heritage; Sufi orders; syncretic and revivalist movements; challenges of modernity, contemporary Islam in India and Pakistan.

5601. FICTION: IRAN AND CENTRAL ASIA. (4 cr, §CAS 5601, §SCAS 5601) Bashiri
Social, political, and religious thought of Iranian and Central Asian fiction writers since beginning of 20th century, emphasizing themes of tradition, modernization, women's rights, and secularization.

5602. PERSIAN POETRY IN TRANSLATION. (4 cr, §3602) Bashiri
Major poetic works of Iran: quatrains of Omar Khayyam, sonnets of Hafiz; "new" Persian poetry such as works of Farugh Farukhzad.

5730. PROSEMINAR IN MIDDLE EAST HISTORY: 16TH TO 19TH CENTURIES. (4 cr, §Hist 5730)
Topics, which vary widely, on Mamluk, Safavid-Qajar, and Ottoman era concerning relations with each other and outside world, including political, diplomatic, and ideological orientations and conflicts; cultural and social trends; commerce; transformations due to Western impact, to secularization, and to modernization and colonial encroachments.

5940. TOPICS PROSEMINAR. (1-4 cr)
Selected topics in language, literature, or civilization.

5960. TOPICS IN MIDDLE EASTERN STUDIES. (4 cr)
Topics specified in *Class Schedule*.

5970. DIRECTED STUDIES. (Cr ar)
Guided individual reading or study.

5990. DIRECTED RESEARCH. (Cr ar; prereq #, Δ, □)

Persian (Per)

5011. STRUCTURE OF PERSIAN. (4 cr; prereq 3013 or #) Bashiri
Phonology, morphology, and syntax of Persian; linguistic skills necessary for understanding modern standard Persian.

5900. READINGS IN AN IRANIAN LANGUAGE.

(1-4 cr per qtr [max 12 cr], SSCAS 5900; prereq 3013 or #) Bashiri, Malandra
Pre-medieval and medieval Iranian texts. Topics specified in *Class Schedule*.

Spanish

See Hispanic and Luso-Brazilian Literatures and Linguistics.

Speech-Communication (Spch)

Professor: Karlyn Kohrs Campbell, *chair*; Robert L. Scott, *director of graduate studies*; Ernest Bormann (*emeritus*); Donald R. Browne; Sheldon Goldstein (Media Resources); Alan G. Gross (rhetoric); Dean E. Hewes; J. Vernon Jensen (*emeritus*); Josef A. Mestenhauser (Office of International Education); Harold A. Miller (Continuing Education and Extension); Marshall Scott Poole; George L. Shapiro; Robert P. Sonkowsky (Classical and Near Eastern studies); Richard E. Sykes

Visiting Professor: Janice E. Schuetz

Associate Professor: Rosita Albert; David L. Rarick; Amy L. Sheldon

Visiting Associate Professor: Michael E. Holmes

Assistant Professor: Becky L. Omdahl; Janice A. Peck

Lecturer: Becky S. Kroll (Minnesota Women's Center; on leave 1994-95)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Emphases in the M.A. and Ph.D. programs are communication theory and research (including interpersonal, small group, organizational, and intercultural communication); rhetoric and public address (including history of public address, rhetorical theory, and criticism); and electronic media (including history, cultural theory and criticism, programming, and social effects).

Prerequisites for Admission—All applicants must have completed at least 16 undergraduate credits in speech or communication courses related to their proposed area of emphasis in the department. A brochure detailing prerequisite requirements is available from the department. All prerequisites must be completed before admission.

Special Application Requirements—

Applicants must submit scores from the Graduate Record Examination General Test, transcripts of all post-secondary academic work, and a written statement of academic and occupational objectives. Letters of recommendation are required of all applicants for assistantships or fellowships. Graduate study may begin in any quarter. A deadline of January 15 is recommended for students applying for teaching assistantships or University fellowships for the following academic year. Scores from the Graduate Record Examination General Test are also required for fellowship applicants.

Master's Degree Requirements—All M.A. students must take Spch 5421 and complete at least one 8xxx speech-communication seminar. Degree program requirements are flexible (see department brochure). For Plan B majors, one Plan B project is required. Written and oral final examinations are required for Plan A. Ordinarily, only a written examination is required for Plan B.

Doctoral Degree Requirements—A minimum of 39 credits in speech-communication completed at Minnesota, including 15 credits in department seminars, are required. Students must acquire research competence in an approved methodology (see department brochure), or by demonstrating competence in a foreign language appropriate for their dissertation research.

Language Requirements—For the master's degree, none. For the doctoral degree, see Doctoral Degree Requirements above.

For Further Information and Applications—Contact the Department of Speech-Communication, University of Minnesota, 460 Folwell Hall, 9 Pleasant Street S.E., Minneapolis, MN 55455 (612/624-5800). A brochure detailing admission procedures and M.A. and Ph.D. programs is available.

Graduate Programs

Spch 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Spch 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Spch 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5110. ADVANCED TOPICS IN SPEECH-COMMUNICATION THEORY. (4 cr [may be repeated for cr with #]; prereq 3211, 3401, 3601 [whichever is relevant to the topic]) Advanced theoretical problems. See department office for current topic.

5211. CONTEMPORARY PROBLEMS IN AMERICAN BROADCASTING. (4 cr; prereq 3211, sr status) Browne, Peck, Rarick
Problems affecting American commercial and public broadcasting. Cable television, development of prime-time television programming, violence on television, management issues, regulatory agencies.

5215. HISTORY OF TELEVISION PROGRAMMING. (4 cr; prereq 3211 or #)
Evolution of television program from pre-commercial beginnings to present. Key genres, persons, issues, and trends in development of prime-time television programming in the United States.

5222. EDUCATIONAL TELEVISION PROGRAMMING AND ADMINISTRATION. (4 cr; prereq 3211 or #)
Television applied to educational needs; current practices; significant research findings; relative effectiveness of differing types of television use; impact of various modes of transmission on programming and administrative concepts.

5231. COMPARATIVE BROADCAST SYSTEMS. (4 cr; prereq 3211 or #) Browne
Historical, sociological, and political aspects of various systems of broadcasting throughout the world. American, Canadian, British, French, German, Russian/Commonwealth of Independent States, and other broadcast institutions: why and how they are regulated and what impact they have had on political, social, and economic development.

5232. INTERNATIONAL BROADCASTING. (4 cr) Browne
Broadcasting as an international medium of communication in the United States, Great Britain, Russia/Commonwealth of Independent States, Japan, and other countries. Theories of informing and persuading through direct broadcast and regional and international exchange of programs; international and regional regulatory agreements; current problems in spectrum control; social and legal implications of broadcasting via satellite.

5233. BROADCASTING AND NATIONAL DEVELOPMENT. (4 cr) Browne
Purposeful employment of radio and television to effect changes in the social, political, economic, and cultural life of various peoples and nations. Emphasis on the use of broadcasting by developing nations to improve agricultural practices, promote better hygienic standards, increase literacy, and develop an awareness of civic responsibility.

5261. THE COMMUNICATIVE PROCESSES OF TELEVISION. (4 cr; prereq 3211 or #) Peck
Television as a system of communicative processes: the organizational processes of televised communicators and communicatees, and how viewers use television.

5281. BROADCASTING AUDIENCE ANALYSIS AND PROGRAMMING. (4 cr; prereq 3211) Rarick
Methods of measuring and analyzing radio and television audiences. Structure and appeals of program formats. Strategies in programming and scheduling. Critical perspectives on audience estimates.

5401. ADVANCED THEORIES OF COMMUNICATION. (4 cr; prereq 3401 or grad student) Hewes, Omdahl, Sykes
Analysis of theories of communication, usefulness for particular purposes. Historical and conceptual development of theories of communication.

5402. PROBLEMS IN INTERPERSONAL COMMUNICATION. (4 cr; prereq 3401 or #) Omdahl, Shapiro
Factors contributing to misunderstanding, not understanding, disagreement, and cessation of contact in dyads.

5403. THEORY CONSTRUCTION AND ANALYSIS IN COMMUNICATION. (4 cr; prereq 3401 or #) Hewes, Omdahl, Sykes
Problems in development of communication theory. Existing theory. Relationship of theory to research.

5404. LANGUAGE, CULTURE, AND EDUCATION. (4 cr, \$SeEd 5404; prereq 1102, 3401 or #) Sheldon
Psychological and social-psychological perspectives for study of language-communication; dimensions of language variation (dialects, codes, registers); implications for program development and instructional practices.

5405. NONVERBAL COMMUNICATION: THEORY AND RESEARCH. (4 cr) Omdahl, Sykes
Nonverbal (extralinguistic) elements and dimensions of interpersonal communication. Nonverbal categories examined include gesture, facial expression, posture, clothing, and environment.

5407. COMMUNICATION AND INTERPERSONAL CONFLICT. (4 cr; prereq 3401, 3411) Poole
Theory and research on role of communication in conflict in groups, organizations, and interpersonal relationships. Communication in negotiations. Interventions into interpersonal conflicts.

5411. SMALL GROUP COMMUNICATION THEORY. (4 cr; prereq 3411 or #) Hewes, Poole
Theories of communication within small, task-oriented group. Group cohesiveness, leadership, role structure, information processing, decision making.

5414. AUTHORITY AND POWER IN TASK-ORIENTED COMMUNICATION. (4 cr; prereq 3411 or #; S-N only) Shapiro
Authority and power in task-oriented groups. Tavistock-type small group, intergroup and large group lab experiences. Verbal and nonverbal processes in and among groups that affect leadership and followership.

5421. QUANTITATIVE RESEARCH IN COMMUNICATION. (4 cr; prereq 3401 or 5403 or #) Hewes, Sykes
Review and discussion of experimental and descriptive research; analysis of research design and procedures; individual research projects.

5422. INTERVIEWING AND COMMUNICATION. (4 cr; prereq 1101, 6 cr social sci or #) Rarick
Theory and practice of communication in the information interview. Role of interpersonal perception, empathy, and cognitive structure in dyadic communication. Experience in interviewing and communication analysis.
Applications to research in interpersonal and mass communication.

5431. THE PROCESS OF PERSUASION. (4 cr; prereq 1102, 3431) Albert, Omdahl, Scott
Theories of modern motivational communication. Process of social control through persuasive speech.

5441. COMMUNICATION IN HUMAN ORGANIZATIONS. (4 cr; prereq 3401 or 8 cr social sci, 3441 or #) Kroll, Poole, Shapiro
Communication in organizational settings. Organizational structure and dynamics and their effect upon communication process. Individual projects.

5443. THEORIES OF ORGANIZATIONAL COMMUNICATION. (4 cr; prereq 3401, 3441 or #) Poole
Survey of theories and relevant empirical research. Implications for modern organizations, their members, and society.

5451. INTERCULTURAL COMMUNICATION. (4 cr; recommended 3401, Anth 1102 or other course in cultural anthropology or #) Albert
Successful interpersonal communication across cultures. Verbal and nonverbal communication.

5452. INTERCULTURAL INTERACTION: THEORY AND APPLICATION. (4 cr; prereq #) Albert
Small group interaction across cultures for international and U.S. students; readings, group discussions, role playing, simulations, lectures.

5602. CONTEMPORARY POLITICAL PERSUASION. (4 cr; prereq 1101 or 1101H, 5431 or #) Campbell, staff
Ideologies in political persuasion.

5611. CLASSICAL RHETORIC. (4 cr; prereq 1101 or 1101H) Scott
Greek and Roman theories of speech making; historical and philosophical context and influence on education.

5615. INTRODUCTION TO RHETORICAL CRITICISM. (4 cr; prereq 1101 or 1101H; 3601 recommended) Campbell, Scott
Traditional and contemporary rhetorical theory and its application to contemporary public address.

5617. HISTORY AND CRITICISM OF AMERICAN PUBLIC ADDRESS. (4 cr; prereq 1101 or 1101H, Psy 1001)
Survey: history and criticism of religious and reform speech in the United States from 1620 to 1920.

5618. HISTORY AND CRITICISM OF AMERICAN PUBLIC ADDRESS. (4 cr; prereq 1101 or 1101H, Psy 1001)
Survey: history and criticism of political speech in the United States from the Revolution to the present.

5621. WOMAN'S RIGHTS/WOMAN SUFFRAGE RHETORIC. (4 cr; prereq 5615 or #) Campbell
History and criticism of rhetoric of woman's rights/woman suffrage movement in United States, 1835-1925.

5622. CONTEMPORARY FEMINIST RHETORIC. (4 cr; prereq 5615 or #) Campbell
History and criticism of rhetoric of contemporary feminist movement in United States, 1945-present.

5625. ISSUES IN COMMUNICATION ETHICS. (4 cr; prereq 3625 or #)
Issues in ethical dimension of interpersonal, small group, public, and mass communication, clustered around communicator, receiver, message, medium, situation, and effects.

5970. DIRECTED READINGS. (Cr ar; prereq 9 cr upper division speech, #, Δ, □; S-N only)
Directed reading and preparation of reports on selected subjects.

8110-8120-8130. SEMINAR: ADVANCED SPEECH PROBLEMS. (3 cr per qtr; prereq undergrad degree in spch-comm or equiv)
Evaluation of research methods in speech and communication.

8210. SEMINAR: SELECTED TOPICS IN U.S. ELECTRONIC MEDIA. (3 cr [may be repeated for cr]; prereq 5211 or #; offered when feasible) Browne, Rarick

8211. CRITICAL COMMUNICATION STUDIES: HISTORY, THEORY, METHOD. (3 cr; A-F only) Peck
Qualitative research methods for studying media institutions, texts, audiences, and contexts.

8231. SEMINAR: NATIONAL AND INTERNATIONAL ELECTRONIC MEDIA SYSTEMS. (3 cr; prereq 5231 or 5232 or 5233 or #) Browne
Historical and contemporary aspects of national and international electronic media systems. Roles of national and international regulatory bodies. Approaches to programming and evidence of effectiveness.

Graduate Programs

8401. CURRENT ADVANCED THEORIES OF PERSON-TO-PERSON COMMUNICATION. (3 cr; prereq 5401 or #) Sykes

Readings and research on recent theorists of person-to-person communication. Tapes of natural conversations as illustrative raw material for application of theory.

8402. SEMINAR: INTERPERSONAL COMMUNICATION PROBLEMS. (3 cr) Omdahl, Shapiro

Evaluation and development of new perspectives for analysis, diagnosis, and management of interpersonal communication problems.

8411. SEMINAR: SMALL GROUP COMMUNICATION. (3 cr; prereq 1101, 5411) Hewes, Poole

Research problems and methods.

8421. SEMINAR: COMMUNICATION AND NEGOTIATION. (3 cr; prereq 5411, 5441 or #) Hewes, Poole

Influence of communication patterns on bargaining outcomes. Formal negotiation as a model for situations of partial conflict.

8440. SEMINAR: TOPICS IN ORGANIZATIONAL COMMUNICATION. (3 cr; prereq 5441 or #)

8441. SEMINAR: ORGANIZATIONAL COMMUNICATION. (3 cr; prereq 5441 or #) Shapiro
Directed projects. Emphasis on studies conducted in real or simulated organizations.

8451. SEMINAR: FACE-TO-FACE INTERCULTURAL COMMUNICATION. (3 cr; prereq, if US citizen, Anth 5101 or similar course in cultural anthropology or #; 5451 recommended) Albert
Factors influencing face-to-face communication in varied cultures, concentrating upon task-oriented communication between North American and nationals in the host country. Verbal (linguistic) and nonverbal (nonlinguistic) dimensions of communication.

8452. SEMINAR: FACILITATING INTERCULTURAL COMMUNICATION. (3 cr; prereq 5451 or #; 8451 recommended) Albert
Theories and techniques of managing effective interpersonal communication across cultural boundaries.

8501. INTRODUCTION TO SURVEY RESEARCH IN SPEECH-COMMUNICATION. (3 cr; prereq Jour 8001 or #) Poole, Rarick

Research-survey-based projects in broadcasting and public address. Design and execution of small scale, research-based survey; problems attendant upon execution of studies.

8502. QUANTITATIVE RESEARCH IN SPEECH-COMMUNICATION. (3 cr; prereq Jour 8001 or #; 8201 recommended) Hewes, Poole, Rarick
Design, execution, and reporting of quantitative studies in speech-communication. Experimental and field methods appropriate to specific problems. Research problem and technique defined each quarter.

8503. HISTORICAL AND DESCRIPTIVE RESEARCH IN SPEECH-COMMUNICATION.

(3 cr) Browne
Elements involved in conducting and analyzing historical and descriptive research in speech-communication; approaches to historical research, assessment of primary and secondary sources; execution of major research project.

8504. SEMINAR IN RHETORICAL CRITICISM.

(3 cr) Campbell, Scott
Theories of rhetorical criticism; methods of criticizing rhetorical discourse. Rhetoric as applied to literary studies and the growth of hermeneutics as vantage points for reassessing rhetorical methods.

8606. SEMINAR: RHETORICAL ANALYSIS OF CAMPAIGNS AND MOVEMENTS. (3 cr; prereq 5431, 5617 or 5618, 10 cr social sci or #) Campbell, Scott
Literature and methodology in historical and contemporary rhetorical campaigns and movements.

8611, 8612, 8613. SEMINAR IN RHETORIC. (3 cr per qtr; prereq 5611 or #) Scott
History and criticism of rhetorical theory. Research in rhetoric.

8621. SEMINAR: HISTORY AND CRITICISM OF PUBLIC ADDRESS. (3 cr; prereq 5617, 5618 or Δ) Campbell, Scott
Methods of rhetorical criticism. Application of method in individually selected research projects.

8625. SEMINAR: COMMUNICATION ETHICS. (3 cr; prereq 3625 or 5625 or #)
Independent research on communication ethics in interpersonal, small group, public speaking, or mass communication.

8990. RESEARCH. (Cr ar, prereq #, Δ; S-N only)
Open to graduate students engaged in research on special problems.

Statistics (Stat)

Professor: Seymour Geisser, *director*, School of Statistics; David A. Lane, *chair*, Department of Theoretical Statistics; Douglas M. Hawkins, *chair*, Department of Applied Statistics; Glen D. Meeden, *director of graduate studies*; Christopher Bingham; R. Dennis Cook; James M. Dickey; Morris L. Eaton; John F. Geweke (economics); Kinley Larntz; Bernard W. Lindgren; Thomas A. Louis (biostatistics); Christopher J. Nachtsheim (management sciences); Ronald R. Regal¹; William D. Sudderth; Luke Tierney; Sanford Weisberg

Associate Professor: Kathryn M. Chaloner; Patricia M. Grambsch (biostatistics); Frank B. Martin; Gary Oehlert; Ronald C. Pruitt; Daniel Zelterman (biostatistics)

Assistant Professor: Bradley P. Carlin (biostatistics); Charles J. Geyer; Birgit Grund

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

¹ University of Minnesota, Duluth

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Students may specialize in any area of statistics or probability. The core program for all students has strong components of both theoretical and applied statistics.

Prerequisites for Admission—For admission to the master's program, familiarity with basic statistical concepts and methods, and mathematics through multivariable calculus and linear algebra, are required. For admission to the doctoral program, in addition to the above, knowledge of the elements of real analysis is required.

Special Application Requirements—Two letters of recommendation are required. Applicants are strongly encouraged to submit scores from the General (Aptitude) Test (and from the mathematics Subject Test for mathematics majors) of the Graduate Record Examination. A minimum TOEFL score of 550 is required of applicants whose native language is not English. Applicants are considered for admission for fall, winter, spring, or summer terms; however, financial support is usually available only to those beginning fall quarter, on the basis of applications received by the preceding February 15 (February 1 for fellowships).

Master's Degree Requirements—For Plan B, which is ordinarily taken, the following courses in statistics are required: 5151-5152-5153, 5161-5162-5163 (if these or equivalent courses are not included in the student's undergraduate program), as well as 1 credit each in 8801 and 8900, the latter involving preparation and delivery of a seminar talk on a specific topic. Both written and oral final examinations are required.

Doctoral Degree Requirements—The preliminary written examination covers the material in 8151-8152-8153, 8162, 8311-8312, and Math 8656-8657-8658. In addition, students must complete a minimum of 27 credits in advanced statistics courses, distributed in at least three areas, as well as 3 credits in 8801 and one credit in 8900, the

latter involving preparation and delivery of a seminar talk. A second seminar talk is required by the Graduate School in connection with the final defense of the student's thesis.

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—For the master's degree, at least 12 credits in 5xxx or 8xxx statistics courses are required. For the doctoral degree, a theory sequence (5121-5122 or 5151-5152-5153) and familiarity with various statistical methods (e.g., 5201, 5301, 5302, 5401, 5421, 5601) are required. Typical programs contain 21 to 27 credits. The director of graduate studies should be consulted in advance for planning and approval of a balanced program.

For Further Information and

Applications—Contact the School of Statistics, University of Minnesota, 270 Vincent Hall, 206 Church Street S.E., Minneapolis, MN 55455 (612/625-8046; fax 612/624-8868; e-mail info@stat.umn.edu).

Stat 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Stat 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Stat 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5021. STATISTICAL ANALYSIS. (5 cr, §3012; prereq college algebra)

Intensive version of 3011-3012, for graduate students needing statistics as research technique.

5091. STATISTICAL METHODS FOR QUALITY IMPROVEMENT. (4 cr; prereq 3012 or 3091 or 5021 or 5122 or 5132 or 5152, Math 1252)

Application of statistical concepts of random variability and sampling, statistical process control, Shewhart and accumulative charting, analysis of plant data, applications of trend surface analysis, analysis of variance and design of experiments, quality improvement by reduction of random variability.

5121-5122. THEORY OF STATISTICS. (5 cr per qtr, §5131-5132-5133; prereq Math 1252)

Univariate and multivariate distributions, law of large numbers, sampling, likelihood methods, estimation and hypothesis testing, regression and analysis of variance, confidence intervals, distribution-free methods.

Graduate Programs

5131f-5132w-5133s. THEORY OF STATISTICS. (4 cr per qtr, §5121-5122; prereq Math 3252)

5131: Probability models, univariate and bivariate distributions, independence, basic limit theorems. 5132-5133: Statistical decision theory, sampling, estimation, testing hypotheses, parametric and nonparametric procedures for one-sample and two-sample problems, regression, analysis of variance. More mathematical treatment than 5121-5122.

5151f-5152w-5153s. THEORY OF STATISTICS. (4 cr per qtr, §5121-5122, §5131-5132-5133; prereq Math 3252, stat grad student)

A more in-depth version of 5131-5132-5133.

5161-5162-5163. APPLIED STATISTICAL METHODS. (4 cr per qtr, §5201, §5301, §5302, §5421; prereq ¶5131 or ¶5151, stat grad student or #)

5161: Simple and multiple regression; graphics. 5162: Variance reduction designs for experiments; factorial, fractional, and confounded designs; optimal designs; analysis of covariance; unbalanced data analysis. 5163: Advanced topics in linear regression; nonlinear models; generalized linear models; categorical data analysis; logistic regression.

5201. SAMPLING METHODOLOGY IN FINITE POPULATIONS. (4 cr; prereq 3091 or 5021 or 5121 or #)

Simple random, systematic, stratified, and unequal probability sampling. Ratio and regression estimation. Multistage and cluster sampling.

5271. BAYESIAN DECISION MAKING. (4 cr; prereq ¶5122 or ¶5132 or ¶5152)

Axioms for personal probability and utility. Elements of statistical decision theory. Bayesian analysis of linear models.

5301. DESIGNING EXPERIMENTS. (5 cr, §5163; prereq 3012 or 5021 or 5133 or 5153 or #)

Control of variation, construction and analysis of complete and incomplete block, split plot, factorial, and groups of similar experiments. Confounding, crossover, and optimum seeking designs.

5302. APPLIED REGRESSION ANALYSIS. (5 cr, §5161; prereq 3012 or 5021 or 5133 or #)

Simple, multiple, and polynomial regression. Estimation, testing, and prediction. Stepwise and other numerical methods; examination of residuals; weighted least squares; nonlinear models; response surface. Experimental research and economic applications.

5401. INTRODUCTION TO MULTIVARIATE METHODS. (4 cr; prereq 5302 or 5133 or 5153)

Bivariate and multivariate distributions. Inference on multivariate normal distribution. Discrimination and classification. Multivariate analysis of variance. Partial, canonical correlation and independence. Principal component analysis, factor analysis, analysis of repeated measurements, cluster analysis, profile analysis.

5421. ANALYSIS OF CATEGORICAL DATA. (4 cr, §5162; prereq 3012 or 5021 or 5133 or #)

Varieties of categorical data, cross-classifications and contingency tables, tests for independence. Multidimensional tables and log-linear models, maximum-likelihood estimation and tests of goodness of fit. Analysis of Markov chain data. Smoothing counts.

5601. NONPARAMETRIC METHODS. (4 cr; prereq 5021 or 5122 or 5132 or 5152 or #)

Survey of necessary discrete and continuous probability distributions. Goodness of fit, sign tests, order statistics, rank tests for location and for scale, two-sample and k-sample comparisons, association. Emphasis on methods and application.

5900. TUTORIAL COURSE. (Cr ar; prereq #)

Directed study in areas not covered by regular offerings.

5911, 5912. TOPICS IN STATISTICS. (3 cr per qtr [may be repeated for cr]; prereq 5021 or 3091, #)

Topics vary according to student needs and available staff.

8151-8152-8153. MATHEMATICAL STATISTICS.

(4 cr per qtr; prereq 5133 or 5153 or #, advanced calculus, matrix algebra)

8151: Probability distributions in statistical inference, derivations of sampling distributions. 8152: Elements of decision theory, tests of hypotheses, principles and methods of estimation including confidence regions. 8153: Introduction to sequential and nonparametric inference, and to large-sample theory.

8162. COMPUTATIONAL STATISTICAL METHODS.

(4 cr per qtr; prereq 8312, programming exper)

Random variate generation, variance reduction techniques. Robust location estimation and regression, smoothing additive models, regression trees. Programming projects; basic programming ability and familiarity with standard high-level language (preferably FORTRAN or C) is essential.

8171-8172. THEORY OF INFERENCE. (3 cr per qtr; prereq 8153, Math 8658 or #)

Topics may vary according to interests of instructors and students. Possible topics include conditional distributions and sufficiency, theory of estimation, comparison of various theories of statistical inference, Neyman-Pearson theory of hypothesis testing and its extensions, confidence regions, invariance, most stringent tests, nonparametric and sequential inference.

8191. LARGE-SAMPLE THEORY. (3 cr; prereq 8153, Math 8658 or #)

Types of convergence. Limit theorems. Asymptotic properties of sampling distributions. Asymptotic efficiency. Likelihood and other methods of inference. Categorical data.

8221. TOPICS IN SAMPLING. (3 cr; prereq 8312)

Stratification and clustering, double sampling, unequal probability sampling, analysis of data from complex surveys, superpopulation theory, Bayesian methods in sample surveys, nonresponse.

8311-8312. LINEAR MODELS. (4 cr per qtr; prereq 5122 or 5133 or 5153, linear algebra)

Theory of the general linear model from coordinate-free geometric perspective. Estimation, distribution theory, testing, confidence statements, diagnostics, random effects models, Bayesian approaches.

8313. TOPICS IN EXPERIMENTAL DESIGN. (3 cr; prereq 8312)

Bayesian design of experiments, repeated measures experiments, optimal design, algorithms for computing designs, design robustness.

8321. LINEAR AND NONLINEAR REGRESSION. (3 cr; prereq 8312 or #)

Advanced topics in linear regression, including computational methods, residual and influence analysis; incomplete data problems; nonlinear modeling and generalized linear models, including asymptotic theory, maximum likelihood estimation, measure of curvature; selected topics in robust methods.

8331. STATISTICAL COMPUTING. (3 cr per qtr; prereq 8162 or #)

Structure of the computer. Basic numerical analysis for statisticians. Approximating probability and other functions. Random number generation. Linear models. Classification (analysis of variance) models. Optimization, nonlinear regression, and robust methods. Writing and evaluating statistical software.

8411-8412. MULTIVARIATE ANALYSIS. (3 cr per qtr; prereq 8153)

Multivariate normal distribution. Inference on the mean, covariance, and correlation and regression coefficients; related sampling distributions such as Hotelling's T^2 and Wishart distributions. Multivariate analysis of variance. Principal components and canonical correlation. Discriminant analysis. Distribution of determinantal roots. Invariance, admissibility, minimax, and other properties of tests and estimates. Large-sample distributions.

8431. THEORY OF CATEGORICAL DATA ANALYSIS. (3 cr per qtr; prereq 5162 or #)

Multidimensional cross-classified arrays, sampling models and statistical theory for categorical data. Model selection and simultaneous testing. Logit and multinomial response models. Models for mixed categorical/continuous data. Logistic regression. Analysis of ordered categorical variables. Multiplicative and multiplicative-interaction models. Latent-structure models. Bayesian estimation of cell frequencies. Computing algorithms.

8501. INTRODUCTION TO STOCHASTIC PROCESSES WITH APPLICATIONS. (3 cr; prereq 5131 or 5151 or #)

Markov chains, Markov processes, Poisson process, Brownian motion, and other stochastic models encountered in applications.

8511. TIME SERIES ANALYSIS. (3 cr; prereq linear algebra, 5133 or 5153 or #)

Basic concepts and examples of stochastic processes; classical analysis of trends, cycles, and autoregressive models; spectral analysis; linear operations, prediction and filtering; problems of inference.

8611. NONPARAMETRIC INFERENCE. (3 cr; prereq 8153 or #)

Inference methods based on order statistics. U-statistics. Sign, rank, permutation, and run tests. Large-sample results. Confidence and tolerance regions. Asymptotic optimality. Categorical data. Estimation.

8731. STATISTICAL DECISION THEORY. (3 cr; prereq 8153, Math 8658 or #)

Convex sets and functions. Elements of game theory. Wald's formulation; mixed randomized rules. Bayes rules, least favorable distributions. Minimax theorems. Admissibility and complete class theorems. Sufficiency. Invariance. Comparison of experiments. Compound and multiple-decision rules.

8751. SEQUENTIAL ANALYSIS. (3 cr; prereq 8153)

Wald's sequential probability ratio test and modifications. Sequential decision theory. Martingales. Sequential estimation, design, and hypothesis testing: Recent developments.

8801. STATISTICAL CONSULTING. (1-3 cr; prereq stat grad major or #)

Topics in data analysis and/or consulting with members of University research community through Statistical Center.

8900. STUDENT SEMINAR. (1 cr; prereq stat grad major or #)

Preparation and presentation of seminar on statistical topic.

8901. DIRECTED READINGS AND RESEARCH. (1-3 cr; prereq #)

Directed study in areas not covered by regular offerings.

8931-8932-8933-8934. ADVANCED TOPICS IN STATISTICS. (3 cr per qtr [may be repeated for cr]; prereq #)

Topics vary according to student needs and available staff.

Math 5681-5682-5683. PROBABILITY AND STOCHASTIC PROCESSES

Math 8650-8651-8652. THEORY OF PROBABILITY

Math 8656-8657-8658. MEASURE THEORY AND PROBABILITY

Math 8690-8691-8692. TOPICS IN THE THEORY OF PROBABILITY

Related Courses

A limited number of the following related courses may be used in constructing major and minor programs in statistics. To do so, the approval of the director of graduate studies should be obtained in advance. It is to be emphasized that many of these courses have considerable overlap in content and that such duplications are to be avoided.

Graduate Programs

Econ 8111-8112-8113. INTRODUCTION TO MATHEMATICAL ECONOMICS

Econ 8201-8202-8203. APPLIED ECONOMETRICS

Econ 8211-8212-8213. ECONOMETRICS

EE 5700. INFORMATION THEORY AND CODING

EE 5702. STOCHASTIC PROCESSES AND OPTIMUM FILTERING

EE 8220. TOPICS IN STATISTICAL THEORY OF COMMUNICATION

EPsy 8260, 8261, 8262. STATISTICAL METHODS

EPsy 8263. DESIGN AND ANALYSIS OF EXPERIMENTS

EPsy 8264. MULTIPLE REGRESSION ANALYSIS

EPsy 8279. PROBLEMS: STATISTICS FOR STUDENTS IN EDUCATION AND PSYCHOLOGY

IEOR 5030. QUALITY CONTROL AND RELIABILITY

IEOR 5040. INTRODUCTION TO OPERATIONS RESEARCH

IEOR 5441-5442. OPERATIONS RESEARCH II-III

IEOR 5550. DESIGN AND ANALYSIS OF EXPERIMENTS I

IEOR 5551. DESIGN AND ANALYSIS OF EXPERIMENTS II

PubH 5450. BIostatISTICS I

PubH 5452. BIostatISTICS II

PubH 5454. BIostatISTICS III

PubH 5462. CLINICAL TRIALS I

Studies in Africa and the African Diaspora

Professor: Joanne B. Eicher (design, housing, and apparel); Caesar E. Farah (Afro-American and African studies); Allen F. Isaacman (history; Afro-American and African studies); Philip W. Porter (geography; Afro-American and African studies); Earl P. Scott (geography; Afro-American and African studies)

Associate Professor: Rose M. Brewer (Afro-American and African studies); Susan N. G. Geiger (women's studies); Ronald C. McCurdy (music; Afro-American and African studies); August H. Nimtz, Jr. (political science; Afro-American and African studies); Angelita D. Reyes (women's studies); John M. Taborn (Afro-American and African studies); John S. Wright (Afro-American and African studies; English)

Assistant Professor: Charles Ben Pike (Afro-American and African studies), *director of graduate studies*; Teirab AshShareef (Afro-American and African studies); Victoria B. Coifman (Afro-American and African studies)

Course of Study—Minor in studies in Africa and the African diaspora, applicable to master's (M.A. and M.S.) and doctoral programs.

Curriculum—An interdisciplinary graduate minor in studies in Africa and the African diaspora is administered through the Department of Afro-American and African Studies. The minor program provides students from a variety of disciplines with a structured graduate curriculum that offers a systematic understanding of the contemporary and historical experiences of peoples of Africa and of African descent. It is organized around a group of core seminars and focuses on two broad areas: 1) the humanities and the arts and 2) the social and behavioral sciences.

Prerequisites for Admission—Admission to the graduate minor in studies in Africa and the African diaspora is contingent upon prior admission to a master's or doctoral degree-granting program within the Graduate School.

Special Application Requirements—Completion of an application form by the end of winter quarter to be considered for acceptance into the minor program for the following academic year. It is expected that no more than 15 students will be admitted to this minor each year. An undergraduate major or minor in Afro-American and/or African studies is not required for admission to the program, but students are expected to have had sufficient background to begin graduate-level study.

Minor Requirements—The program requires a minimum of 11 graduate credits for a master's minor and 19 graduate credits for the Ph.D. minor. Each student for the minor is required to take a core seminar on Afro-American and African studies. Doctoral students take one additional seminar. Remaining courses are selected from one of the following areas: 1) the humanities and the arts or 2) the behavioral and social sciences. All courses for the minor must be outside the student's major field of study.

Language Requirements—None specific to the minor program.

For Further Information and Applications—Contact the Department of Afro-American and African Studies, 808 Social Sciences Building, 267 19th Avenue South, Minneapolis, MN 55455 (612/624-9847; fax 612/624-9383).

Afro-American and African Studies (Afro)

5072. RACISM: SOCIAL AND PSYCHOLOGICAL CONSEQUENCES FOR BLACK AMERICANS.

(4 cr, §3072) Taborn
 Racism and its effects on black Americans; definitions, determinants, and dynamics examined in an experiential context to reflect individual and institutional racism in milieu of student interest.

5142. GEOGRAPHY OF EAST AFRICA. (4 cr, §Geog 5142)

Physical and human geography of Kenya, Tanzania, and Uganda. Environment as resource; historical geography of colonial and postcolonial eras; geographical organization of human activity; regional contrasts.

5143. GEOGRAPHY OF WEST AFRICA. (4 cr, §Geog 5143)

West Africa from Senegal to Cameroon: social geography of resource use, population, settlement, economic development, and international relations.

5145f. DEVELOPMENT IN AFRICA. (4 cr, §Geog 5145, §IntR 5145; prereq #) Scott

Economic, political, and social development in Africa from independence to present. Reordering of colonial landscapes, bases for North-South relations, big power interventions, and participation in world economy.

5181 (formerly 5182). BLACKS IN AMERICAN THEATRE, 1820-1960s. (4 cr, §Th 5181)

Historical survey of significant events in development of American black theatrical tradition; essays, plays, playwrights, and theatres from early colonial references to Black Arts Movement.

5182 (formerly 5181). CONTEMPORARY BLACK THEATRE, 1960-PRESENT. (4 cr, §Th 5182)

Essays, plays, playwrights, and theatres that have contributed significantly to contemporary black theatre, from beginning of Black Arts Movement to present.

5200. BLACK AMERICANS AND MENTAL HEALTH. (4 cr; prereq grad student or #) Taborn

Factors and issues affecting mental health of black Americans. Development process of the black person's mental health; current trends in public policy and mental health.

5301. AFRICAN LITERATURE: THE NOVEL. (4 cr) Pike

The novel in continental Africa in English, French, and African languages. Non-English materials in translation.

5341. SEMINAR IN CONTEMPORARY KENYAN LITERATURE. (4 cr; prereq one African studies course or #) Pike

Novels of Ngugi, Mwangi, Njau, and Ruheni. Prose works and critical essays. All readings in English.

5352. BLACK FAMILIES IN COMPARATIVE PERSPECTIVE. (4 cr; prereq upper div or grad student) Brewer

To understand, cross-culturally, family formation, social structure, and gender patterns of families of African descent. Black families in West Africa, the Caribbean, and the United States.

5401. FIELD STUDY IN AFRO-AMERICAN AND AFRICAN STUDIES. (1-8 cr; prereq affiliated major or minor)

Faculty-supervised experiences working with, relating to, and conducting focused research on Afro-American and African populations with goal of experiencing cultural diversity through concurrently acknowledging, affirming, studying, and becoming a participant-observer in a cultural milieu that is Afro-American and/or African diasporic.

5551. USE OF ORAL TRADITIONS AS RESOURCES FOR HISTORY: METHODS. (4 cr) Coifman

Spoken information passed from person to person through time, mainly in nonliterate societies, as sources for writing history. Canons of history for analysis and critique of oral traditions, integration into written history.

5593. THE AFRO-AMERICAN NOVEL. (4 cr, §Engl 5593) Wright

Contextual readings of 19th- and 20th-century black novelists such as Charles Chesnutt, James Weldon Johnson, Zora Neale Hurston, Richard Wright, Chester Hines, Ann Petry, James Baldwin, John Williams, Toni Morrison, and Ishmael Reed.

5595. AFRO-AMERICAN POETRY. (4 cr, §Engl 5595) Wright

Selected Afro-American poets from 18th to 20th century, including Phillis Wheatley, Paul Laurence Dunbar, Sterling Brown, Gwendolyn Brooks, Melvin Tolson, Robert Hayden, Amiri Baraka.

5596. AFRO-AMERICAN AUTOBIOGRAPHY. (4 cr, §Engl 5596) Wright

Literary and intellectual traditions of black autobiography beginning with 18th-century slave narrative: Equiano, Douglass, DuBois, Hurston, Wright, Malcolm X, Angelou, and others.

5597. SEMINAR: THE HARLEM RENAISSANCE. (4 cr, §Engl 5597) Wright

Multidisciplinary review of Harlem Renaissance of Jazz Age: literature, popular culture, visual arts, political journalism, and black and white figures such as Jean Toomer, Claude McKay, Langston Hughes, Bessie Smith, DuBose Heyward, Carl Van Vechten, Eugene O'Neill, and Marcus Garvey.

Graduate Programs

5598. SEMINAR: THE BLACK ARTS RENAISSANCE, 1960s AND 1970s. (4 cr; prereq Afro studies major or minor or #) Wright
Multidisciplinary perspectives on post-Civil Rights and Black Power Era "renaissance" of African-American art and politics (literature, popular culture, visual arts, political journalism, etc.). Research projects and papers. Complementary course to 5597.

5678. AFRICAN-ARABIC FICTION IN TRANSLATION. (4 cr) AshShareef
Continental African novels and short stories written in Arabic from Algeria, Egypt, Libya, Mauritania, Morocco, Sudan, Tunisia, and Western Sahara. Writers include Barrada, Idris, Mahfouz, al-Matwi, al-Qa'id, Rifaat, El-Saadawi, Salih, Shukri, Wattar, and el-Zayat. African-Arabic oral narrative as backdrop. Emphasis on 20th century. Cultural and historical context of texts. Theoretical and critical essays. All readings in English; no knowledge of Arabic required.

5701, 5702. PROSEMINAR: AFRO-AMERICAN STUDIES. (4 cr per qtr, §3701, 3702; prereq #)
Classic works in Afro-American studies. Comparatist framework for Afro-American studies; cultural criticism and related issues in multidisciplinary study.

5800. AFRICAN STUDIES INTERDISCIPLINARY SEMINAR. (4 cr)
Staffed by cooperating faculty from the social sciences and humanities. Emphasis on selected themes that benefit from interdisciplinary analysis.

5864, 5865. AFRO-AMERICAN HISTORY. (4 cr per qtr, §Hist 5864, 5865)
Development of Afro-American ethnicity and culture, slavery, race relations, and public policy from period of slave trade to the present.

5876. SEMINAR: APPROACHES TO AFRICAN DEVELOPMENT. (4 cr; prereq 1021) Coifman
Study, critical analysis, and comparison of core documents relevant to development in Africa from the World Bank, Organization of African Unity, U.N. Economic Commission on Africa, and John-Paul II. Consideration of ethics.

5900. AFRO-AMERICAN SEMINAR. (2-4 cr; prereq jr or sr or grad student)
Staffed by scholars of Afro-American experience. In-depth analyses and discussion of selected issues and themes.

5910. TOPICS IN AFRO-AMERICAN/AFRICAN STUDIES. (4 cr) Staff
Selected topics that vary quarterly. Topics specified in the *Class Schedule*.

5970. DIRECTED STUDIES. (1-6 cr; prereq #, Δ, CLA approval; qualified srs and grads may register with # for work on tutorial basis) Staff

Engl 8590. STUDIES IN AFRO-AMERICAN LITERATURE

Fren 5289. TOPICS IN AFRICAN LITERATURE

Geog 8140. SEMINAR: AFRICA

Hist 5436. SOCIAL HISTORY OF AFRICAN WOMEN: 1850 TO PRESENT

Hist 5447. PROBLEMS IN EAST AFRICA

Hist 5931. HISTORY OF AFRICA: SOCIAL GROUPINGS, CONFLICTS

Hist 5932. AFRICAN HISTORIOGRAPHY

Hist 8430. TOPICS IN THE HISTORY OF AFRICAN PEOPLES

Hist 8944, 8945. AFRICAN HISTORY

Pol 5478. GOVERNMENT AND POLITICS OF AFRICAN COUNTRIES

Pol 8605. GOVERNMENT AND POLITICS OF AFRICA

Studies of Science and Technology (SST)

Professor: Ronald N. Giere (philosophy); Keith Gunderson (philosophy); William H. Hanson (philosophy); Geoffrey Hellman (philosophy); Sally Gregory Kohlstedt (history of science and technology); Edwin T. Layton (history of science and technology); Arthur L. Norberg (history of science and technology); C. Wade Savage (philosophy); Robert W. Seidel (chemical engineering and materials science); Alan E. Shapiro (history of science and technology); Roger H. Stuewer (history of science and technology)

Associate Professor: John H. Beatty (history of science and technology); John M. Eyler (history of medicine); Helen E. Longino (women's studies); C. Kenneth Waters (philosophy)

Course of Study—Minor in studies of science and technology, applicable to master's (M.A. and M.S.) and doctoral programs.

Curriculum—Studies of science and technology (SST) deals with a rapidly expanding field that seeks to understand the conceptual foundations, historical development, and social context of science and technology. SST faculty are drawn from five research or teaching units dedicated in whole or in part to the history and philosophy of science and technology: the Departments of Philosophy, History of Science and Technology, History of Medicine; the Center for Philosophy of Science; and the Charles Babbage Institute for the History of Information Processing. The SST minor is for students from any major who want to gain a deeper understanding of the nature and

development of science and technology. It should be particularly valuable for students who are planning teaching careers in science or engineering, or those majoring in philosophy or history of science and technology. It may also be of interest to students majoring in history, sociology, or related fields of study.

The SST minor provides introductory core courses in historiography and philosophy of science, followed by team-taught research seminars and other elective courses in four main research areas: models, theories, and reality; physical science; biological and biomedical sciences; and science, technology, and society. Seminar topics vary yearly, depending on faculty and student interest.

Prerequisites for Admission—Admission to the SST graduate minor is contingent upon prior admission to a master's or doctoral degree-granting program within the Graduate School and is by permission of the director of graduate studies in SST.

Minor Requirements—Master's students are required to take 12 credits, which must include HSci 8111, Phil 8605, and one SST seminar (SST 8100, 8200, 8300, or 8400). Doctoral students are required to take 19 credits, which must include HSci 8111, Phil 8605, 3 credits in SST 8000, and two SST seminars (SST 8100, 8200, 8300, or 8400). Students may not use courses from their major departments to make up any remaining credits.

Language Requirements—None specific to the minor.

For Further Information and

Applications—Contact the director of graduate studies, Studies of Science and Technology, University of Minnesota, 342-E Physics Building, 224 Church Street S.E., Minneapolis, MN 55455 (612/625-6635).

Core Courses

SST 8000. COLLOQUIUM. (1 cr [may be repeated for cr])
Nationally and internationally known scholars with diverse disciplinary and methodological backgrounds speak on variety of issues within the field.

HSci 8111. HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY. (4 cr) Staff

Phil 8605. ISSUES AND APPROACHES IN PHILOSOPHY OF SCIENCE. (4 cr) Staff

Elective Courses—

Models, Theories, and Reality

SST 8100. SEMINAR: MODELS, THEORIES, AND REALITY. (4 cr [may be repeated for cr]; prereq HSci 8111 or Phil 8605 or #) Beatty, Giere, Gunderson, Hanson, Hellman, Shapiro, Stuewer, Waters
Students participate in ongoing research on role of models and theories in science. Students prepare and present research papers as major part of course.

HSci 5113. NATURAL PHILOSOPHY IN THE SCIENTIFIC REVOLUTION. (4 cr) Shapiro

HSci 5511. HISTORY OF SCIENTIFIC METHODOLOGY. (4 cr) Beatty

Phil 5222. PHILOSOPHY OF MATHEMATICS. (4 cr) Hanson, Hellman

Phil 5601. THE EVALUATION OF SCIENTIFIC HYPOTHESES. (4 cr) Giere, Hanson, Hellman, Savage, Waters

Phil 5602. THE NATURE OF SCIENTIFIC THEORIES. (4 cr) Giere, Hellman, Savage, Waters

Phil 5603. SCIENTIFIC EXPLANATION. (4 cr) Giere, Hellman, Savage, Waters

Phil 5615. MINDS, BODIES, AND MACHINES. (4 cr) Gunderson

Phil 5617. TWENTIETH-CENTURY PHILOSOPHY OF SCIENCE: LOGICAL EMPIRICISM. (4 cr) Giere, Savage

Phil 5618. TWENTIETH-CENTURY PHILOSOPHY OF SCIENCE: THE HISTORICAL SCHOOL. (4 cr) Giere, Savage, Waters

Elective Courses—Physical Science

SST 8200. SEMINAR: THE PHYSICAL SCIENCES. (4 cr [may be repeated for cr]; prereq HSci 8111 or Phil 8605 or #) Hellman, Shapiro, Stuewer
Students participate in ongoing research in history, philosophy, and social study of physical sciences. Students prepare and present research papers as major part of course.

Graduate Programs

HSci 5924. HISTORY OF 19TH-CENTURY PHYSICS. (4 cr) Stuewer

HSci 5925. HISTORY OF 20TH-CENTURY PHYSICS. (4 cr) Stuewer

HSci 5935. HISTORY OF NUCLEAR PHYSICS. (4 cr) Stuewer

HSci 8121. FOUNDATIONS FOR RESEARCH IN ANCIENT SCIENCE. (4 cr) Shapiro

HSci 8122. FOUNDATIONS FOR RESEARCH IN THE SCIENTIFIC REVOLUTION. (4 cr) Shapiro

Phil 5604. DETERMINISM AND CAUSATION. (4 cr) Hellman

Phil 5605. TIME AND SPACE. (4 cr) Hellman, Savage

Phil 5606. PHILOSOPHY OF QUANTUM MECHANICS. (4 cr) Hellman

Elective Courses—

Biological and Biomedical Sciences

SST 8300. SEMINAR: THE BIOLOGICAL AND BIOMEDICAL SCIENCES. (4 cr [may be repeated for cr]); prereq HSci 8111 or Phil 8605 or #) Beatty, Eyler, Waters

Students participate in ongoing research in history, philosophy, and social study of biological and biomedical sciences. Students prepare and present research papers as major part of course.

HMed 5002. PUBLIC HEALTH ISSUES IN HISTORICAL PERSPECTIVE. (4 cr) Eyler

HMed 5035. THE GERM THEORY AND THE MEDICAL PROFESSION. (4 cr) Eyler

HSci 5201. HISTORY OF BIOLOGY: BIOLOGY FROM ANTIQUITY THROUGH EARLY MODERN PERIOD. (4 cr) Beatty

HSci 5202. HISTORY OF BIOLOGY: BIOLOGY IN THE 19TH AND 20TH CENTURIES. (4 cr) Beatty

HSci 5242. THE DARWINIAN REVOLUTION. (4 cr) Beatty

Phil 5607. PHILOSOPHY OF THE BIOLOGICAL SCIENCES. (4 cr) Beatty, Waters

Elective Courses—

Science, Technology, and Society

SST 8400. SEMINAR: SCIENCE, TECHNOLOGY, AND SOCIETY. (4 cr [may be repeated for cr]); prereq HSci 8111 or Phil 8605 or #) Beatty, Eyler, Kohlstedt, Layton, Norberg, Stuewer

Students participate in ongoing research on interactions involving science, technology, and society. Students prepare and present research papers as major part of course.

HMed 5045. MEDICAL PROFESSION IN AMERICA. (4 cr) Eyler

HMed 5120-5130. HISTORICAL TOPICS: MEDICINE AND THE MODERN STATE. (4 cr per qtr) Eyler

HSci 5321. HISTORY OF COMPUTING. (4 cr) Norberg

HSci 5331. TECHNOLOGY AND AMERICAN CULTURE. (4 cr) Norberg

HSci 5332. SCIENCE AND AMERICAN CULTURE. (4 cr) Kohlstedt

HSci 5681. ENGINEERING IN HISTORY. (4 cr) Layton

HSci 5825. PHYSICS AND SOCIETY IN 20TH-CENTURY AMERICA. (4 cr) Stuewer

HSci 8941. WOMEN IN SCIENCE: HISTORICAL PERSPECTIVES. (4 cr) Kohlstedt

Phil 5770. SELECTED TOPICS IN PHILOSOPHY: ETHICAL ISSUES IN BIOMEDICINE. (4 cr) Staff

Studio Arts

See Art.

Surgery (Surg)

Professor: Edward W. Humphrey, *interim chair*; David L. Dunn, *director of graduate studies*; R. Morton Bolman; Henry Buchwald; Michael D. Caldwell; Frank B. Cerra; Bruce L. Cunningham; John P. Delaney; John Foker; Robert L. Goodale; Theodor B. Grage; Arnold S. Leonard; Arthur J. Matas; Donald G. McQuarrie; John S. Najarian; David G. Reynolds; David E. R. Sutherland

Associate Professor: Jerome H. Abrams; William C. Engeland; Paul F. Gores; David R. Knighton; Caliann T. Lum; J. Ernesto Molina; William D. Payne; Sara J. Shumway

Assistant Professor: Gregg D. Phillips; Nancy L. Reinsmoen

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S.Exp.Surg. (Plan A only), M.S.Surg. (Plan A only), and Ph.D.Surg.

Curriculum—The program in general surgery trains medical doctors both for the practice of surgery and for academic positions. See the *Medical School Bulletin* for professional degree requirements; see below for academic degree requirements.

Trainees spend two to three years in lab research, either in a basic science or in surgery, after which they enter into their senior residency and chief residency training. The fundamental laboratories of the Medical School offer numerous graduate courses closely related to surgery (see Anatomy, Biochemistry, Laboratory Medicine, Microbiology, Pathobiology, Pharmacology, and Physiology). These fields also offer opportunities for special investigative and research work. Supervised work is offered by the Department of Surgery in its experimental research laboratories, as well as in its hospital and outpatient departments, in the areas of surgical diagnosis and operative surgery, and in some surgical specialties (such as colon and rectal surgery, transplantation, thoracic and cardiovascular surgery, and pediatric surgery). The M.S. in experimental surgery program provides an opportunity to obtain practical research experience for those who are fully trained in clinical surgery.

Prerequisites for Admission—Applicants must hold an M.D. degree from an approved medical school.

Master's Degree Requirements—For the M.S. in experimental surgery, 40 credits (two years' work), including at least 30 in surgical research, are required. The minor consists of 9 credits in a nonclinical field. The final examination is an oral defense of the thesis.

For the M.S. in surgery, 70 credits (five years' work), including at least 20 in surgical research, and passage of the department surgical examination are required. The minor consists of 9 credits in a nonclinical field. The final examinations are an oral defense of the thesis and a written examination.

Doctoral Degree Requirements—Of the required 100 credits (six years' work), at least 40 must be in research (basic science lab credit may be interchangeable with surgical lab credit at department discretion). Passage of department surgical examination is also required. The minor consists of 18 to 24 credits in a nonclinical field.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Surgery, University of Minnesota, Box 195 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/625-1400).

Surg 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Surg 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Surg 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5527. HOSPITAL NUTRITION SUPPORT. (9 cr; prereq acceptance to master's program in nutrition support dietetics)

Clinical experience in hospital nutrition support. Rotations in medicine, surgery, pediatrics, and home nutrition support. Principles of parenteral and enteral feeding; nutritional assessment. Exposure to clinical nutrition research.

8200. CLINICAL SURGICAL PROBLEMS IN MANAGEMENT. (5 cr) Staff

Graduate students act as house surgeons and are required to study all phases of patient care including diagnosis, pre- and postoperative management, and operative therapy. Graded responsibility offered under supervision of staff. Fellows operate under supervision beginning with simple procedures. When properly qualified, senior and chief residents manage entire care of some patients. Attendance at rounds, conferences, and seminars is mandatory.

8201. SURGICAL-ROENTGENOLOGICAL CONFERENCE. (1 cr) Najarian, staff

Weekly review of films of all surgical patients presenting interesting roentgen findings. Staffs of the Departments of Radiology and Surgery.

8202. SURGICAL RESEARCH. (5 cr) Staff

Properly qualified students undertake original investigation of problems in either experimental or clinical surgery.

8203. SURGERY COMPLICATIONS AND RESEARCH CONFERENCE. (1 cr) Najarian, staff

Evaluation of selected surgical patients including postoperative course. Current research problems are presented for discussion and critical evaluation.

8207. TRANSPLANTATION AND BONE MARROW CONFERENCE. (1 cr) Najarian

Current clinical and research problems are presented for interdepartmental discussion and evaluation.

Theatre Arts

Professor: Barbara Reid, *chair*; Lee Adey; H. Wesley Balk (on leave); C. Lance Brockman; Charles Nolte

Associate Professor: Jean A. Montgomery, *director of graduate studies*; Barbara M. Barker; Maria Cheng; Glen W. Gadberry; Nels Hennum; Stephen C. Kanee; Michal Kobjalka; Elizabeth H. Nash; James Norwood

Assistant Professor: Kathleen J. Egan; Martin B. Gwinup; Nancy Houfek; Margaret L. Maddux

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—Theatre Arts: M.A. (Plan A and Plan B), M.F.A., and Ph.D.

Curriculum—The Ph.D. in theatre arts certifies the mastery of the history, theory, and literature of theatre arts and the facility for applying and communicating that knowledge. Doctoral students are required to take nine core courses: eight consecutive courses in history, theory, and literature of theatre and one course in theatre historiography. Various seminars support these core courses. The M.A. emphasizes academic pursuits and is generally viewed as a prerequisite to work on the Ph.D. The five formal areas of study in both the Ph.D. and M.A. programs are theatre history and dramatic literature, playwriting and dramatic theory, acting, directing, and design and technical production. Candidates are required to take coursework in both academic and performance areas. Special facilities include the University's Performing Arts Archives and various language centers.

The three-year, performance-oriented M.F.A. degree offers three areas of specialization: acting, directing, or design and technical production. The *M.F.A. in acting*, an intensive, highly individualized professional actor training program, provides students with the physical, vocal, emotional, and intellectual skills necessary to succeed as working, growing artists. The *M.F.A. in directing*, an intensive course of study emphasizing performance, focuses on the advancement of intellectual and artistic skills and on the development of the leadership talent needed to make a significant

contribution to contemporary theatre. The *M.F.A. in design and technical production* provides a solid understanding of each area of design in order to communicate with other directors and designers. The student is expected to achieve proficiency in two of the three design areas (scenery/properties, costuming, and lighting) and a level of expertise in at least one of these areas. The M.F.A. degree is considered a terminal degree in these theatre arts areas.

Prerequisites for Admission—For all programs, a minimum of 18 undergraduate credits or the equivalent in theatre arts is required. Also required is a minimum 3.00 grade point average. International students must submit scores from the Test of English as a Foreign Language (TOEFL) by January 15; the minimum score for admission is 550. The master's degree is a prerequisite for admission to the Ph.D. program.

Special Application Requirements—The application deadline for all degree programs is January 15. Applications received after that date will be considered only if there is an opening in the particular program. M.A./Ph.D. students who want materials reviewed for the Graduate School Fellowship must submit them by January 5. Students are admitted in fall quarter only. Applicants for all degree programs except the M.F.A. in acting must submit scores from the Graduate Record Examination by February 1.

The *M.F.A. in acting* requires an initial audition either through the U/RTA process or as an independent auditionee, plus a final callback audition by invitation in Minneapolis in early March. Acting candidates using the independent audition process must have completed their application to the Graduate School before scheduling an audition. All candidates for final invitational callbacks must have completed their application to the Graduate School before scheduling callback auditions. The *M.F.A. in directing* requires an audition by invitation in Minneapolis in early March after an initial screening of application files. The *M.F.A. in design and technical*

production requires a portfolio review either through the Evanston U/RTA or by submitting materials by February 1. Contact the director of graduate studies for specific information.

General Degree Requirements—There are limits to the number of credits in practicum and performance courses that may be used to satisfy degree requirements for the M.A. and the Ph.D. For the M.A. the limit is 12 credits; for the Ph.D., 24.

Master of Arts Degree Requirements—For the M.A. degree, Plan A, general Graduate School requirements prevail. For the M.A. degree, Plan B, 12 credits of graduate work must be selected from history, theory, and dramatic literature; 12 credits from acting, design, directing, and playwriting; 8 credits from outside the department; and 12 elective credits. Written examinations are required. Contact the director of graduate studies for specific details.

Master of Fine Arts Degree Requirements—For the M.F.A. degree, a *minimum* of 84 graduate credits is required, as is a final oral examination. Each program requires a final performance practicum, including a written record of it. For specific program requirements, contact the director of graduate studies.

Doctoral Degree Requirements—The program of study for each Ph.D. student is designed by the student and adviser to develop appropriate skills in research and scholarship. Central to this is the core curriculum of 36 credits in theatre history/dramatic literature and historiography. The student will demonstrate special competence in theatre history, theory, dramatic literature, and a performance area. The choice of a minor is subject to approval from the major and minor advisers. A supporting program may be substituted for the minor with approval from the major adviser and director of graduate studies. Students must pass written and oral examinations.

One foreign language is required, which may serve as the research technique for the dissertation, if appropriate. Typically

students consult with advisers or the director of graduate studies for other research options.

Language Requirements—For the master's degree, none. For the doctoral degree, one language is required. See Doctoral Degree Requirements above.

For Further Information and Applications—Contact the Department of Theatre Arts and Dance, University of Minnesota, 204 Middlebrook Hall, 412 22nd Avenue South, Minneapolis, MN 55455 (612/625-5029; fax 612/625-6334).

Th 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Th 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Th 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Theatre Arts (Th)

History and Dramatic Literature

5131. SHAKESPEARE: THE COMEDIES AND ROMANCES. (4 cr; prereq 1101 or #) Norwood Seminar from perspectives of live theatre, staging in theatre, and film/television productions. Video clips from selected plays.

5132. SHAKESPEARE: THE HISTORIES. (4 cr; prereq 1101 or #) Norwood Seminar from perspectives of live theatre, staging in theatre, and film/television productions. Video clips from selected plays.

5132. SHAKESPEARE: THE TRAGEDIES. (4 cr; prereq 1101 or #) Norwood Seminar from perspectives of live theatre, staging in theatre, and film/television productions. Video clips from selected plays.

5171, 5172, 5173. HISTORY OF THEATRE. (4 cr per qtr) Gadberry Theatre as mirror of society. Aesthetics, philosophy, and techniques of theatre arts. *5171*: Origins to 1642. *5172*: Renaissance to 1875. *5173*: Theatre after 1875.

5181. BLACKS IN AMERICAN THEATRE. (4 cr, §Afro 5181) Historical survey of significant events in development of American Black theatrical tradition; essays, plays, playwrights, and theatres from early colonial references to Black Arts Movement.

5182. CONTEMPORARY BLACK THEATRE: 1960-PRESENT. (4 cr, §Afro 5182) Essays, plays, playwrights, and theatres that have contributed significantly to contemporary Black theatre, from beginning of Black Arts Movement to present.

Graduate Programs

5191. MYTH AND THE PERFORMANCE OF MODERN DRAMA I. (4 cr; prereq 5173 or #; offered alt yrs)
Examination of construction, reinforcement, or destruction of myth in selected theatre works.

5192. MYTH AND THE PERFORMANCE OF MODERN DRAMA II. (4 cr; prereq 5191 during preceding qtr; offered alt yrs)
Examination of construction, reinforcement, or destruction of myth in selected theatre performances.

8102. THEATRE HISTORIOGRAPHY. (4 cr)
Kobialka
Current trends in historiography; research strategies and methods. Required of all theatre doctoral students.

8103. THE THEATRE DRAMATURG. (4 cr; offered alt yrs) Staff
Role of dramaturg in theatrical performance: history, theory, practice.

8111, 8112, 8113, 8114, 8115, 8116, 8117, 8118. HISTORY/THEORY OF WESTERN THEATRE. (4 cr per qtr) Gadberry, Kobialka
Theories, arts, and crafts of theatre. *8111*: Ancient world. *8112*: Medieval. *8113*: Renaissance. *8114*: Rise of National Theatres. *8115*: 18th century. *8116*: Romanticism through Naturalism. *8117*: Symbolism through World War II. *8118*: 1945 to present.

8120. SEMINAR IN THEATRE: ADVANCED STUDY OF SELECTED FIELDS OF THEATRE. (4 cr per qtr [max 16 cr]) Staff
Selected research topics from various fields and periods of theatre.

Playwriting and Dramatic Theory

5115. PLAYWRITING I. (4 cr, §EngW 5204; prereq #)
Workshop for students with established competence.

5116. PLAYWRITING II. (4 cr, §EngW 5205; prereq 5115, #)
Workshop for students with advanced competence.

Acting

5321. CAREER PREPARATION FOR ACTORS. (4 cr; prereq 3323 or grad student)
Information and techniques necessary for professional acting careers.

5322. ACTING FOR THE CAMERA. (4 cr; prereq 3323 or grad student)
Differences between stage acting and acting for the camera. Scenes enacted and played back on videotape for class critique.

5331-5332-5333. ADVANCED MOVEMENT FOR ACTORS. (2 cr per qtr; prereq 3323, # by audition or grad student) Hennem
Explores awareness, flexibility, observation, releasing, mime and mask, improvisation, verbal and nonverbal physical techniques. *5331*: Fundamentals; *5332*: Introduction to mime and mask; *5333*: Mime and mask.

5334-5335. STAGE COMBAT. (2 cr per qtr; prereq 3323, # by audition or grad student) Hennem
Advanced movement techniques for the stage with focus on physical life of scenes of a violent nature. *5314*: Unarmed combat. *5315*: Armed combat.

5341. SHAKESPEAREAN TEXT ANALYSIS. (4 cr; prereq 3341, 3321-3322 or grad student) Nash
Analysis and performance of Shakespearean text.

5342. SINGING FOR MUSICAL THEATRE. (2 cr; prereq 3321-3322, #) Nash
Analysis and performance of songs for musical theatre.

8321-8322-8323. MFA ACTING I. (3-3-4 cr; prereq MFA acting student or # by audition) Reid
Advanced acting training. Internal approach based on Stanislavski's principles. *8321*: Preparation, elements of situation, given circumstances, and characterization. *8322*: Continued work on characterization and relationship leading to scene study. *8323*: Scene study leading to directed projects.

8324-8325-8326. MFA ACTING II. (3-4-3 cr; prereq MFA acting student or # by audition)
Advanced techniques for performing classical and contemporary texts with extended vocal and physical demands. *8324*: Techniques applied to scenes and monologues from Shakespeare. *8325*: Advanced acting techniques and character analysis applied to a performance project from classical canon. *8326*: Advanced acting techniques applied to modern and post-modern texts.

8330. ALEXANDER TECHNIQUE FOR MFA ACTORS. (1 cr; prereq MFA acting student or #)
Principles of Alexander Technique to develop body-mind awareness, improve performance, and develop ease of movement and range of physical expression. Group and individual work.

8341-8342. VOCAL PRODUCTION FOR MFA ACTORS I-II. (2 cr per qtr; prereq MFA acting student or #)
8341: Physiology of human voice, phonetics, tonal placement, vowel standardization and articulation. *8342*: Theories of theatre speech and application of advanced voice and speech techniques to dramatic texts.

8343-8344-8345. VOCAL PRODUCTION FOR MFA ACTORS III-IV-V. (2 cr per qtr; prereq MFA acting student or #) Houfek
Use and application of spoken voice for stage. *8343*: Fundamentals of spoken voice: body awareness, breath and support, resonance. *8344*: Extended uses of spoken voice: pitch, rate, volume, and applications to poetic text. *8345*: Application of rhythm, musicality, placement, and articulation to dialect study for stage.

8346. ADVANCED TEXT AND VOICE PRODUCTION FOR MFA ACTORS. (2 cr; prereq MFA acting student or #) Nash
Analysis and performance of texts by Congreve, Sheridan, and Shaw.

Design and Technical Production

5510f,s. DRAWING AND RENDERING FOR THEATRE DESIGNERS. (2 cr; prereq 3513 or 3515 or grad student, #) Brockman, Egan
Development of drawing (fall) and rendering (spring) skills necessary for presentation of theatre scene and costume designs.

5511. THEATRE DRAFTING AND GRAPHICS. (4 cr; prereq 3513, 3515 or equiv or #) Brockman, Gwinup, Montgomery
Practical study of drafting skills for the theatre designer (scenery and lighting) and technical director. Interpretation of rendering, sketches, and models for realization on the stage.

5515. DESIGN COMPOSITION AND COLLABORATION. (4 cr; prereq 3513 or equiv, #) Brockman, Kanee
In-depth study of classical composition of art and its application to stage design and directing. Emphasis on creative development of good design composition through tools of classical composition and the organic collaborative process.

5520. SCENE DESIGN. (4 cr [max 12 cr]; prereq 3513, 5511 or #) Brockman
Theory and design of stage scenery. Development of scenic model and rendering.

5530. COSTUME DESIGN. (4 cr [max 12 cr]; prereq 3515 or #) Egan
Theory and design of costumes; special projects. Laboratory arranged.

5532. ADVANCED MAKEUP FOR THE STAGE. (2 cr; prereq 1502 or equiv or grad student)
Facial casting, prosthetics, and hair ventilating.

5540. LIGHTING DESIGN. (4 cr [max 12 cr]; prereq 3515, 3711, 5511 or #) Montgomery
Theory of stage lighting design. Development of the lighting plot and paperwork. Laboratory arranged.

5550. THEATRE SOUND DESIGN. (2 cr [max 6 cr]; prereq 1504, 5564 or #) Gwinup
Theory of and approaches to analysis and creation of auditory environment for theatrical productions. Listening, psychoacoustics, microphone techniques, script analysis, projects. Laboratory arranged.

5560. THEATRE CRAFTS PRACTICUM. (1-4 cr per qtr [max 6 cr for undergrads]; prereq 3513 or 3515, #, Δ)
Individual creative projects that further student's practical skills and knowledge in specialized craft areas of theatre.

5561. STAGE CRAFT. (4 cr; prereq 3513, 5511, #) Gwinup
In-depth study and practical application of scenic materials, tools, and construction processes currently used in theatre. Laboratory arranged.

5562. SCENE PAINTING TECHNIQUES. (4 cr; prereq 3513 or #) Brockman
Practical study of materials, layout, and painting techniques used in theatre. Emphasis on painting styles and texturing techniques.

5563. COSTUME/PROPERTIES CRAFTS. (4 cr; prereq 3513 or grad student) Egan, Gwinup, guest instructors
Accessories, fabric enhancement techniques, materials, construction techniques, tools, and processes.

5564. LIGHTING AND SOUND TECHNOLOGY FOR THE THEATRE. (2 or 4 cr; prereq 3515 or equiv) Gwinup, Montgomery, guest instructors
Equipment, techniques, control operation, wiring, and maintenance from practical standpoint. Laboratory arranged.

8511, 8512. HISTORY OF THEATRE DECOR AND DRESS I, II. (4 cr per qtr) Design faculty
Theory and practice in history of decor and dress, research methods with emphasis on extracting essence of style for theatrical design and production. 8511: Classical-17th Century. 8512: 18th-20th Centuries.

8515. SEMINAR: THEATRE DESIGN. (4 cr) Design faculty
Culmination of various areas of theatre design and their applications throughout entertainment field. Exploration through critiques, field studies, and projects.

8560. THEATRE CRAFTS PRACTICUM. (1-4 cr; prereq Δ, #) Design faculty
Individual creative projects that further student's practical skills in specialized craft areas of theatre.

8575. SEMINAR: TECHNICAL PRODUCTION. (4 cr; prereq 5511, 5561 or #) Gwinup, guest instructors
In-depth study and projects using technology necessary to realize current scenic requirements. Rigging, stage mechanics, management, and audience/shop safety.

Directing

5711. ADVANCED STAGE DIRECTION. (4 cr; prereq 3713 or grad student or #)
Dramatic forms. Theory of rehearsal and production problems and direction of two one-act plays.

5712. STAGE DIRECTION OF NON-REALISTIC THEATRE. (4 cr; prereq 5711, grad student or #) Adey, Kanee
Theory, technique, and production of 20th-century non-realistic theatre from Beckett to Müller; direction of two one-act or extended scenes from the genre.

5716. STAGE MANAGEMENT FOR THE THEATRE. (4 cr; prereq 3711 or ¶3711 or grad student) Montgomery
Stage management as a specialized area. Theories and techniques of rehearsal and performance, organization and management in educational, community, and professional theatres.

5718. THEATRE MANAGEMENT AND PROMOTION. (4 cr; prereq 1504)
Introduction to theory, problems, and solutions of administrative planning, budgeting, advertising, and publicity for not-for-profit theatre.

Graduate Programs

5720. PLAYS IN PRODUCTION AND PERFORMANCE. (2-4 cr per qtr [max 6 cr for undergrads]; prereq 5712, #, Δ) Adey, Kanee, staff
Work in the field with a community, high school, touring or professional theatre group, or on campus to further develop expertise as a stage director.

5728. THEATRE MANAGEMENT PROBLEMS: AUDIENCE AND FINANCIAL DEVELOPMENT. (2 cr; prereq 5718)
Practical analysis of audience and financial development problems in U.S. theatre. Concentrates on various solutions.

5760. ADVANCED STAGE MANAGEMENT. (1-3 cr per qtr [max 6 cr for undergrads]; prereq 5716 or ¶5716, #) Montgomery
Practical experience in stage management for specific productions of the University Theatre with emphasis on rehearsal and performance.

8711, 8712, 8713. SEMINAR: STAGE DIRECTION. (4 cr; prereq 5712 or equiv) Adey, Kanee

8730. ONE-ACT LIMITED WORKSHOP PRODUCTION. (2 cr per qtr; prereq student in MFA directing program)
Fully rehearsed and performed production of published or original one-act-length play with limited design and technical support.

8740. SUPPORTED WORKSHOP PRODUCTION. (4 cr per qtr; prereq student in MFA directing program)
Fully rehearsed and performed production of published or original full-length play with budgeted design and technical support.

8750. MAINSTAGE PRODUCTION. (6 cr per qtr; prereq student in MFA directing program)
Rehearsed and performed mainstage production of published or original full-length play with generous design and technical support.

8770. ADVANCED DIRECTING LABORATORY. (2 cr; prereq MFA director or #) Adey, Hennem, Kanee
Theory and practice of advanced staging and interpretive directing problems. Staging techniques and conceptual thinking applied to variety of complex visual and textual situations.

General

5100. THEATRE PRACTICUM. (1-6 cr; prereq Δ, written #)
Arranged individual creative projects in production of a play as actor, designer, director, dramaturg, or playwright.

5110. THEATRE PERFORMANCE. (1 cr per qtr [max 9 cr]; prereq written # after casting and/or assignment to a production; S-N only) Montgomery
Participation in the rehearsals and performances of a University Theatre production. Credit given for the quarter the performance takes place.

5950. TOPICS IN THEATRE. (1-5 cr per qtr [max 12 cr]; prereq #, Δ)
Selected topics. Topics listed in *Class Schedule*.

5970. DIRECTED READINGS. (1-6 cr per qtr; prereq 9 cr theatre, #, Δ, CLA approval)
Directed reading and preparation of reports on selected subjects.

8100. THEATRE PRACTICUM. (1-6 cr; prereq Δ, #)
Arranged individual advanced creative projects in production of a play as actor, designer, director, dramaturg, or playwright.

8980. DIRECTED INSTRUCTION. (1-3 cr; prereq Δ) Staff
Teaching experience in an area in which a graduate student does not hold a teaching assistantship but in which she or he may be required to teach when entering the field. Limited to students with appropriate coursework background.

8990. RESEARCH. (Cr ar; prereq #, Δ) Staff
Open to graduate students engaged in research on special problems.

Dance (Dnce)

5010-5020-5030. ADVANCED MODERN I-II-III. (3 cr per qtr [max 9 cr each number]; prereq # or Δ for 5010, # or Δ or 5010 for 5020, # or Δ or 5020 for 5030)
Guest artist
Continuation of technical development, emphasizing performance range and style. Study with 5-6 guests artists of renown with disparate aesthetics and technical styles.

5040-5050-5060. ADVANCED BALLET I-II-III. (2 cr per qtr [max 6 cr each number]; prereq # or Δ for 5040, # or Δ or 5040 for 5050, # or Δ or 5050 for 5060)
Mathis
Continuation of intermediate technique, emphasizing musicality, performance, and stylistic differences. Practical work is conducted within context of study of choreographic and aesthetic development of ballet.

5070-5080-5090. ADVANCED JAZZ I-II-III. (1 cr per qtr [max 3 cr each number]; prereq # or Δ for 5070, # or Δ or 5070 for 5080, # or Δ or 5080 for 5090)
Sealy
Continuation of technical development. Additional work on syncopation, performance projection, and specific jazz styles: swing, bebop, lyrical, funk, Latin.

5100. DANCE PRACTICUM. (1-6 cr)
Arranged individual creative projects in dance.

5312-5313-5314. COMPOSITION IV-V-VI. (3 cr per qtr; prereq Δ or 3313 for 5312, Δ or 5312 for 5313, Δ or 5313 for 5314)
Guest artists
Continuation of exploration of movement vocabulary through improvisation, analysis of form and structure, experimentation with tone and performance persona, exploration of effects of lights/costumes/text/props/music, development of larger ensemble works.

5487. WORLD DANCE STUDIES. (4 cr) Maddux
Dance as art, ritual, social activity, and entertainment in selected cultures of Asia, Africa, the Americas, and Eastern Europe. Comparative analysis from historical, visual, and ethnological perspectives.

5616. TEACHING MODERN DANCE. (4 cr; prereq intermediate competency in modern dance, # or Δ)
Principles and methods of dance pedagogy.

5700. WORKSHOP: DANCE PERFORMANCE.

(3 cr; prereq enrollment in technique course, Δ)
Principles of technique, improvisation, choreography, music, design, and technical production as they relate to dance performance.

5910. TOPICS IN DANCE. (1-5 cr per qtr [max 12 cr])

Topics listed in *Class Schedule*.

5920. TOPICS IN DANCE PERFORMANCE. (1-3 cr [max 6 cr])

Discussion of various aspects of performance and performing.

5970. DIRECTED STUDIES. (1-6 cr per qtr; prereq 9 cr dance, #, Δ)

Guided individual reading or study in dance.

Therigenology

See Veterinary Medicine.

Toxicology (Txcl)

Professor: W. Thomas Shier (medicinal chemistry), *director of graduate studies;* Yusuf J. Abul-Hajj (medicinal chemistry); Robert M. Carlson¹ (chemistry); Joseph DiSalvo¹ (physiology); Lester R. Drewes¹ (biochemistry and molecular biology); Patrick E. Hanna (medicinal chemistry); Chester J. Mirocha (plant pathology); Herbert T. Nagasawa (medicinal chemistry); Joseph R. Prohaska¹ (biochemistry and molecular biology); Lawrence B. Schook (veterinary medicine); Sheldon B. Sparber (pharmacology)

Associate Professor: Jean F. Regal¹ (pharmacology), *associate director of graduate studies,* Duluth campus; David R. Brown (veterinary pathobiology); Vincent F. Garry (laboratory medicine and pathology); Randall E. Hicks¹ (biology); Richard G. Hoffman¹ (behavioral sciences); Michael E. McDonald¹ (chemical engineering); Gerald J. Niemi¹ (Center for Water and the Environment); Ashok K. Singh (veterinary diagnostic medicine); Lawrence P. Wackett (biochemistry); Kendall B. Wallace¹ (pharmacology)

Assistant Professor: Michael J. Murphy (veterinary diagnostic medicine), *associate director of graduate studies,* St. Paul campus; Lawrence J. Felice (veterinary diagnostic medicine); Robert R. Roy (pharmacy practice)

Adjunct Assistant Professor: Steven P. Bradbury¹ (U.S. Environmental Protection Agency); John W. Nichols¹ (medical and molecular physiology)

Senior Research Associate: Subhash C. Basak¹ (Center for Water and the Environment)

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) under special circumstances and Ph.D.

Curriculum—This University-wide program provides comprehensive training in the broad scope of toxicology. Specialized training is available through advanced courses and research in a number of subdisciplines, including human health risk assessment; epidemiology; environmental chemistry and engineering; ecotoxicology; food additives and nutritional toxicology; biochemical and physiological mechanisms; histopathology; diagnostic and analytical toxicology; drug metabolism; chemical carcinogenesis; behavioral toxicology; and the toxicity of noxious agents to various organ systems (e.g., nervous, heart, liver, kidneys).

Prerequisites for Admission—All applicants should have a full year of biology, chemistry, and physics and have completed mathematics through calculus.

Special Application Requirements—Scores from the General (Aptitude) Test of the Graduate Record Examination and three letters of recommendation from college-level faculty are required of all applicants.

Master's Degree Requirements—Completion of a core curriculum consisting of 12 credits in toxicology is required. Additional courses and credits are arranged on an individual basis. A final oral examination and research thesis defense is required.

Doctoral Degree Requirements—All students must complete a core curriculum composed of physiology (6 cr), biochemistry (8 cr), statistics (4 cr), and toxicology (13 cr). Additional advanced courses in toxicology or related fields may be specified by the major adviser. Students must complete and defend an original preliminary research proposal. The final requirement for graduation is the oral defense of the written research dissertation.

Language Requirements—None.

¹ University of Minnesota, Duluth

Minor Requirements for Students

Majoring in Other Fields—Students must complete 12 credits of core courses and 6 credits of advanced courses in toxicology.

For Further Information, Applications, and a List of Courses—Contact the Toxicology Graduate Program, University of Minnesota, 138 School of Medicine, 10 University Drive, Duluth, MN 55812 (218/726-8572; e-mail toxic@ua.d.umn.edu).

Txel 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Txel 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Txel 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5164. TOXICOLOGY OF POISONOUS PLANTS. (1 cr, §VDM 5164; prereq VB 5401 or #) Murphy
Toxicology and identification of poisonous plants.

5165. VETERINARY TOXICOLOGY. (2 cr, §VDI 5165; prereq VB 5401 or #) Murphy
Toxicology of minerals, pesticides, herbicides, venoms, and miscellaneous toxicants.

5214. PRINCIPLES OF TOXICOLOGY. (4 cr; prereq Chem 5336, Chem 5337, Phsl 5927, Phsl 5928 or BioC 5751, BioC 5752, Phsl 5440, Phsl 5441, #) Wallace, staff
Includes factors that determine disposition of foreign chemicals in living systems.

5215. ORGAN SYSTEM TOXICOLOGY. (4 cr; prereq 5214, #) Murphy, staff
Kinetic and dynamic determinants of target organ toxicity; pathological alterations in structure/function relationship for major organ systems.

5216. CHEMICAL AND ENVIRONMENTAL TOXICOLOGY. (4 cr; prereq 5214, #) Shier, staff
Mechanisms of toxicity of specific classes of chemical agents; application of toxicology in various professional careers.

8101-8102-8103†. TOXICOLOGY SEMINAR. (1 cr per qtr; prereq #) Staff
Issues in investigative toxicology research.

8572. INVESTIGATIVE TOXICOLOGY. (2 cr; prereq 5214-5216) Staff
Current investigations in toxicological sciences.

8800. DIRECTED RESEARCH. (Cr ar) Staff
Experimental investigation of toxicological problems.

Veterinary Biology

See Veterinary Medicine.

Veterinary Medicine

Major and minor programs for the M.S. and Ph.D. degrees are available in the various disciplines offered by the College of Veterinary Medicine: theriogenology; veterinary biology; veterinary medicine; veterinary pathobiology; and veterinary surgery, radiology, and anesthesiology. Veterinary biology and veterinary pathobiology offer a combined D.V.M./Ph.D. program to selected students. An emphasis in veterinary public health within the M.P.H. degree is offered by the School of Public Health. For information about a major area, applicants should contact the director of graduate studies in the major field.

Theriogenology

Professor: Bradley E. Seguin, director of graduate studies; Bo G. Crabo; Gary D. Dial; M. L. Fahning; Alan G. Hunter; Shirley D. Johnston; Han Soo Joo; Jonathon E. Wheaton

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Emphases in the major are food-producing and companion animals. Within these emphases, interest can be further directed to such areas as reproductive physiology, reproductive pathology, and infectious or managerial reproductive problems of animals.

Prerequisites for Admission—A D.V.M. degree or its foreign equivalent is required.

Special Application Requirements—At least three letters of recommendation, a statement of purpose, and a résumé detailing professional experiences and publications are required.

Degree Requirements—For the master's and doctoral degrees, at least one quarter of CAPS 8595 is required. The final examination for the master's degree includes a seminar and an oral examination.

Language Requirements—None.

Minor Requirements for Students

Majoring in Other Fields—Students must have a D.V.M. degree or advanced training in the biological sciences to minor in theriogenology.

For Further Information and

Applications—Contact the Theriogenology Graduate Program, Department of Clinical and Population Sciences, University of Minnesota, 435-H Animal Science/Veterinary Medicine, 1988 Fitch Avenue, St. Paul, MN 55108 (612/624-4741).

Tgen 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Tgen 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Tgen 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

Note—In addition to the following courses, many other courses are commonly taken for the theriogenology major, especially among those listed for the animal physiology and animal science programs. The three programs also share a number of graduate faculty members.

CAPS 5535. ADVANCED DAIRY PALPATION. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track)

For developing technical skills of palpating reproductive tract of cow through rectum.

CAPS 5545. ADVANCED DAIRY THERIOGENOLOGY MANAGEMENT. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track)

Two-week rotation of lecture and laboratory, including embryo transfer, breeding soundness evaluation, obstetrics, and reproductive management of dairy herd.

CAPS 5550. DIAGNOSTICS AND OBSTETRICS IN THERIOGENOLOGY. (2 cr; prereq regis vet med or grad student or #) Fahning

Lectures on diagnostic, therapeutic, and obstetrical procedures in theriogenology.

CAPS 5551. THERIOGENOLOGY DIAGNOSTICS LABORATORY. (1 cr; prereq regis vet med or grad student or #) Seguin, staff

Demonstrations and laboratory practices in diagnostic and therapeutic procedures in theriogenology.

CAPS 5552. VETERINARY OBSTETRICS

LABORATORY. (1 cr; prereq 5550 or #) Fahning
Demonstrations and practices in application of obstetrical procedures.

CAPS 5570. REPRODUCTIVE DISEASES OF DOMESTIC ANIMALS. (5 cr; prereq 5550 or #)

Fahning, staff

Lectures covering physiology and pathology of reproduction, artificial insemination, abortive diseases, postpartum injuries, and breeding management in domestic animals.

CAPS 5571. REPRODUCTION AND INFERTILITY IN THE HORSE. (1 cr; prereq 5570, regis vet med or grad student or #) Troedsson

Lectures and demonstrations covering reproductive patterns, breeding practices, management, artificial insemination, economics of reproductive performance, and infertility in horses.

CAPS 5595. ADVANCED GENERAL THERIOGENOLOGY. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track)

Comparative theriogenology training program based on clinical case load in Veterinary Teaching Hospital and theriogenology field herds. Comparative teaching laboratories (e.g., semen evaluation). Students focus on species of interest (bovine, equine, small animal), depending on season and case load.

CAPS 8590. ADVANCED DIAGNOSTIC METHODS. (Cr ar; prereq 5570 or #) Staff

Discussion and laboratory practices of methods for determining fertility status of female and male animals.

CAPS 8591, 8592, 8593. ADVANCED ENDOCRINOLOGY OF REPRODUCTION. (2 cr per qtr; prereq regis grad student) Staff

Review of endocrine patterns of domestic animals, emphasizing topics in theriogenology. Endocrine changes that occur with certain reproductive diseases. Application of hormone analysis to clinical diagnosis and herd monitoring.

CAPS 8594. SPECIAL PROBLEMS IN ANIMAL REPRODUCTION. (Cr ar; prereq 5570 or #) Staff

Detailed discussion and laboratory study of specific reproductive disorders.

CAPS 8595. SEMINAR. (1 cr) Seguin, staff

Veterinary Biology

Professor: Lawrence B. Schook, *chair*; Esther M. Gallant, *director of graduate studies*; Alvin J. Beitz, Caroline M. Czarnicki; Robert H. Dunlop; Thomas F. Fletcher; Alice A. Larson; Charles F. Louis; Thomas W. Molitor; Akhouri A. Sinha; Alvin F. Weber (*emeritus*)

Associate Professor: David R. Brown; Victor S. Cox, Jr.; Lawrence J. Felice; Sally E. Jorgensen; Mathur S. Kannan; Michael P. Murtaugh; Scott M. O'Grady; John W. Osborn; Patrick T. Redig; Ashok K. Singh

Assistant Professor: James R. Mickelson; Mark S. Rutherford

Research Associate: Frank G. Williams

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Graduate Programs

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—This program provides students with a broad base of knowledge in biomedical sciences, followed by advanced training in a specific area of expertise within the program. Major research interests in the program focus on molecular biology, immunology, and genetics; neuroanatomy and neuropharmacology; gastrointestinal physiology and pharmacology; muscle physiology, pharmacology, and biochemistry; and animal biotechnology.

Prerequisites for Admission—Applicants for both degrees must have a background in chemistry, physics, mathematics, and biology that is acceptable to the graduate faculty. Some background work may be done after acceptance.

Special Application Requirements—A statement of career goals, Graduate Record Examination scores, and three letters of recommendation evaluating the applicant's potential for graduate study are required. Additional information may be requested as necessary. For both the M.S. and the Ph.D. degree, requirements are individualized in accordance with the specialty area and interest of the student. Students are accepted for admission each quarter. Additional information is available from the director of graduate studies.

Degree Requirements—The final examination for the master's degree is oral.

Language Requirements—For the master's degree, none. For the doctoral degree, facility with a computer programming language may be required.

Minor Requirements for Students

Majoring in Other Fields—Students should consult the director of graduate studies in veterinary biology.

For Further Information and

Applications—Contact the Department of Veterinary Pathobiology, University of Minnesota, 295 Animal Science/Veterinary Medicine, 1988 Fitch Avenue, St. Paul, MN 55108 (612/624-2700).

VB 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

VB 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

VB 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

VB 5100. VETERINARY ANATOMY I. (6 cr; prereq #) Cox, Fletcher, Gallant
Gross anatomic structure and function. The dog is used as a type species to introduce nomenclature and principles of mammalian gross anatomy. Cervical, thoracic, and abdominal viscera of the dog, cat, ruminant, horse, pig, and laboratory animals presented from comparative approach.

VB 5102. VETERINARY NEUROBIOLOGY. (3 cr; prereq #) Beitz, Fletcher
Structural and functional organization of the central nervous system of domestic animals.

VB 5103. VETERINARY DEVELOPMENTAL ANATOMY. (3 cr; prereq #) ox, Fletcher
Ontogenetic processes in organ systems of domestic animals and developmental anomalies of clinical significance.

VB 5104-5105. MICROSCOPIC ANATOMY OF DOMESTIC ANIMALS. (5 cr for 5104, 4 cr for 5105; prereq #) Beitz, Czarnecki, Gallant
Light microscopic and relevant ultrastructural studies of cells, tissues, and organ systems.

VB 5110. CYTOGENETIC EVALUATION IN ANIMAL DISEASES. (1 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #; offered when feasible) Weber

VB 5126. VETERINARY ANATOMY II. (5 cr; prereq 5100 or #) Cox
Comparative anatomy with emphasis on the pelvis, reproductive system, limbs, and head from a morphodynamic and radiographic approach. Species covered include horse, domestic ruminants, swine, dog, cat, and bird.

VB 5140. VERTEBRATE MICROANATOMY. (1-6 cr; prereq 5120 or #; offered when feasible) Czarnecki

VB 5149. TOPICS IN ORGANOLGY. (1-5 cr per qtr [may be repeated for cr]; prereq 5104 or equiv, #; offered when feasible) Czarnecki

VB 5210f. VETERINARY BIOCHEMISTRY. (3 cr; prereq 1st-yr vet med or #) Jorgensen, Louis, Mickelson
Molecular nature of cells and tissues and ways in which dietary carbohydrates, lipids, and proteins are metabolized to generate energy for growth and maintenance of the animal.

VB 5211w. VETERINARY BIOCHEMISTRY LABORATORY. (1 cr; prereq #) Louis, Mickelson
Basic biomedical laboratory techniques and analyses of biological materials (pH and buffers, spectrophotometry, chromatography, electrophoresis, enzymes).

VB 5212w. VETERINARY BIOCHEMISTRY. (4 cr; prereq 5210 or #) Jorgensen, Louis, Mickelson, Murtaugh
Control and integration of metabolism in whole animal. Hormonal regulation, specialized metabolism in different mammalian tissues and species, and applications of molecular biology to animal health.

VB 5306w. ANIMAL PHYSIOLOGY. (4 cr; prereq regis vet med or #) O'Grady, Osborn
Lectures on physiology of cell membranes and cardiovascular, renal, and body fluid systems of animals.

VB 5308s. ANIMAL PHYSIOLOGY. (4 cr; prereq regis vet med or #) O'Grady, Osborn
Lectures on physiology of digestion, respiration, and mechanisms of temperature regulation and heat production in animals.

VB 5310f. ANIMAL PHYSIOLOGY. (3 cr; prereq regis vet med or #) Hunter, Redig, Wheaton
Physiology of endocrine and reproductive systems of animals.

VB 5320w. AVIAN PHYSIOLOGY. (4 cr; prereq 3301 or 5 cr systemic physiology or equiv, #; offered alt yrs) Duke, El-Halawani, Redig
Physiology of wild and domestic birds.

VB 5400f. VETERINARY PHARMACOLOGY AND THERAPEUTICS I. (3 cr per qtr; prereq 5310 or equiv or #) Larson
General principles of drug action, drug disposition, and drug use, focusing on drug action in central and peripheral nervous systems. Pharmacology of autonomic drugs, anesthetics, tranquilizing agents, analeptics, anticonvulsants, and neuromuscular blockers.

VB 5401w. VETERINARY PHARMACOLOGY AND THERAPEUTICS II. (4 cr per qtr; prereq 5310, 5400 or #) Brown
Pharmacology of cardiopulmonary drugs (e.g., inhalational anesthetics, antiarrhythmic agents, cardiac glycosides), anti-inflammatory agents (e.g., NSAIDs, corticosteroids, antihistamines), and drugs affecting fluid and electrolyte homeostasis (e.g., diuretics, gastrointestinal drugs). Veterinary applications.

VB 5402s. VETERINARY PHARMACOLOGY AND THERAPEUTICS III. (3 cr; prereq 5401 or #) Kannan
Pharmacology of sulfonamides, nitrofurans, arsenicals, antibiotics, coccidiostats and other antiprotozoan drugs, antifungal agents, anthelmintics, and other anti-infectious drugs. Principles and applications in prevention and treatment of microbial and parasitic diseases of domestic animals.

VB 5444. MUSCLE CONTRACTION. (3 cr; prereq undergrad biochem or physiology, #) Barnett, Gallant, Louis, Mickelson, Thomas
Introduction to physiology, biochemical regulation, and physical chemistry of muscle contraction.

VB 5460f. NEUROCHEMICAL COMMUNICATION. (4 cr, §MdBc 5460, §NSc 5460; prereq biochemistry) Koerner, Wilcox
Electrophysiology and biochemistry of neuronal signaling, manipulation by pharmacological agents; historical context and current research techniques. Information about most systems (e.g., autonomic and central nervous systems) delivered in context of specific transmitter systems wherever practical.

VB 8111. HISTOLOGICAL AND ULTRAHISTOLOGICAL TECHNIQUES. (3 cr; prereq 5105, #; offered when feasible) Staff

VB 8150. RESEARCH PROBLEMS IN VETERINARY ANATOMY. (1-5 cr; prereq #; offered when feasible) Beitz, Cox, Czarniecki, Fletcher

VB 8349. RESEARCH IN PHYSIOLOGY. (Cr ar; prereq #; offered when feasible) Gallant, O'Grady, Osborn

VB 8448. PROBLEMS IN VETERINARY PHARMACOLOGY. (Cr ar; prereq 5401 or equiv or #; offered when feasible) Brown, Kannan, Larson

VB 8450. DRUG-RECEPTOR INTERACTIONS. (2 cr; prereq 5400, 5401 or equiv, calculus through differential equations, Chem 5520-5521 or equiv; offered alt yrs) Brown
Dynamics of interaction between drugs and their receptors. Historical development of drug-receptor theory, factors affecting drug concentration in receptor compartment, determination of agonist and antagonist activity, and functional receptor classification.

VB 8550. SEMINAR: VETERINARY BIOLOGY. (1 cr; prereq #) Gallant, Williams

Veterinary Medicine

Professor: Trevor R. Ames; John F. Anderson; Stephen I. Bistner; Gary D. Dial; Stanley L. Diesch; Robert H. Dunlop; Ralph J. Farnsworth; John Fetrow; Sagar M. Goyal; David A. Halvorson; Robert M. Hardy; Donald W. Johnson; Shirley D. Johnston; Han Soo Joo; Jeff S. Klausner; Patrick J. McKeever; Thomas W. Molitor; K. V. Nagaraja; Phillip Ogburn; Carl A. Osborne; Carlos Pijoan; David J. Polzin; Michael M. Pullen; Jeffrey K. Reneau; R. Ashley Robinson; David G. Thawley; Ronald E. Weir

Associate Professor: P. Jane Armstrong; Lawrence J. Felice; Dale L. Haggard; Thomas H. Hostetter; William E. Marsh; Frank B. Martin; Martha A. Mellencamp; Robert B. Morrison; Michael P. Murtaugh; William G. Olson; Richard E. Shope, Jr.; Ashok K. Singh; Vaithianathan Sivanandan; Tracy A. Turner

Assistant Professor: Calvin N. Kobluk; Jody P. Lulich; Daniel P. Shaw; Stephanie J. Valberg

Research Associate: Vickie L. King

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Graduate Programs

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Emphases in the major are large, small, and comparative animal medicine. Emphasis can further be directed toward specific systems or population medicine.

Prerequisites for Admission—A D.V.M. degree or its foreign equivalent is required.

Special Application Requirement—At least two letters of recommendation and a résumé detailing professional experiences and publications are required.

Degree Requirements—For the M.S. and Ph.D. programs, at least one quarter of CAPS or SACS 8291 and of CAPS and SACS 8290 is required. An oral examination is required for the M.S. degree.

Language Requirement—None.

Minor Requirements for Students

Majoring in Other Fields—The director of graduate studies determines these requirements, which vary with the major field, for each individual.

For Further Information and

Applications—Contact the Veterinary Medicine Graduate Program, Department of Clinical and Population Sciences, University of Minnesota, 225E Veterinary Teaching Hospitals, 1352 Boyd Avenue, St. Paul, MN 55108 (612/625-7755).

VMed 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

VMed 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

VMed 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

CAPS 5015. ADVANCED VETERINARY PUBLIC HEALTH (VPH) CLINIC ROTATION. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track)

Preparation for health and socially responsible role in veterinary community medicine (rural and urban); preparation for federal accreditation; introduction to public practice veterinarians.

CAPS 5115. ADVANCED LARGE ANIMAL MEDICINE. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track)

Medical diseases of horses, cattle, and small ruminants. History taking, clinical diagnosis, and patient management.

CAPS 5150. DIAGNOSTIC AND THERAPEUTIC TECHNIQUES. (1 cr) Ames

Demonstration and application of diagnostic techniques and procedures and restraint of animals. Discussion of therapeutic regimens and demonstrations of therapeutic procedures.

CAPS 5151. DIAGNOSTIC AND THERAPEUTIC TECHNIQUES I. (1 cr; prereq CVM 5150 or #) Ames, Valberg

Application of general physical examination procedures, special diagnostic techniques, and therapeutic procedures to large animals.

CAPS 5153. DIAGNOSTIC AND THERAPEUTIC TECHNIQUES II. (1 cr; prereq #) Ames

Demonstration and practice of restraint and diagnostic and therapeutic techniques for large animals.

CAPS 5160. LARGE ANIMAL MEDICINE. (6 cr; prereq 5151 or #) Ames, Valberg

Diseases of ruminants covered on a system basis.

CAPS 5161. LARGE ANIMAL MEDICINE. (5 cr; prereq 5160 or #) Ames, Valberg

Continuation of study of ruminant diseases and equine diseases on a system basis.

CAPS 5162. LARGE ANIMAL MEDICINE. (6 cr; prereq 5161 or #) Ames, Pijoan, Valberg

Continuation of equine diseases and porcine diseases.

VDM 5164. TOXICOLOGY OF POISONOUS PLANTS. (1 cr, §Txl 5164; prereq VB 5401 or #) Murphy

Toxicology and identification of poisonous plants.

CAPS 5165. INTRODUCTION TO ANIMAL NUTRITION. (2 cr; prereq VB 5210, VB 5212, VB 5306 or #) Olson

Requirements and functions of nutrients in large and small animals; sources of nutrients and evaluation of feedstuffs.

VDM 5165. VETERINARY TOXICOLOGY. (2 cr; prereq VB 5401 or #) Murphy

Toxicology of minerals, pesticides, herbicides, venoms, and miscellaneous toxicants.

SACS 5170. SMALL ANIMAL MEDICINE. (4 cr; prereq #) Bistner, Hardy, Klausner, McKeever, Ogburn, Osborne

Etiology, pathophysiology, diagnosis, prognosis, and treatment of disorders of various body systems of companion animals. Fundamental principles of diagnosis and treatment, and polysystemic disorders including nutritional abnormalities, immune-mediated diseases, infectious diseases, intoxications, and neoplasia.

SACS 5171. SMALL ANIMAL MEDICINE. (4 cr; prereq 5170 or #) Bistner, Hardy, Klausner, McKeever, Ogburn, Osborne
(Continuation of 5170.)

SACS 5172. SMALL ANIMAL MEDICINE. (5 cr; prereq 5171 or #) Bistner, Hardy, Klausner, McKeever, Ogburn, Osborne
(Continuation of 5171.)

CAPS 5180. INTRODUCTION TO HERD HEALTH AND DAIRY HERD HEALTH MANAGEMENT.

(2 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #) Farnsworth
Herd health management, general epidemiology, disease surveillance, and economics of farming. Dairy cattle genetics and breeding, reproduction, applied nutrition, housing, preventative medicine programs, and management practices.

CAPS 5182. SHEEP AND GOAT HERD HEALTH MANAGEMENT. (1 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #)

Sheep and goat breeds and breeding, reproduction, applied nutrition, housing, preventative medicine programs, and management practices.

CAPS 5190. LARGE ANIMAL INTERNAL MEDICINE I. (3 cr; prereq DVM, enrollment in SACS or CAPS clinical residency)

Pathophysiology, clinical manifestations, and therapeutic regimens for major organ systems of main large animal species.

CAPS 5191. LARGE ANIMAL INTERNAL MEDICINE II. (3 cr; prereq DVM, enrollment in SACS or CAPS clinical residency)

Pathophysiology, clinical manifestations, and therapeutic regimens used for major organ systems of main large animal species.

CAPS 5215. ADVANCED LARGE ANIMAL SURGERY. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track) Kobluk, Trent, Turner
Clinical rotation for diagnostic and therapeutic management in hospital setting of lameness and surgical diseases of equine, bovine, and small ruminant species.

CAPS 5225. ADVANCED EQUINE LAMENESS. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track) Kobluk, Turner
Two-week course involving clinical, didactic, and laboratory learning.

CAPS 5235. ADVANCED EQUINE PODIATRY. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track) Turner

CAPS 5245. ADVANCED BOVINE SURGERY. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track) Trent
Technical and theoretical skills necessary for mixed or dairy practice that involves managing cow surgical diseases.

SACS 5250. SMALL ANIMAL DERMATOLOGY. (1-2 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #) McKeever
Pathogenesis, clinical features, diagnosis, and therapy of skin diseases of companion animals.

SACS 5251. COMPARATIVE CLINICAL VETERINARY DERMATOLOGIC PATHOLOGY. (1 cr; prereq grad student or #) McKeever
Microscopic pathology of basic dermatologic reactions and variable disease states.

SACS 5256. DISEASES OF THE LIVER AND PANCREAS. (2 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #) Hardy
Etiopathogenesis, diagnosis and treatment of hepatic and pancreatic diseases in companion animals.

SACS 5257. A CLINICIAN'S ANALYSIS OF URINALYSIS. (1 cr; prereq completion of 1st 3 yrs of vet curriculum)

Overview of proper interpretation of urinalysis findings in patients with variety of disorders of various body systems.

SACS 5260. THE PROBLEM-ORIENTED MEDICAL SYSTEM. (1 cr; prereq #)

Introduction to fundamentals of problem definition and solution. Problem-oriented system of diagnosis and therapy, problem-oriented medical record.

SACS 5265. COMPARATIVE CARDIOLOGY. (2 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #) Ogburn

Helps students develop skills in recognition, definition, and resolution of problems involving the cardiovascular system.

CAPS 5270. ECONOMICS AND PRACTICE MANAGEMENT. (2 cr; prereq regis vet med or #)
Basic economic concepts and terminology. Relationship of animal health to productivity; cost/benefit relationships for disease control programs; financial return and economic analysis of livestock operations; economics of practice management; trends in livestock production.

SACS 5270. ANIMAL BEHAVIOR. (2 cr; prereq #)
Principles of animal behavior; managing clinical behavioral problems primarily of companion and food animals.

CAPS 5271. LAW AND ETHICS IN VETERINARY MEDICINE. (2 cr; prereq regis vet med or #)
Discussion of legal and ethical issues in veterinary medicine.

SACS 5271. HOSPITAL MANAGEMENT. (1 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #)
Lectures. Management of small animal hospital. Zoning restrictions, employee supervision, drug purchases, facilities, fees, and other pertinent information.

Graduate Programs

CAPS 5274. UNDERSTANDING THE BUSINESS OF VETERINARY PRACTICE. (1 cr; prereq 5270 or #)

For senior veterinary students: review of veterinary business management and preparation for finding professional position, choosing a practice, interviewing for associate position, and negotiating contracts, benefits, hours, and covenants. Law, tax, business and financial concepts, insurance, ownership vs. partnership.

CAPS 5275. DISEASES OF ZOO ANIMALS AND EXOTIC PETS. (1 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #) Farnsworth

Diseases of and management procedures for zoo animals and exotic pets, restraint procedures, medication and diagnosis.

CAPS 5276. ADVANCED ZOO ANIMAL MEDICINE. (1 cr; prereq regis 3rd- or 4th-yr vet med, 5275 or #)

Adaptation of existing veterinarian techniques and principles to practice of zoo animal medicine. Animal management and preventive medicine programs used in zoo animal medicine.

CAPS 5280. WORLD FOOD PROBLEMS. (3 cr, §AgEc 5790, §FScN 5643, §Soc 5675; prereq major in agriculture, veterinary medicine, nutritional sciences, social sciences or # or grad student with #) Robinson, staff

Multidisciplinary approach to the social, economic, and technical problems of feeding the world's growing population. Principles sought from social and economic, plant, animal, and nutritional sciences for their application to food problems.

SACS 5285. CANINE CLINICAL NEUROLOGY.

(1 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #) Hardy

Anatomic and physiologic bases for neurological examination of the dog. Emphasizes clinical approach to neurology.

CAPS 5301su, 5302f, 5303w, 5304s. ADVANCED PROFESSIONAL CAREER DEVELOPMENT. (4 cr per qtr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track)

Rotation provides advanced skill development for selecting, procuring, and maintaining a job. Skills include goal setting, time and stress management, leadership, and team building.

CVM 5301su, 5302f, 5303w, 5304s. PROFESSIONAL CAREER DEVELOPMENT. (4-24 cr; prereq #)

Rotation provides skill development for selecting, procuring, and maintaining a job.

SACS 5572. REPRODUCTIVE PATTERNS AND INFERTILITY IN THE DOG AND CAT. (1 cr; prereq CAPS 5570, regis 3rd- or 4th-yr vet med or grad student or #)

Lectures on reproductive patterns, breeding management, artificial insemination, and infertility in dogs and cats.

CAPS 5605. ANALYTICAL TECHNIQUES IN VETERINARY MEDICINE I. (3 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track) Marsh, Waddell

Developing and using computer systems for processing, analyzing, and interpreting animal health data. Resources needed for research program. Developing critical approach to reading veterinary medical literature.

VDM 5611su, 5612f, 5613w, 5614s. ADVANCED VETERINARY TOXICOLOGY. (4-24 cr per qtr; prereq 5164, 5165 or #)

In-depth examination of toxins affecting animals. Clinical, diagnostic, mechanistic, and therapeutic aspects of biotoxins and organic and inorganic toxins that affect livestock, poultry, wildlife, and companion animals or that present a potential threat to public health.

CAPS 5615. ADVANCED SWINE DISEASE DIAGNOSTICS, THERAPEUTICS, AND PREVENTION. (4 cr; prereq IV track or grad or #) Joo, Morrison, Pijoan

Two-week rotation deals primarily with on-farm disease diagnostics, treatment, and control programs.

VDM 5620. SCIENTIFIC WRITING AND SPEAKING. (2 cr; prereq #; for grad students in hlth sciences) Goyal

Techniques of writing and publishing scientific papers and theses, including manuscript preparation, submission and review process, and proofreading and publishing process. Oral and poster presentations at scientific meetings covered.

CAPS 5625. SWINE PRODUCTION SYSTEMS.

(4 cr; prereq grad student or IV track or #) Dial, Marsh
Comprehensive review of factors affecting biological productivity and financial competitiveness of commercial swine farms.

CAPS 5635. ADVANCED SWINE NUTRITION.

(4 cr; prereq grad student or # or IV track) Dial, Pettigrew
Rotation focusing on nutrition and feeding management of pigs.

CAPS 5645. ADVANCED SWINE ECONOMICS, FINANCIAL MANAGEMENT, AND MARKETING.

(4 cr; prereq IV track or grad student or #) Marsh
Manipulation, analysis, and interpretation of data from all phases of swine production, using biological and financial records. Case studies help develop analytic and diagnostic skills in identification of causes of suboptimal productivity. Financial analysis techniques used to develop cost-effective and feasible solutions to production problems; swine marketing alternatives.

CAPS 5650. VETERINARY EPIDEMIOLOGY AND STATISTICS. (4 cr; prereq 10 cr biology, 12 cr chemistry or #) King, Robinson, Wilson

Principles of epidemiology, ecology, and veterinary public health. Biostatistics applied to the measurement of health and disease in populations.

CAPS 5651. VETERINARY COMMUNITY MEDICINE. (3 cr; prereq VPB 5703, VPB 5503 or equiv or #) Diesch, Pullen
Principles and practices of environmental health and food hygiene; includes meat, poultry, milk, and other foods as they are related to animal and human health. Diseases transmitted between animals and humans.

CAPS 5663. INTERNATIONAL ANIMAL DISEASE PROBLEMS. (1 cr; prereq #) Diesch, Shope
Diagnosis, transmission, and epidemiology of diseases not currently present in the United States. International role of veterinarians in reducing disease and increasing world animal production.

CAPS 5665. MONITORING AND SURVEILLANCE OF DISEASE. (Cr ar; prereq #; offered alt yrs) Diesch, Robinson
Seminars and discussions on techniques used to monitor disease in animal populations.

CAPS 5671. BIOHAZARDS IN VETERINARY MEDICINE. (Cr ar; prereq #) Goyal, Robinson
Seminars and discussions on microbiological, toxicologic, drug, and other hazards.

CAPS 5672. PERSPECTIVES: ANIMAL-HUMAN RELATIONSHIPS AND COMMUNITY HEALTH. (2-3 cr; prereq #) Robinson
(Same as PubH 5303) Perspectives on cultural, psychological, ethological, and environmental aspects of the interrelationships of people and animals as they affect individual and community health.

CAPS 5673. PROBLEMS IN DISEASE CONTROL AND ERADICATION. (Cr ar; prereq PubH 5330 or #; offered alt yrs) Diesch, Robinson
Past and present disease control and eradication programs, factors influencing success and failure. Development of models for disease control and eradication programs in the United States or a foreign country for group evaluation and analysis.

CAPS 5680. PROBLEMS IN VETERINARY EPIDEMIOLOGY AND PUBLIC HEALTH. (Cr ar; prereq 5650 or equiv or #) Diesch, Pullen, Robinson
Individual study arranged with faculty member.

CAPS 5695. ADVANCED EPIDEMIOLOGY AND BIostatISTICS. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track) Marsh, Morrison
Strengths and limitations of statistical methodologies used in veterinary medicine and epidemiology. Designing feasible research program given constraints of funding, time, and facilities. Preparing detailed research proposal suitable for submission for competitive funding.

CAPS 5715. ADVANCED EQUINE SPORTS AND PREVENTIVE MEDICINE. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track) Turner
Rotation provides broad exposure to equine industry, emphasizing sports performance activities and role of veterinarian.

SACS 5802. RESIDENCY IN VETERINARY DERMATOLOGY. (Cr ar; prereq #)
Rotations in veterinary dermatology clinics and review of dermatopathology slides submitted to Veterinary Diagnostic Laboratory. Rotations through Veterinary Internal Medicine and Human Dermatology Service (Medical School); dermatology journal club.

SACS 5812s. COMPANION ANIMAL ONCOLOGY. (2 cr; prereq DVM or equiv; offered alt yrs)
Principles of veterinary oncology; biological behavior, treatment, and prognosis of neoplastic disorders.

CAPS 5815. ADVANCED DAIRY DISEASE CONTROL, PARASITOLOGY, YOUNGSTOCK MANAGEMENT. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track)
Common infectious diseases and parasites that limit dairy calf performance.

CAPS 5825. ADVANCED MASTITIS, MILKING MACHINES, AND MILK QUALITY. (4 cr; prereq grad student or # or IV track)
Rotation for training students to evaluate herd mastitis problems and provide recommendations for solutions.

CAPS 5835. ADVANCED RUMINANT NUTRITION. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track)
Nutrient requirements of ruminants, nutrient content of feed stuffs (primarily forages), energy utilization, protein and nonprotein nitrogen utilization, nutritional disorders, formulation of adequate rations, and techniques for analyzing rations. Strongly recommended for students interested in dairy and suggested for those interested in beef.

CAPS 5845. ADVANCED DAIRY NUTRITION. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track)
Principles, techniques, goals, and objectives of providing nutrition advice, counseling, and/or assessment to a dairy farm.

CAPS 5855. ADVANCED DAIRY RECORD ANALYSIS, EPIDEMIOLOGY, AND ECONOMICS. (4 cr; prereq IV track or grad student or #)
Evaluation of a dairy herd as a whole using biological and economic records.

CAPS 5915. ADVANCED BUILDING DESIGN AND TOTAL HERD EVALUATION. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track)
Housing, ventilation, equipment, and building design principles using epidemiologic approach to promoting animal health. Integration of total animal health care, environmental control, and herd management into herd veterinary services.

CAPS 5925. ADVANCED BEEF PRODUCTION MEDICINE. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track)

CAPS 5945. ADVANCED SMALL RUMINANT HEALTH AND PRODUCTION. (4 cr; prereq regis 3rd- or 4th-yr vet med or grad student or # or IV track)

Graduate Programs

CAPS 5951. DIRECTED STUDIES. (1-8 cr; prereq #, Δ)

Independent, directed study in veterinary science in areas arranged by the student and a faculty member.

SACS 8180. ADVANCED CLINICAL NEUROLOGY. (Cr ar; prereq #) Hardy

Diagnosis and therapy of neurologic diseases based on sound understanding of underlying fundamentals in neuroanatomy, neurophysiology, and neuropathology. Lectures, individual study, programmed learning texts, and discussion of material.

SACS 8190.* COMPARATIVE CARDIOVASCULAR DISEASES. (3 cr; prereq grad student) Ogburn

Lectures, seminars, and special laboratory exercises on diseases of the cardiovascular system of domestic animals. Specialized methods of diagnosis emphasized. Research project in experimental or clinical cardiology required.

SACS 8192. SPECIAL CARDIOLOGY CLINICS.

(Cr ar; prereq grad student, #) Ogburn
Intensive clinical studies in investigative clinical cardiology. Diagnosis and management of cardiovascular disease in small animals.

CAPS 8194.* PROBLEMS IN DIAGNOSTIC VIROLOGY, SEROLOGY, AND IMMUNOLOGY.

(Cr ar; prereq grad student or #) Joo, Molitor
Laboratory techniques of diagnostic virology, serology, and immunology. Research techniques of fluorescent antibody; determination of classes of immunoglobulins and immunostimulation of lymphocytes.

CAPS 8195.* PREVENTIVE VETERINARY MEDICINE. (Cr ar) Anderson, Diesch, Robinson

Application of the principles and practice of preventive veterinary medicine in food-animal production at the herd, state, national, or international levels.

SACS 8196.* INTERNAL MEDICINE IN SMALL COMPANION ANIMALS. (2 cr; prereq grad student, #) Bistner, Hardy, Klausner, McKeever, Ogburn, Osborne

Lectures, assigned readings, and discussions on internal medical problems of dogs and cats.

CAPS 8197. METABOLIC AND NUTRITIONALLY INDUCED DISEASES OF CATTLE. (2 cr; prereq grad student, #) Olson

Etiology, pathogenesis, current research, treatment, and prevention of metabolic diseases including vitamin and mineral diseases and energy and protein abnormalities associated with production.

SACS 8197.* ADVANCED DERMATOLOGIC CLINICS. (Cr ar; prereq grad student, #) McKeever

In-depth clinical study of dermatologic disease states, diagnosis and therapy in animals.

CAPS 8199. PROBLEMS IN ECONOMICS OF ANIMAL HEALTH. (1-3 cr; prereq #) Marsh, Olson, staff

Impact of animal disease on animal productivity and the return to investment in animal health by producers or the society studied using disease problems of current interest as subjects. Questions involving human health problems may be studied.

SACS 8200. DIRECTED STUDIES IN VETERINARY COMPARATIVE DERMATOLOGY. (2 cr; prereq grad student, #) McKeever

Readings and literature review.

CAPS and SACS 8290. ADVANCED VETERINARY MEDICINE. (Cr ar; prereq CAPS 5162, SACS 5172, #) Ames, Hardy, Joo, Larson, Osborne, Pijoan, Robinson, staff

Discussions of the diseases of organs or systems in animals from the following etiologic group: prenatal, metabolic, toxic infectious, physical influences.

CAPS and SACS 8291. ADVANCED DIAGNOSIS AND THERAPEUTICS OF ANIMAL DISEASES.

(Cr ar; prereq CAPS 5162, SACS 5172, #) Ames, Joo, Larson, McKeever, Ogburn, Olson, Osborne, Pijoan
Detailed examination, discussions, and treatment of cases of animal diseases.

CAPS and SACS 8292. SEMINAR: VETERINARY MEDICINE. (Cr ar; prereq grad student, #) Osborne, staff

CAPS and SACS 8293. MEDICAL CONFERENCE. (Cr ar; prereq CAPS 5162, SACS 5172, #) Larson, Osborne, staff

Medical, surgical, or obstetrical cases supported by anatomic, bacteriologic, pathologic, physiologic, pharmacologic, and radiologic evaluations whenever applicable.

CAPS and SACS 8299. RESEARCH IN VETERINARY MEDICINE. (Cr ar) Staff

Research problems relating to any aspect of internal medicine or to the various systems in animals.

CAPS 8690. EPIDEMIOLOGY OF ZOOSES AND DISEASES COMMON TO HUMANS AND ANIMALS. (Cr ar; prereq #) Diesch, Pullen, Robinson

Major human zoonotic diseases; methods of transmission, diagnosis, control, and prevention.

Veterinary Microbiology

See Veterinary Pathobiology.

Veterinary Parasitology

See Veterinary Pathobiology.

Veterinary Pathobiology

Professor: Lawrence B. Schook, *chair*; Bert E. Stromberg, *director of graduate studies*; William J. Bemrick (*emeritus*); James E. Collins; Stanley L. Diesch; Sagar Goyal; David A. Halvorson; David W. Hayden; Kenneth H. Johnson; Han Soo Joo; Harold J. Kurtz; Samuel K. Maheswaran; Thomas W. Molitor; Roger D. Moon; K. V. Nagaraja; John A. Newman; Victor Perman; Phillip K. Peterson; Carlos B. J. Pijoan; Michael Pullen; Robert A. Robinson; George R. Ruth; Jagdev M. Sharma; S. R. Tatini; Mary M. Walser; Douglas J. Weiss; Ronald E. Werdin

Associate Professor: Russell F. Bey; Martha A. Mellencamp; Michael P. Murtaugh; Timothy D. O'Brien; Terrance P. O'Leary; Daniel P. Shaw; Richard E. Shope, Jr.; V. Sivanandan

Assistant Professor: Rebecca Rose; Michael R. Riggs; Mark S. Rutherford

Research Associate: Connie J. Gebhart

Lecturer: Randy R. Simonson

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Along with program coursework, basic and applied research opportunities are offered in the areas of immunology, biotechnology, bacteriology, parasitology, anatomic and clinical pathology, and virology as related to animals. The graduate faculty encourage interdisciplinary interactions in related fields. For interested students, the Graduate School also offers a minor in psychoneuroimmunology.

Prerequisites for Admission—Applicants must have the background knowledge in biology, chemistry, and mathematics that is acceptable to the graduate faculty.

Special Application Requirements—A brief statement of career goals and three letters of recommendation evaluating the applicant's potential for graduate study are required. Additional information may be requested. Students may enter at the beginning of any quarter, but fall quarter is preferred.

Degree Requirements—For the master's degree, students take a final oral

examination. Students enrolled in the doctoral program are expected to write a thesis proposal and take a preliminary oral examination after the second year of graduate study.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Veterinary Pathobiology, University of Minnesota, 205g Veterinary Science, 1971 Commonwealth Avenue, St. Paul, MN 55108 (612/624-2282; fax 612/625-0204).

VPB 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

VPB 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

VPB 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

VPB 5504. VETERINARY CLINICAL PATHOLOGY. (4 cr; prereq 5502 or #) Perman, Weiss
Technique, application, and interpretation of laboratory tests used in clinical diagnosis.

VPB 5520. ADVANCED VETERINARY CLINICAL PATHOLOGY. (1-3 cr; prereq 5204, #) Perman, Weiss
Application of clinical laboratory methods.

VDM 5521. SURGICAL PATHOLOGY. (3 cr; prereq #) Collins, staff
Preparation and interpretation of surgical and necropsy specimens.

VDM 5522. DIAGNOSTIC PATHOLOGY. (5 cr; prereq #) Collins, staff
History, necropsy lesions, laboratory results, and histopathology in the diagnosis of animal diseases.

VPB 5523. PATHOLOGY OF SPONTANEOUS DISEASES OF LABORATORY ANIMALS. (2-3 cr; prereq #; offered alt yrs) Gunther
Gross and microscopic pathology of laboratory animals.

VPB 5524. PATHOLOGY OF SPONTANEOUS DISEASES OF POULTRY. (3 cr; prereq #; offered alt yrs) Walser
Gross and microscopic pathology of spontaneous diseases of chickens, turkeys, and game birds.

VPB 5601. VETERINARY PARASITOLOGY I. (4 cr; prereq 5501 or #) Stromberg
Helminth parasites and parasitic diseases of animals with emphasis on principles of control.

VPB 5602. VETERINARY PARASITOLOGY II. (4 cr; prereq 5601 or #) Stromberg
Systematic and biologic study of protozoan and arthropod parasites of animals; emphasis on their relationships to diseases and principles of parasite control.

Graduate Programs

VDM 5622. PROBLEMS IN DIAGNOSTIC

VIROLOGY. (1-4 cr; prereq #) Goyal
Laboratory techniques in diagnostic virology and viral research.

CAPS 5650. VETERINARY EPIDEMIOLOGY AND

STATISTICS. (4 cr; prereq 10 cr biology, 12 cr chemistry or #) Diesch, Pullen, Robinson
Principles of epidemiology, ecology, and veterinary public health. Biostatistics applied to the measurement of health and disease in populations.

CAPS 5651. VETERINARY COMMUNITY

MEDICINE. (3 cr; prereq VPB 5703, VPB 5503 or equiv or #) Diesch, Pullen, Robinson
Principles and practice of environmental health and food hygiene including meat, poultry, milk, and other foods as related to animal and human health. Selected diseases transmitted between animals and humans.

CAPS 5665. MONITORING AND SURVEILLANCE

OF DISEASE. (Cr ar; prereq #) Diesch, Robinson
Seminars and discussions on techniques used to monitor disease in animal populations.

CAPS 5680. PROBLEMS IN VETERINARY

EPIDEMIOLOGY AND PUBLIC HEALTH. (Cr ar; prereq 5650 or equiv or #) Diesch, Pullen, Robinson
Individual study arranged with faculty member.

VPB 5701. VETERINARY IMMUNOLOGY. (3 cr;

prereq 3101, 1st-yr vet med, #) Bey, Shope
Cellular and humoral immune responses, hypersensitivity, regulation of immune system, immunosuppression, autoimmunity, and vaccination.

VPB 5702. PATHOGENIC BACTERIA AND

FUNGI. (5 cr; prereq 5701 or equiv or #) Mellencamp, Rutherford

Lectures and laboratory on animal pathogens, with emphasis on basic mechanisms of infection.

VPB 5703. VETERINARY VIROLOGY. (5 cr; prereq

5702 or equiv or #) Molitor, Shope
Lectures and laboratory on the basic techniques of virology; emphasis on viral and rickettsial agents causing animal diseases.

VPB 5704. AVIAN DISEASES. (3 cr; prereq 5703,

5503 or #) Newman, staff
Lectures on diseases involving poultry, cage and aviary birds.

VPB 5707. POULTRY DISEASE CONTROL. (3 cr;

not open to vet med students; prereq AnSc 1100, Biol 1106, VPB 3103 or equiv) Newman
General anatomy; physiology of digestion and reproduction; prevention and control of the more important diseases affecting poultry.

VPB 5709. PREVENTIVE AVIAN MEDICINE.

(1-2 cr; prereq regis 4th-yr vet med or grad student or #) Staff

Preventive avian disease programs and management practices. Visits to poultry and aviary establishments.

VPB 5780. APPLIED IMMUNOLOGY. (1 cr; prereq

vet med grad student or #)
Review of principles of immunology and their clinical application.

VMic 8026. NEURO-IMMUNE INTERACTIONS.

(3 cr, \$Nsc 8026, \$PNI 8026, \$Psy 8026; prereq MicB 5218 or equiv, Nsc 5111 or equiv) Molitor, Murtaugh, staff
Regulatory systems (neuroendocrine, cytokine, and autonomic nervous systems) linking brain and immune systems in a brain-immune axis. Functional effects of bidirectional brain-immune regulation.

CAPS 8193.* ADVANCES IN CLINICAL

IMMUNOBIOLOGY. (Cr ar; prereq grad student or #)

Molitor
Students, faculty members, and guest speakers present seminars on current research in and clinical application of immunologic procedures in diagnosis, control, and treatment of disease processes in animals.

CAPS 8194.* PROBLEMS IN DIAGNOSTIC

VIROLOGY, SEROLOGY, AND IMMUNOLOGY.

(Cr ar; prereq grad student or #) Goyal, Molitor
Laboratory techniques in diagnostic virology, serology, and immunology. Research techniques of fluorescent antibody; determination of classes of immunoglobulins and immunostimulation of lymphocytes.

VPB 8500. SEMINAR: VETERINARY

PATHOLOGY. (1-3 cr; prereq 5503, #) O'Leary

VPB 8501s. ADVANCED VETERINARY BASIC

PATHOLOGY. (4-6 cr; prereq #) Johnson, staff
Basic mechanisms and concepts relating to reaction of tissue to injury. Emphasis on gross and microscopic interpretation of retrogressive cellular changes, cellular infiltrations, inflammation, and neoplasia. Requires completion of a special project selected in conjunction with course instructor.

VPB 8504s. ADVANCED VETERINARY

HISTOPATHOLOGY. (1 cr; prereq 5502, 5503, #) Hayden

Discussion and study of selected case materials from the veterinary anatomic, diagnostic, and surgical pathology programs.

VPB 8531. HOSPITAL PATHOLOGY. (1-2 cr; prereq

5501, 5502, 5503, #) Hayden, staff
Necropsy and surgical pathology techniques, examination of tissue for diagnosis, and preparation of reports and records.

VPB 8533. PROBLEMS: PATHOLOGY. (Cr ar;

prereq #) Johnson, staff

VPB 8534. PROBLEMS: CLINICAL PATHOLOGY.

(Cr ar; prereq #) Perman, Weiss

VPB 8648. PROBLEMS: VETERINARY

PARASITOLOGY. (Cr ar; prereq #) Stromberg, staff

CAPS 8690. EPIDEMIOLOGY OF ZOOSES

AND DISEASES COMMON TO HUMANS AND ANIMALS. (Cr ar; prereq #) Diesch, Pullen, Robinson
Major human zoonotic diseases; methods of transmission, diagnosis, control, and prevention.

VPB 8700. SEMINAR: VETERINARY PATHOBIOLOGY. (1 cr; prereq #) Staff

VPB 8716. COLLOQUIUM ON CURRENT TOPICS IN AVIAN IMMUNOLOGY. (2 cr; prereq MicB 5216, grad student; offered alt yrs) Nagaraja, Sharma, Sivanandan

VPB 8720. ADVANCED VETERINARY MICROBIOLOGY. (Cr ar; prereq #) Staff

VPB 8721. IMMUNODIAGNOSTIC TECHNIQUES FOR AVIAN DISEASES. (2 cr; prereq MicB 5216, grad student; offered alt yrs) Nagaraja, Sivanandan

VPB 8724. ADVANCED VETERINARY DIAGNOSTIC MICROBIOLOGY. (Cr ar; prereq #) Newman, staff
Lectures and laboratory in techniques of diagnostic mycology, bacteriology, virology, and serology.

VPB 8725. CELL CULTURE TECHNIQUES. (2 cr; prereq 5703 or equiv, #) Shope
Laboratory exercises and discussions on culture of vertebrate cells; proper preparation of all materials necessary for handling cell cultures; establishment of primary cell cultures by various techniques and maintenance of cells as monolayers or in suspension. Animal viruses used for plaque assays, neutralization tests, limited fluorescent antibody techniques and microtitration. Laboratory work in student's specific area of interest.

Veterinary Pathology

See Veterinary Pathobiology.

Veterinary Surgery, Radiology, and Anesthesiology

Professor: Daniel A. Feeney, *director of graduate studies;* Dennis D. Caywood; Carl R. Jessen; Donald W. Johnson; Gary R. Johnston, Alan J. Lipowitz; Marc R. Raffé; Roby C. Thompson; Larry J. Wallace

Associate Professor: David R. Brown; Mathur S. Kannan; Patrick T. Redig; Elaine P. Robinson; Ava M. Trent; Tracy A. Turner; Patricia A. Walter

Assistant Professor: Calvin N. Kobluk

Clinical Professor: Paul G. Gannon; Claude R. Swayze

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Prerequisites for Admission—The D.V.M. degree or its foreign equivalent is required. The applicant must also have completed an internship program or the equivalent of at least one year of clinical experience since the award of the D.V.M. degree.

Special Application Requirements—A statement of preferred emphasis in the major and three letters of recommendation evaluating the applicant's potential must be submitted. Students may begin in any term, but fall quarter entry is preferred.

Degree Requirements—For both the M.S. and the Ph.D. degrees, students must complete, or have completed, the basic coursework relevant to their area of emphasis in the program. For further details on coursework, contact the director of graduate studies. The final examination for the master's degree is oral.

Language Requirements—None.

For Further Information and Applications—Contact the Veterinary Surgery, Radiology, and Anesthesiology Graduate Program, Department of Small Animal Clinical Sciences, University of Minnesota, C-339 Veterinary Teaching Hospitals, 1352 Boyd Avenue, St. Paul, MN 55108 (612/625-7744).

VSRA 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

VSRA 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

VSRA 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

SACS 5330. WILD BIRD MEDICINE. (2 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #)
Summary of avian anatomy and physiology. Survey of diseases common to wild birds; surgical repair of common injuries and fractures.

SACS 5350. PRINCIPLES OF VETERINARY SURGERY. (5 cr; prereq VPB 5126 or #)
Basic materials necessary for clinically managing large and small animal surgical patients. Aseptic technique, patient evaluation, physiologic responses of body systems to surgery, repair and healing of tissue, surgical anatomy.

SACS 5351. VETERINARY SURGERY. (5 cr; prereq CVM 5350 or #) Caywood, Lipowitz, Wallace
Common surgical procedures applied to small animals.

CAPS 5352. LARGE ANIMAL SURGERY. (5 cr; prereq #) Kobluk, Trent, Turner
Common surgical procedures applied to large animals.

Graduate Programs

CAPS 5355. EQUINE COLIC MANAGEMENT.

(2 cr; prereq 1st-yr vet med)
Lecture and laboratory on principles and techniques involved in evaluation and treatment of equine colic cases. Successful completion is a prerequisite for colic team, CAPS 5356 and CAPS 5357.

CAPS 5356. EQUINE COLIC TEAM. (1 cr; prereq vet med, 5355; 4-qr course, cr granted upon completion of 4th qtr)

Participation in clinical management of equine colic cases and periodic review of past cases, success rates, and topics in related fields.

SACS 5356. SMALL ANIMAL SURGERY LABORATORY. (1 cr; prereq 5352 or #) Caywood, Lipowitz

CAPS 5357. ADVANCED COLIC TEAM. (1 cr; prereq vet med, 5356; 4-qr course, cr granted upon completion of 4th qtr)

Participation in clinical management of cases and periodic review of past cases, success rates, and topics in related fields. Students act as team leaders during clinical management and assist in laboratory exercises for CAPS 5355.

SACS 5360. SMALL ANIMAL ORTHOPEDICS.

(2-3 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #) Wallace
Small animal orthopedic problems and surgical procedures to correct them.

SACS 5380. ANESTHESIOLOGY AND CRITICAL CARE. (3 cr; prereq 5170 or #) Raffé

Principles and application of anesthesia. Management of severely injured patient.

SACS 5398. INDEPENDENT RESEARCH IN VETERINARY ANESTHESIOLOGY. (1-6 cr; prereq regis vet med or grad student or #) Raffé, Robinson

Special problems course for evaluating research methods. Controlled study, prospective, and retrospective models of evaluation defined, critiqued, and used for experimental design and data collection. Analysis of data collection to validate research methods.

SACS 5451. VETERINARY RADIOLOGY I. (1 cr; prereq #) Walter Radiographic interpretation of normal systems.

SACS 5452. VETERINARY RADIOLOGY II. (3 cr; prereq 5451 or #) Feeney, Johnston, Walter Principles of radiography and radiographic interpretation of abnormal systems.

SACS 5453. SPECIAL PROCEDURES IN VETERINARY RADIOLOGY. (2 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #) Feeney, Johnston Contrast agents and imaging procedures used to examine various body systems or anatomical areas.

SACS 5454. ROENTGENOLOGY BONE—LARGE ANIMALS. (1 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #) Feeney, Johnston, Walter Roentgen signs of common bone diseases of large animals. Emphasis on the horse.

SACS 5455. ROENTGENOLOGY BONE—SMALL ANIMALS. (1 cr; prereq regis 3rd- or 4th-yr vet med or grad student or #) Feeney, Johnston, Walter Roentgen signs of common bone diseases of small animals.

CAPS 8390. SEMINAR: VETERINARY SURGERY. (Cr ar; prereq DVM or equiv) Kobluk, Trent, Turner

SACS 8390. SEMINAR: VETERINARY SURGERY. (Cr ar; prereq 5360, 5365 or equiv and #) Caywood, Lipowitz, Wallace

SACS 8391. ADVANCED SMALL ANIMAL SURGERY. (Cr ar; prereq 5360 or equiv, #) Caywood, Lipowitz, Wallace

Surgery of various systems in small animals with preoperative and postoperative evaluation and treatment.

CAPS 8392. ADVANCED LARGE ANIMAL SURGERY. (Cr ar; prereq DVM or equiv, #) Kobluk, Trent, Turner

Surgery of various systems in large animals with preoperative and postoperative evaluation and treatment.

CAPS 8393. PROBLEMS IN LARGE ANIMAL ORTHOPEDICS. (3 cr; prereq 5365 or equiv, #) Kobluk, Trent, Turner

SACS 8394. SURGERY OF THE GASTROINTESTINAL SYSTEM. (Cr ar; prereq 5201 or equiv, #) Caywood, Lipowitz, Wallace

SACS 8396. ADVANCED VETERINARY ANESTHESIA. (Cr ar; prereq 5380 or equiv) Raffé, Robinson Principles of anesthesia; administration of local, regional, and general anesthesia in large or small animals.

SACS 8398.* RESEARCH IN VETERINARY ANESTHESIA. (2-4 cr; prereq grad of professional vet curriculum, 8397, SACS 8396 or equiv, #) Raffé, Robinson Special problems course for evaluating research methods. Controlled study, prospective, and retrospective models of evaluation defined, critiqued, and used for experimental design and data collection. Analysis of data collection to validate research methods.

SACS 8399. SEMINAR: VETERINARY ANESTHESIA. (1-4 cr; prereq grad of professional vet curriculum, 8397, SACS 8396 or equiv, #) Raffé, Robinson Topics in veterinary anesthesia and critical care in large and small animal species.

SACS 8410.* SURGICAL PHYSIOLOGY. (2 cr; prereq 8391 or equiv, #) Caywood, Lipowitz, Wallace Macro and micro physiological changes that occur in the animal body as the result of surgical disease and intervention.

SACS 8420.* NEUROSURGERY. (2-3 cr; prereq 8391 or equiv, #) Wallace Treatment of surgical diseases of animal nervous system, including pathophysiology of these diseases.

SACS 8430. THORACIC AND CARDIOVASCULAR SURGERY. (3 cr; prereq 8391 or equiv, #) Caywood, Lipowitz, Wallace

Advanced surgical management of diseases of the thorax and cardiovascular system.

SACS 8471.* THERAPEUTIC RADIOLOGY. (Cr ar [max 2 cr]; prereq 5452 or equiv, #) Feeney, Jessen, Johnston, Walter

General procedures in therapeutic radiology presently available in veterinary medicine. One credit equals approximately 10 lecture hours or 30 laboratory hours or 40 hours of preparation on paper.

SACS 8480. SEMINAR: VETERINARY RADIOLOGY. (1 cr; prereq 5452 or equiv, #) Feeney, Jessen, Johnston, Walter

Current reviews, reports, and discussion of problems.

SACS 8483. ABDOMINAL ROENTGENOLOGY. (Cr ar [max 3 cr]; prereq 5452 or equiv, #: offered alt yrs) Feeney, Johnston, Walter

Soft tissue roentgenology of abdominal structures. One credit equals approximately 10 lecture hours, or 30 laboratory hours, or 40 hours of paper preparation.

SACS 8485. THORACIC ROENTGENOLOGY. (Cr ar [max 3 cr]; prereq 5452 or equiv, #: offered alt yrs) Feeney, Johnston, Walter

Soft tissue roentgenology of structures within the thorax with emphasis on pulmonary and mediastinal roentgenology. One credit equals approximately 10 lecture hours, 30 laboratory hours, or 40 hours of paper preparation.

SACS 8490. PROBLEMS IN DIAGNOSTIC ROENTGENOLOGY. (Cr ar [max 2 cr]; prereq 5452 or equiv, #) Feeney, Jessen, Johnston, Walter

Problems associated with diagnostic procedures and their interpretation.

SACS 8491. FUNDAMENTALS OF NUCLEAR MEDICINE. (Cr ar; prereq grad student, #: offered when feasible) Feeney, Jessen, Johnston, Walter

Veterinary Pathobiology

See Veterinary Medicine.

Veterinary Surgery, Radiology, and Anesthesiology

See Veterinary Medicine.

Vocational and Technical Education

AGRICULTURAL EDUCATION

Professor: Patrick Borich; George Copa¹; Richard A. Krueger¹; Curtis D. Norenberg¹; Edgar Persons¹; Roland Peterson¹

Associate Professor: Gary W. Leske¹; Barbara A. Warren¹

Other: Antony J. Warner

BUSINESS AND MARKETING EDUCATION

Professor: David C. Bjorkquist¹; Charles R. Hopkins¹; Judith J. Lambrecht¹; Gary N. McLean¹; David J. Pucel

Associate Professor: Theodore Lewis¹; James R. Stone III¹

Lecturer: Sherry A. Schwartz¹

FAMILY EDUCATION

Professor: Richard A. Krueger¹; Ruth Thomas¹; Howard Y. Williams¹

Associate Professor: Jerry McClelland¹; Jane Plihal¹; Marilyn A. M. Rossmann¹; Mary A. Smith¹; James R. Stone III¹; Barbara A. Warren¹

Lecturer: Jeanette R. Daines¹

INDUSTRIAL EDUCATION

Professor: David Bjorkquist¹; Charles R. Hopkins¹; Judith J. Lambrecht¹; Gary N. McLean¹; David Pucel¹; Richard Swanson¹

Associate Professor: James M. Brown¹; Theodore Lewis¹; James R. Stone III¹

VOCATIONAL EDUCATION

Professor: Charles R. Hopkins¹; *chair;* David Bjorkquist¹; George Copa¹; Richard A. Krueger¹; Judith J. Lambrecht¹; Gary N. McLean¹; Edgar Persons¹; Roland Peterson¹; David Pucel¹; Richard Swanson¹; Ruth Thomas¹; Howard Y. Williams¹

Associate Professor: James M. Brown¹; Harlan G. Copeland¹; Gary Leske¹; Theodore Lewis¹; Jerry McClelland¹; Rosemarie J. Park¹; Jane Plihal¹; Marilyn M. Rossmann¹; Mary A. Smith¹; James R. Stone III¹; Barbara A. Warren¹

Assistant Professor: Nancy J. Rohde¹

Lecturer: Jeanette R. Daines¹; Sherry A. Schwartz¹

Other: James R. Daines¹; Robert D. Shumer¹

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.A. (Plan A and Plan B) in agricultural education, business and marketing education, education (emphasis in vocational education), family education, industrial education. Ph.D. in education

¹ Also holds graduate faculty appointment in education.

Graduate Programs

(emphasis in vocational education). Ed.D. in vocational education.

Curriculum—M.A. degrees are offered in these areas: *agricultural education* (emphasis on school and non-school instruction in agriculture, adult education, agricultural extension, planning, organization, evaluation, or youth activities); *business and marketing education* (emphasis on school and non-school instruction/training in the processes, technologies, and materials employed in modern office and business operations, management, and marketing of goods and services); *education with emphasis in vocational education* (specializations in adult education, vocational administration, comprehensive vocational education, extension education, human resource development, international vocational education and training, and vocational special needs); *family education* (emphasis on school and non-school instruction, family education, home economics extension, planning, evaluation, and youth activities); and *industrial education* (emphasis on processes, technologies, and materials employed in preparing individuals for teaching, training, and supervision in education and industry).

Two doctoral degrees are offered with specializations in adult education, agricultural education, business and marketing education, extension education, family education, human resource development, industrial education, international vocational education and training, and vocational education. The Ed.D. in vocational education is designed for professionals who primarily synthesize and apply knowledge to problems of practice. The Ph.D. in education with emphasis in vocational education is designed for professionals who are involved in research and generation of knowledge for the field.

Prerequisites for Admission—Prospective master's degree students generally have completed an undergraduate degree or extensive coursework in the field. Others, however, may be admitted if they complete

appropriate background preparation. Prospective doctoral degree students should have academic background and experience in at least one vocational education specialization.

Special Application Requirements—Scores from the Miller Analogies Test or the Graduate Record Examination (GRE) are required for all master's degree program applicants with a bachelor's degree from a U.S. institution. Master's degree applicants should designate the specific degree program to which they seek admission. Scores from the GRE are required for doctoral degree program applicants with a bachelor's degree from a U.S. institution. Doctoral degree applicants should designate either the Ph.D. or the Ed.D. program. Students are admitted each quarter.

Master's Degree Requirements—Specific degree requirements are flexible. Students should consult the director of graduate studies for information on the final examination for the master's degree.

Doctoral Degree Requirements—For the Ed.D. in vocational education, the following is required: a minimum of 88 credits plus a 36 credit field study (thesis credits); at least 18 credits in the general aspects of vocational education; at least 42 credits in the specialization/subspecialization, including a 6 credit internship; and at least 11 credits in research.

For the Ph.D. the following is required: a minimum of 88 credits plus a 36 credit thesis; at least 24 credits in the general aspects of vocational education; at least 24 credits in the specialization/subspecialization; and at least 24 credits in research.

Examinations focus on the general aspects of vocational education, specialization/subspecialization, and research. For further information about the doctoral degrees, see the departmental degree handbooks.

Language Requirement—None.

Minor, Supporting, or Related Field Requirements for Students Majoring in Other Fields—Any vocational and technical education specialization (except the emphasis in the major field of education) may be used as a minor or supporting field for the doctoral degree, or as a related field for the master's degree. For students who choose one of these specializations as part of a doctoral supporting program (which consists of at least 18 credits total), a minimum of 12 credits in the chosen specialization is required. For students who choose a vocational and technical education specialization as a related field for the master's degree, a minimum of 8 credits in the chosen specialization is required.

For Further Information and Applications—Contact Gary Leske, Director of Graduate Studies, Department of Vocational and Technical Education, University of Minnesota, R-350 VoTech Building, 1954 Buford Avenue, St. Paul, MN 55108 (612/624-1221).

Educ 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

VoEd 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral EdD student who has not passed oral prelims)

AgEd 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

BME 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Educ 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only with emphasis in VoEd)

FE 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Ind 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Educ 8888. THESIS CREDITS: DOCTORAL. (36 cr required; PhD only)
Section 2. Vocational Education

VoEd 8888. THESIS CREDITS: DOCTORAL. (36 cr required; EdD only)

Adult Education (AdEd)

5103. ADULT EDUCATION WORKSHOP. (1-12 cr [max 12 cr], §Educ 5103; prereq practicing adult educator or #)

Topics appropriate to activities and interests of the participants.

5104. SURVEY OF ADULT EDUCATION. (3 cr, §Educ 5104; prereq sr) Copeland
General concepts in the field; literature, objectives, history, philosophy, research, institutions, issues, and problems.

5110. THE STATUS AND ROLE OF WOMEN IN AMERICAN SOCIETY. (4 cr, §Educ 5110; offered alt yrs) Park

The role of women in American history; perceptions of women in literature and art; attention to women in social studies curricula; human sexuality; male and female character-nature and/or nurture; choices of family and career.

5201. INTRODUCTION TO THE UNDEREDUCATED ADULT. (3 cr, §Educ 5201)

Issues in literacy education, characteristics, problems, individual differences of the undereducated adult learner; traditional and innovative approaches for working with adults in literacy programs.

5202. ADULT LITERACY: DIAGNOSIS AND PRESCRIPTION. (3 cr, §Educ 5202; prereq 5201 or #) Park

Application of diagnostic information, instruments, and techniques to learning difficulties of adults in reading and mathematics programs.

5203. ADULT LITERACY: METHODS AND MATERIALS. (3 cr, §Educ 5203; prereq 5202 or Elem 5331 or #) Park

Teaching literacy skills to adults: basic theories, approaches, overview of methods and materials for implementation.

5204. READING IN WORK SETTINGS. (3 cr, §VoEd 5204) Park

Overview of concepts involved in integrating reading instruction into vocational training programs and work settings; diagnosis and methods of assessing needs of vocational students and workers on a job; techniques for building needs into training programs.

5205. FIELD EXPERIENCE IN ADULT EDUCATION. (4-8 cr [max 8 cr], §Educ 5205; prereq #)
Supervised fieldwork practice and seminars; presentations on and evaluations of adult education practices.

5301. DESIGNING THE ADULT EDUCATION PROGRAM. (3 cr, §Educ 5301) Copeland
Designing and implementing educational programs for adults: concepts, theories, determining needs, educational objectives, learning experiences, and evaluating outcomes.

Graduate Programs

5401. ADULT LEARNING AND DEVELOPMENT THROUGH THE LIFE SPAN. (3 cr, §Educ 5401)

Williams
Physiological, social, and cultural bases of adult behavior; motivation, socialization, personality change as applied to education of adults.

5411. STRATEGIES FOR TEACHING ADULTS. (3 cr, §Educ 5411)

Identification, classification and analysis of techniques used in teaching adults.

5421. DISTANCE EDUCATION. (3 cr)

Survey covering concept, theories, history, delivery systems, and present practice. Emphasizes practice in United States, but explores topics from international perspective.

5440. MULTIDISCIPLINARY PERSPECTIVES ON AGING. (4 cr, §CPsy 5305, §HSU 5009, §PA 5514, §PubH 5737, §Soc 5960, §SW 5024)

Copeland
Multidisciplinary introduction to aging and the aging process.

5450. CRITICAL PEDAGOGY. (3 cr, §FE 5450, §VoEd 5450)

Critical pedagogy in schools and adult education; application to education for family, work, and community; other topics.

5501. CONTINUING EDUCATION AND THE PROFESSIONS. (3 cr, §Educ 5501)

Review of literature; analysis of philosophies, issues, and trends; emphasis on integrating personal growth, professional needs, and statutory requirements in continuing education programs.

5901. INTRODUCTION TO COMMUNITY EDUCATION. (3 cr, §Educ 5901)

Exploration and investigation of school, park, and recreation joint and individual programs; relationship to community education; introduction to administration of such programs.

8090. ANALYSIS OF ISSUES IN ADULT EDUCATION. (3 cr, §Educ 8090; prereq 6 cr adult ed or #) Williams

Social, legal, moral/ethical, technical, and empirical sources of issues in adult education.

8100. RESEARCH IN ADULT EDUCATION. (3 cr, §Educ 8100; prereq #, coursework in experimental design) Williams

Review and analysis of current research and research procedures in adult education.

8302. PROBLEMS: ADULT EDUCATION. (1-9 cr, §Educ 8302; prereq #)

Individual research in area of adult education.

Agricultural Education (AgEd)

5010. RURAL LEADERSHIP DEVELOPMENT. (3 cr) Peterson

Understanding role, function, and unique features of leaders in rural communities; importance of personal involvement to these roles; personal leadership and vision development for individuals and rural community groups.

5021. EDUCATION THROUGH EXTENSION METHODS. (3 cr, §HEEd 5021; prereq grad student or #) Norenberg

Methods and techniques of formal and nonformal education used by Extension Service and other organizations.

5023. EXTENSION METHODS FOR AGRICULTURAL PRODUCTION IN DEVELOPING COUNTRIES. (3 cr, §HEEd 5023)

Persons
Extension methods to promote the rapid adoption of improved agricultural practices.

5024. EXTENSION HISTORY AND PHILOSOPHY. (3 cr, §HEEd 5024) Smith

Origin, philosophy, historical development, objectives, and organizational structure of the Extension Service.

5025. EXTENSION PROGRAM DEVELOPMENT. (3 cr, §HEEd 5025)

Planning, implementing, and evaluating program development process.

5026. EXTENSION ADMINISTRATION. (3 cr, §HEEd 5026; prereq #)

Administration of the Cooperative Extension Service organization at the county, area, and state levels.

5027. PRACTICUM: PLACEMENT FOR EXTENSION EXPERIENCES. (2-9 cr [max 9 cr], §HEEd 5027; S-N optional) Norenberg

Observation of and participation in activities of Extension Service staff at county and state levels; familiarization with staffing, program planning and development, and educational and administrative functions.

5028. TEACHING METHODS IN AGRICULTURAL EDUCATION. (5 cr; prereq SeEd 3155 or ¶SeEd 3155) Peterson

Methods in teaching agriculture in public schools; use of media, principles of learning, problem solving, test construction, classroom management and specific practice in problem-solving teaching techniques; use of competency-based individualized instruction as medium for course presentation and model for teaching methods.

5031. CLINICAL EXPERIENCE IN TEACHING AGRICULTURE. (6-10 cr; prereq 5028, 4 cr of foundations courses)

Planning, organizing, and teaching agricultural education; supervising occupational experience programs and student organizations in middle, secondary, and adult or post-secondary schools.

5032. HIGH SCHOOL CURRICULUM IN AGRICULTURE. (3 cr; prereq 10 cr education) Peterson

Philosophy, organization, and administration of instruction in agriculture departments in secondary schools.

5034. PROCEDURES IN TEACHING AGRICULTURE. (3 cr; prereq #) Peterson

New developments in methodology; assessment of innovations and procedures; consideration of various levels of instruction.

5041. WORKSHOP: AGRICULTURAL EDUCATION TECHNOLOGY. (1-6 cr [max 6 cr])
New understandings, techniques, and materials in animal science, plant science, horticulture, soil science, agricultural mechanics, forestry, natural resources, youth organization, visual aids, and occupational exploration.

5042. AGRICULTURAL MECHANICS. (1-3 cr [max 12 cr])
Technical and managerial information, techniques, and materials. Facilitates participant's instructional planning, resource development, and instruction.

5043. FARM MANAGEMENT. (1-3 cr [max 12 cr])
Persons
Application of agricultural economics theory and principles, techniques, and materials. Facilitates participant's instructional planning, resource development, and instruction.

5049. AGRICULTURAL EDUCATION FOR ADULTS. (3 cr; 5010, 6 cr ag and applied econ or #)
Persons
Organization and implementation of systematic education programs for beginning and established farmers; organization of local programs to meet needs of production agriculture in areas of enterprises, agricultural mechanics, and management; development of continuing programs.

5051. ENTERPRISE ANALYSIS. (3 cr; prereq #)
Persons
Analyzing the farm business as a basis for identifying problems; planning learning experiences to improve farm management at the high school, young farmer, and adult levels.

5052. FARM BUSINESS MANAGEMENT EDUCATION. (3 cr; prereq 5049 or #) Persons
Administration, organization, and operation of farm business management education programs for adults; development and use of curriculum materials based on farm business record data.

5055. METHODS IN FARMING SYSTEMS RESEARCH AND EXTENSION. (3 cr) Leske
Methodology for integrating research and extension programs designed to identify and solve farm family system problems using interdisciplinary and holistic approaches.

5061. PROGRAM PLANNING AND EVALUATION. (3 cr) Persons
Developing a program of agricultural education in a community school, integration with total school program, administrative relationships, techniques and uses of program evaluation in planning.

5071. SUPERVISED OCCUPATIONAL EXPERIENCES IN AGRICULTURE. (3 cr) Leske
Organization and administration of an occupational experience program in agriculture for high schools and area schools.

5072. PRACTICUM: AGRICULTURAL BUSINESS AND INDUSTRY. (1-3 cr [max 9 cr]; prereq 5071 or #)
Leske
Observation, study, and experience in agricultural business and industry; application to educational problems in agriculture.

5078. FFA ORGANIZATION AND MANAGEMENT. (2 cr) Leske
Development of FFA (vocational agribusiness education student organization) knowledge, organization and integration of activities into curriculum, management of chapter operations.

5080. ORGANIZATION AND MANAGEMENT. (3 cr; prereq #)
Administrative structure and function of subcollegiate programs.

5081. CURRENT ISSUES FOR THE BEGINNING AGRICULTURE TEACHER. (1-3 cr [max 3 cr]; prereq #) Peterson
Teaching methods, organizing learning resource materials, managing classroom and laboratory learning activities, curriculum planning and organization, managing discipline situations, school and community relationships for the beginning teacher.

5082. CURRENT ISSUES IN AGRICULTURAL EDUCATION. (1-3 cr [max 9 cr]; prereq #) Leske, Persons, Peterson
Emphasizes study and clarification of current issues, strategies of response, implications of response actions, and related leadership roles.

5087. MENTORSHIP FOR BEGINNING AGRICULTURE TEACHERS. (2 cr per qtr; prereq postbac student, less than 2 yrs tchg exper in agriculture, §5081. #; registration required in 3 consecutive qtrs)
Year-long program of professional development during induction year of teaching agriculture in public schools. Problem solving, issues and concerns of new teachers, and making a smooth transition into teaching profession.

5088. MENTORING BEGINNING AGRICULTURE TEACHERS. (3 cr; prereq #; 3-qtr course, cr granted upon completion of 3rd qtr)
Professional development training for experienced teachers who serve in mentoring roles for beginning teachers of vocational agriculture. Dealing with problems, concerns, and issues of teachers in applied settings during induction period into teaching profession.

5090. INDEPENDENT STUDY. (1-3 cr)
Topics may be chosen to permit study of areas within education or to supplement areas of inquiry not provided in the regular course structure.

5128. METHODS OF TEACHING. (3 cr; prereq non-agricultural education major and/or #) Peterson
Methods of teaching agriculture or related subjects; developing competencies in planning, organizing, implementing, and evaluating instruction, with practice in instructional techniques.

Graduate Programs

5244. TOPICS IN PROGRAM PLANNING FOR EXTENSION EDUCATION. (1-6 cr [max 9 cr], §HEEd 5244)

Extension education programming in relation to situation and needs analysis; coordination of content, people, methodology; specific aspects in development of program models; managing resources.

5245. TOPICS IN ADMINISTERING EXTENSION EDUCATION. (1-6 cr [max 9 cr], §HEEd 5245)

Issues and current literature; focus on personnel hiring and supervision, financial management, leadership styles, long-range planning; application of theory to administrative practice.

5246. TOPICS IN TEACHING AND DELIVERING EXTENSION EDUCATION. (1-6 cr [max 9 cr], §HEEd 5246)

Teaching techniques related to concepts of use of media, telecommunications, computers, group process methods, and experiential learning in extension education settings.

5247. TOPICS IN EVALUATING EXTENSION EDUCATION. (1-6 cr [max 9 cr], §HEEd 5247)

Krueger

Overall evaluation design; choosing quantitative vs. qualitative evaluation methods; developing skills and conceptual frameworks to apply theory to extension settings.

8001. RESEARCH IN AGRICULTURAL EDUCATION. (Cr ar; prereq 15 cr education)

Selecting problems, preparing bibliographies, analyzing and interpreting data, and preparing manuscripts.

8020. SEMINAR: AGRICULTURAL EDUCATION. (Cr ar) Peterson

8091. FIELD PROBLEMS. (3 cr)

Making investigations, gathering data, and formulating plans regarding agricultural education.

8303. SEMINAR: GRADUATE STUDIES REVIEW. (1-3 cr)

Review of graduate studies in agricultural education being planned or recently completed.

Business and Industry Education (BIE)

5002. TEACHING PROMOTION DISPLAY. (3 cr, §BME 5252)

Identifying materials and methods for teaching visual merchandising, sales promotion, advertising, public relations, and promotion planning.

5010. INTRODUCTION TO MICROCOMPUTER APPLICATIONS IN BUSINESS AND INDUSTRY EDUCATION. (3 cr, §BME 5310)

Instructional uses of microcomputers; representative business and industry education applications, including word processing, databases, spreadsheets, and graphics.

5015. ADVANCED WORD PROCESSING PRACTICUM. (3 cr, §BME 5160)

Completion of projects using advanced editing and printing capabilities.

5020. SPREADSHEET ANALYSIS USING MICROCOMPUTERS IN BUSINESS AND INDUSTRY EDUCATION. (3 cr, §BME 5330; prereq 5010 or equiv)

Introduction to use of spreadsheet software; instructional applications in business areas.

5025. TEACHING MICROCOMPUTER GRAPHICS IN BUSINESS AND INDUSTRY. (3 cr, §BME 5335; prereq 5010 or equiv)

Representative microcomputer-based business graphics software packages; use for making instructional presentations; using simulated projects to teach applications in business and industry classrooms.

5030. DATABASE MICROCOMPUTER APPLICATIONS. (3 cr, §BME 5345; prereq 5010 or equiv)

Introduction to database software; instructional applications in business areas.

5035. TEACHING DESKTOP PUBLISHING. (3 cr, §BME 5363; prereq 5010 or equiv)

Strategies for teaching skill development in page layout and design, text and graphic creation, file merging, printing, equipment and software requirements.

5040. INTEGRATED MICROCOMPUTER APPLICATIONS IN BUSINESS AND INDUSTRY EDUCATION. (3 cr, §BME 5365; prereq 5010 or 5015 or 5020 or 5025 or 5030 or equiv)

Advanced business and industry computer applications integrating business word processing, spreadsheets, business graphics, and database software.

5080. SPECIAL TOPICS IN TECHNICAL UPDATING. (1-6 cr, §BME 5390)

Technological and procedural changes in business content. Topics vary with each offering.

5113. SPECIAL TOPICS IN MANUFACTURING. (1-6 cr, §Ind 5133)

Topic not covered by available courses.

5123. SPECIAL TOPICS IN COMMUNICATIONS. (1-6 cr, §Ind 5123)

Topic not covered by available courses.

5133. SPECIAL TOPICS IN POWER AND ENERGY. (1-6 cr, §Ind 5143)

Topic not covered by available courses.

5143. SPECIAL TOPICS IN TRANSPORTATION. (1-6 cr, §Ind 5153)

Topic not covered by available courses.

5150. TECHNICAL DEVELOPMENT: SPECIALIZED. (1-12 cr [max 18 cr], §Ind 5200; prereq #)

Integration of specialized technical instruction in advanced and emerging areas into courses in industrial education.

5253. SUPERVISORY TRAINING. (3 cr, §BME 5253, §HRD 5253; prereq VoEd 5340)

Problems, practices, programs, issues, and methodologies related to preparing trainers of supervisors in business, office, and marketing occupations.

5261. SALES TRAINING. (3 cr, §BME 5261, §HRD 5261)

Introduction to strategies and techniques for training effective sales people.

5262. CUSTOMER SERVICE TRAINING. (3 cr, §BME 5262, §HRD 5262)

Strategies of successful organizations; training practices to develop customer-oriented personnel.

5300. ORGANIZATIONAL NEEDS ASSESSMENT. (3 cr, §HRD 5300; prereq HRD 5750 or BIE 5330 or CISy 5201)

Organizational performance problems, causes, and recommendations of training solutions, and other intervention to improve performance in business, industry, and schools.

5301. STUDENT AND TRAINEE EVALUATION SYSTEMS. (3 cr, §HRD 5301, §Ind 5301)

Test development, performance, and learning evaluation; affective evaluation, learning progress reporting systems.

5303. INSTRUCTIONAL AIDS. (3 cr, §Ind 5303; prereq educ major or grad student)

Planning, construction, use.

5320. VOCATIONAL GUIDANCE. (3 cr, §Ind 5320)

Self-assessment, use of occupational and labor market information, job-seeking skills, work and work satisfaction. For industrial teachers and trainers in school and industrial settings.

5325. FOUNDATIONS OF INDUSTRIAL EDUCATION. (3 cr, §Ind 5325)

History, objectives, development, and current practices of the field.

5340. TRENDS AND ISSUES IN BUSINESS AND MARKETING EDUCATION. (3 cr [max 6 cr])

Identification, analysis, and discussion of recent issues and trends.

5344. FACILITIES AND MANAGEMENT. (3 cr, §Ind 5344; prereq 1300 or 5630 or #)

Planning, evaluation, and management of industrial education shop and laboratory facilities.

5365. CURRICULUM DEVELOPMENT IN TECHNOLOGY EDUCATION. (4 cr, §Ind 5516)

Nature of technological knowledge. Differing conceptions of technology. Comparison and contrast in structure of thinking between science and technology. Alternative ways of conceptualizing, developing, delivering, and managing technology curricula.

5366. MANAGEMENT TRAINING AND DEVELOPMENT PRACTICES. (4 cr, §HRD 5366; prereq HRD 5750, principles of mgmt or supervision course or #)

Problems, practices, programs, and methodologies relating to training and development of managers, including needs assessment, delivery modes, and evaluation; on-site visits and critiques.

5400. INTRODUCTION TO BUSINESS AND MARKETING EDUCATION. (4 cr, §BME 5300)

Conceptual models useful in design and delivery of programs in secondary and postsecondary schools, adult education settings, and business and industry.

5440. BUSINESS OBSERVATION AND SEMINAR. (3-9 cr, §BME 5361)

Current operating practices and career opportunities in business and industry combining planned experience in work environments and related seminars.

5451. RESEARCH AND METHODS IN TEACHING TYPEWRITING/KEYBOARDING. (3 cr, §BME 5151)

Application of research findings to classroom methodology and materials development.

5452. RESEARCH AND METHODS IN TEACHING THE BASIC BUSINESS SUBJECTS. (3 cr, §BME 5152)

Application of research findings to classroom methodology in general business, economics, introduction to business, business law, and consumer education.

5453. CONSUMER EDUCATION: CURRICULUM, METHODS, AND MATERIALS. (3-4 cr, §BME 5153; prereq FE 5153)

Objectives, content, curriculum organization, teaching methods, materials, and evaluation methods for elementary, secondary, postsecondary, and adult levels.

5457. MATERIALS AND METHODS IN OFFICE EDUCATION. (3 cr, §BME 5157)

Recent research and developments in teaching the following: office procedures, preparatory and related classes for cooperative office education, and advising of vocational office education student organizations.

5462. RESEARCH AND METHODS IN TEACHING ACCOUNTING AND DATA PROCESSING. (4 cr, §BME 5162)

Application of current research findings to teaching methodology and to curriculum and materials development; computerized accounting applications.

5463. TEACHING KEYBOARDING AND WORD PROCESSING IN ELEMENTARY AND MIDDLE SCHOOLS. (3 cr, §BME 5163)

Effective teaching strategies, expected learner outcomes, evaluation methods, criteria for selecting hardware and software, management and organization of computer labs.

5470. ORGANIZATION AND ADMINISTRATION OF BUSINESS AND MARKETING EDUCATION. (4 cr, §BME 5351)

Organization and administrative structure in the United States; objectives, programs, practices, teacher selection and supervision, evaluative criteria for business and marketing education departments.

5475. INSTRUCTIONAL MATERIALS LABORATORY FOR NONMAJORS. (3 cr, §Ind 5400; prereq teaching experience or #)

For students needing manipulative skills and craft activities in their teaching; individual and group projects.

5480. INSTRUCTIONAL MATERIALS LABORATORY. (3-6-9 cr, §Ind 5600; prereq major, tchg exper or #)

Laboratory and shop experiences with new materials, processes, and equipment; development of complementary instructional materials.

Graduate Programs

5485. BUSINESS AND INDUSTRY EDUCATION WORKSHOP. (1-6 cr, §Ind 5306; prereq tchg exper, #)
Areas of concentration vary with each offering.

5490. SPECIAL TOPICS IN INSTRUCTION. (1-6 cr, §BME 5370)

Planning and providing content, evaluating instruction. Topics vary with each offering.

5495. SPECIAL TOPICS IN CURRICULUM. (1-6 cr, §BME 5380)

Content development and evaluation of curriculum and curriculum materials. Topics vary with each offering.

5500. OCCUPATIONAL EXPERIENCE. (1-15 cr, §Ind 5000; prereq adviser approval)

Observation and employment in business and industry focused on developing technical or occupational competencies.

5510. INTERNSHIP: BUSINESS AND INDUSTRY EDUCATION. (1-12 cr [max 12 cr], §BME 8600)

Practical experience in a business or industry professional educator or supervisory role, culminating in an integrating paper.

5512. CLINICAL EXPERIENCE: THE SCHOOL SETTING. (4 cr, §HEEd 5512, §Ind 5512; prereq postbac student or #)

School as a social-political setting; role of vocational education in the school; relation between adolescent development and curriculum; patterns of organizational and interpersonal communication within the school.

5514. CLINICAL EXPERIENCE: TEACHING.

(4-8-12 cr, §HEEd 5514, §Ind 5514; prereq 5512 or #)
Teaching experience in school setting; with seminar.

5605. CRITICAL ISSUES. (3 cr, §Ind 5305; prereq educ major or grad student)

Identification, analysis, and discussion of major current problems in the field.

5630. COURSE DEVELOPMENT. (3 cr, §Ind 5330)

Content identification, stating objectives, sequencing, lesson planning, and selection of methods and media for instruction.

5660. INSTRUCTIONAL METHODS. (3 cr, §HRD 5660, §Ind 5360)

Implementation of instructional strategies and methods.

5700. FIELD-BASED PROJECTS. (1-6 cr [max 12 cr], §BME 5600; prereq adviser approval or #)

Curricular, instructional, developmental, or evaluative problems and projects applicable to local school or business and industry situations.

5752. TECHNICAL SKILLS TRAINING. (4 cr, §HRD 5752; prereq HRD 5750)

Systems and process analysis and troubleshooting of work behavior; methods of design and development of training materials.

5900. DIRECTED STUDY. (1-6 cr [max 12 cr], §Ind 5901; prereq adviser approval or #)

In-depth individual learning, or supplementation of areas not covered in regular course structure.

8300. LITERATURE OF BUSINESS AND INDUSTRY EDUCATION. (3 cr)

Critical review of professional literature regarding research, organizations, leaders, and movements in the field.

8700. RESEARCH SEMINAR. (1 cr per qtr [max 6 cr], §Ind 8700; prereq 8xxx-level research course or #)

Development, reporting, and evaluation of research.

8900. RESEARCH PROBLEMS: BUSINESS AND INDUSTRY. (4-9 cr [max 9 cr]; prereq adviser approval)

Individual research or conferences.

Family Education (FE)

5001. SPECIAL TOPICS. (1-6 cr, §HEEd 5001; S-N optional)

Topics not covered by available courses.

5002. THINKING, LEARNING, AND TEACHING IN WORK, FAMILY, AND COMMUNITY. (3 cr)

Theory and practice relevant to stimulating and supporting thinking and learning within and for the contexts of work, family, and community.

5003. INTERNSHIP: COMMUNITY/WORK SETTINGS. (3-12 cr [max 12 cr], max 3 cr for MEd and MA programs, §HEEd 5003)

Planned work experience focusing on educational competencies in these settings; students assume defined responsibilities of position.

5021. EDUCATION THROUGH EXTENSION

METHODS. (3 cr, §HEEd 5021; prereq grad student or #)

Methods and techniques of formal and nonformal education used by Extension Service and other organizations.

5023. EXTENSION METHODS FOR DEVELOPING COUNTRIES. (3 cr, §HEEd 5023)

Extension methods to promote the rapid adoption of improved practices.

5024. EXTENSION HISTORY AND PHILOSOPHY. (3 cr, §HEEd 5024)

Origin, philosophy, historical development, objectives, and organizational structure of Extension Service.

5025. EXTENSION PROGRAM DEVELOPMENT. (3 cr, §HEEd 5025)

Planning, implementing, and evaluating the program development process.

5026. EXTENSION ADMINISTRATION. (3 cr, §HEEd 5026)

Administration of Cooperative Extension Service organization at county, area, and state levels.

5027. PRACTICUM: PLACEMENT FOR EXTENSION EXPERIENCES. (2-9 cr [max 9 cr], §HEEd 5027; S-N optional)

Observation of and participation in activities of Extension Service staff at county and state level; familiarization with staffing, program planning and development, and educational and administrative functions.

5153. CONSUMER EDUCATION: CURRICULUM, METHODS, AND MATERIALS. (3 or 4 cr, §BME 5153, §HEEd 5153)

Objectives, content, curriculum organization, teaching methods, materials, and evaluation methods for elementary, secondary, postsecondary, and adult levels.

5244. TOPICS IN PROGRAM PLANNING FOR EXTENSION EDUCATION. (1-6 cr [max 9 cr], §HEEd 5244)

Extension educational programming in relation to situation and needs analysis; coordination of content, people, methodology; specific aspects in development of program models; managing resources.

5245. TOPICS IN ADMINISTERING EXTENSION EDUCATION. (1-6 cr [max 9 cr], §HEEd 5245)

Issues and current literature; focus on personnel hiring and supervision, financial management, leadership styles, long-range planning; application of theory to administrative practice.

5246. TOPICS IN TEACHING AND DELIVERING EXTENSION EDUCATION. (1-6 cr [max 9 cr], §HEEd 5246)

Teaching techniques related to concepts of use of media, telecommunications, computers, group process methods, and experiential learning in extension education settings.

5247. TOPICS IN EVALUATING EXTENSION EDUCATION. (1-6 cr [max 9 cr], §HEEd 5247)

Overall evaluation design; choosing quantitative vs. qualitative evaluation methods; developing skills and conceptual frameworks to apply theory to Extension settings.

5300. FAMILY EDUCATION CURRICULUM. (3 cr, §HEEd 5300)

Research and theory, development of programs for all ages, and evaluation of materials.

5310. METHODS IN TEACHING FAMILY EDUCATION. (3 cr, §HEEd 5310)

Theory and relevant research; application to educational objectives, strategies, student needs, and program evaluation.

5315. EVALUATION IN FAMILY EDUCATION. (3 cr, §HEEd 5315)

Collecting and interpreting evidence related to individual and program performance.

5320. ADULT EDUCATION IN FAMILY EDUCATION. (3 cr, §HEEd 5320)

Planning a community program; teaching procedures; special problems.

5321. INTERNATIONAL PERSPECTIVES IN FAMILY EDUCATION. (3 cr, §HEEd 5321; offered alt yrs)

Examination of family education around world; commonalities and differences in purpose, problems, history, methods of delivery, and context.

5404. INTRODUCTION TO EARLY CHILDHOOD FAMILY EDUCATION PROGRAMS. (1 cr, §HEEd 5404)

History, philosophy, and implementation of programs.

5405. CHILD DEVELOPMENT AND PARENT EDUCATION. (4 cr, §HEEd 5405)

Objectives, content, curriculum organization, teaching methods, materials, and evaluation approaches for teaching youth and adults about social, cultural, psychological, economic, and technical aspects of child development, parenting, and parent-child interaction.

5406. SPECIAL TOPICS IN PARENT AND FAMILY EDUCATION. (1-6 cr, §HEEd 5406; S-N optional)

Issues and current literature.

5407. FAMILY EDUCATION. (3 cr, §HEEd 5407)

Objectives, content, curriculum methods, materials, and evaluation approaches for teaching diverse groups about family life.

5408. EDUCATION FOR WORK-FAMILY RELATIONSHIPS. (3 cr, §HEEd 5408)

Examination of interactions between work and family with focus on educational applications for youth and adults.

5409. GROUP METHODS FOR PARENT AND FAMILY EDUCATION. (2 cr, §HEEd 5409)

Development of skills for leading parent and family education groups.

5410. FOOD AND NUTRITION EDUCATION.

(1-4 cr [max 12 cr], §HEEd 5410; offered when feasible)

5416. PARENT EDUCATION: ADVANCED. (3 cr, §HEEd 5416; prereq 5405 or #)

Evolving perspectives; emphasis on psychodynamic, conceptual-change approaches and reflective and dialogic approaches for working with parents in understanding beliefs and examining origins and consequences of beliefs; issues related to diversity and to self-awareness; ethics of professionals.

5450. CRITICAL PEDAGOGY. (3 cr, §AdEd 5450, §VoEd 5450)

Critical pedagogy in schools and adult education; application to education for family, work, and community; other topics.

5500. PROSEMINAR: FAMILY EDUCATION. (2 cr, §HEEd 550)

Relation of processes and standards of rational thought to professional competence and goals of a graduate program.

5510. HISTORY, PHILOSOPHY, AND PROFESSIONAL PRACTICE OF FAMILY EDUCATION. (3 cr, §HEEd 5510)

Critical analysis of family education and the teaching of it; practical problems encountered by families; development of personal orientation to becoming a family education teacher.

5511. FAMILY EDUCATION INSTRUCTION IN SECONDARY SCHOOLS. (5 cr, §HEEd 5511)

Curriculum perspectives and development, instructional methods, student evaluation.

Graduate Programs

5512. CLINICAL SEMINAR: THE SCHOOL SETTING. (4 cr, §HEEd 5512, §Ind 5512; prereq postbac student or #)

School as a social-political setting; role of vocational education in the school; relation between adolescent development and curriculum; patterns of organizational and interpersonal communication within the school.

5513. CLINICAL SEMINAR: EDUCATIONAL PRACTICE. (4 cr, §HEEd 5513; prereq postbac student or #)

Developing curriculum and instructional materials for school classrooms and laboratories; conducting research in school settings.

5514. CLINICAL SEMINAR: TEACHING. (12 cr, §HEEd 5514; prereq postbac student or #)

Teaching experience in public school setting.

5600. PRACTICUM: ADULT EDUCATION. (1-9 cr, §HEEd 5600; prereq 5320 or AdEd 5411 or #)

Individual field assignments under supervision.

5900. INDEPENDENT STUDY IN FAMILY EDUCATION. (1-3 cr [max 12 cr], §HEEd 5900; prereq #)

Self-directed study with faculty advice in areas not covered by regular courses.

8520. SEMINAR: HISTORY AND PHILOSOPHY OF FAMILY EDUCATION. (2 cr, §HEEd 8520)

Data sources used to trace meaning of family education as field of study; relation of developments in field to intellectual forces in society; conceptual foundations.

8530. SEMINAR: FAMILY EDUCATION. (1 cr [max 3 cr], §HEEd 8530)

Discussion and reports of inquiry into selected topics of concern to family educators.

8900. PROBLEMS: FAMILY EDUCATION. (1-9 cr, §HEEd 8900)

Independent study of current educational problems.

Human Resource Development (HRD)

5253. SUPERVISORY TRAINING. (3 cr, §BIE 5253; prereq VoEd 5340)

Problems, practices, programs, issues, and methodologies related to preparing trainers of supervisors in business, office, and marketing occupations.

5261. SALES TRAINING. (3 cr, §BIE 5261)

Introduction to strategies and techniques for training effective sales people.

5262. CUSTOMER SERVICE TRAINING. (3 cr, §BIE 5262)

Strategies of successful organizations; training practices to develop customer-oriented personnel.

5300. ORGANIZATIONAL NEEDS ASSESSMENT. (3 cr, §BIE 5300; prereq 5750, BIE 5330 or CIsy 5201)

Organizational performance problems, causes, and recommendations of training solutions, and other intervention to improve performance in business, industry, and schools.

5301. STUDENT AND TRAINEE EVALUATION SYSTEMS. (3 cr, §BIE 5301, §Ind 5301)

Test development, performance, and learning evaluation; affective evaluation, learning progress reporting systems.

5366. MANAGEMENT TRAINING AND DEVELOPMENT PRACTICES. (4 cr, §BIE 5366; prereq 5750, principles of mgmt or supervision course or #)

Problems, practices, programs, and methodologies relating to training and development of managers, including needs assessment, delivery modes, and evaluation; on-site visits and critiques.

5660. INSTRUCTIONAL METHODS. (3 cr, §BIE 5660, §Ind 5360)

Implementing of instructional strategies and methods.

5750. TRAINING IN INDUSTRY AND BUSINESS.

(3-4 cr, §VoEd 5750) Lewis, Swanson
Appraisal of the training function in industry and business; advancement of competencies in areas of analysis, design, development, delivery, and evaluation of training.

5751. MOTIVATIONAL TRAINING PRACTICES.

(3 cr, §VoEd 5751; prereq 5750 or #)
Assessing need for, planning, developing, delivering, and appraising results of motivational training and development that involve motivational theory, principles, and practices.

5752. TECHNICAL SKILLS TRAINING. (4 cr, §BIE 5752; prereq 5750)

Systems and process analysis and troubleshooting of work behavior; methods of design and development of training materials.

5760. ORGANIZATIONAL DEVELOPMENT IN INDUSTRY AND BUSINESS. (3-4 cr, §VoEd 5760) McLean

Introduction to major concepts, skills, and techniques.

5761. TEAM BUILDING IN BUSINESS AND INDUSTRY. (3 cr, §VoEd 5761; prereq 5760 or #)

Introduction to theories of and techniques for building effective work teams. Developing skills in facilitating team-building activities.

5762. MANAGEMENT OF CONFLICT. (3 cr, §VoEd 5762)

Types, sources, and diagnosis of conflict styles; skills and strategies for managing interpersonal, intergroup, and intragroup conflict.

5770. HUMAN RESOURCE DEVELOPMENT: SPECIAL TOPICS. (1-4 cr, §VoEd 5770) McLean,

Swanson
Developments relating to problems, practices, programs, and methodologies in training and development; content varies with each offering.

5780. INTERNSHIP: HUMAN RESOURCE DEVELOPMENT. (Cr ar [max 15 cr], §VoEd 5780; prereq 5750) McLean, Swanson

Students apply and contract for training and development positions in industry and business; individual contracts describe specific training and development responsibilities to be fulfilled during internship.

5781. INTERNATIONAL FIELD STUDY IN HUMAN RESOURCE DEVELOPMENT. (4 cr; prereq 5750, 5760, 5793 or VoEd 8110 or #)

Training, organization development, career development, and quality improvement theories and practices in selected nation.

5790. STRATEGIC PLANNING IN HUMAN RESOURCE DEVELOPMENT. (3-4 cr, §VoEd 5790; prereq 5750 or 5760) Swanson

Human capital as component of industry and business strategic planning; analysis and articulation of practices.

5792. MANAGING HUMAN RESOURCE DEVELOPMENT. (3 cr; prereq 5750, 5760 or #)

Managing and leading human resource development activities in industry, business, and government to meet organizational objectives. Mission, staffing, resources, systems, process management, and reporting.

5793. INTERNATIONAL HUMAN RESOURCE DEVELOPMENT. (4 cr; prereq 5750, 5760 or #)

Problems, practices, programs, theories, and methodologies in human resource development as practiced internationally and in cross-cultural settings.

5794. CONSULTING IN HUMAN RESOURCE DEVELOPMENT. (3 cr, §VoEd 5794; prereq 5750 or 5760 or #)

Marketing, subject matter expertise, organization, business principles, and communication skills as elements of consulting profession in this field.

5795. HUMAN RESOURCE DEVELOPMENT APPROACH TO QUALITY IMPROVEMENT. (4 cr, §VoEd 5795; prereq 5750, 5760 or #)

Quality management and productivity improvement strategies from training and organizational development perspective. Organizational development interventions to implement three selected quality management strategies. Not a statistical process control course.

5798. CURRENT ISSUES IN HUMAN RESOURCE DEVELOPMENT. (4 cr, §VoEd 5798; prereq 5750, 5760 or #)

Issues confronting practitioners in training and organization development; conflicting viewpoints and resolution options.

5808. DIVERSITY IN EDUCATION AND WORK SETTINGS. (3 cr, §VoEd 5808)

Collaborative diversity-related issues among educators and human resource development personnel. Nature of diverse populations, their unique learning/training needs, and effective diversity-related practices.

8750. ADVANCED THEORIES IN HUMAN RESOURCE DEVELOPMENT. (4 cr; prereq 5750, 5760 or #)

Critique of organizations as adaptive systems; role of human resource development in mediating among the organizational, process, and individual levels of performance.

Vocational Education (VoEd)

5002. THINKING, LEARNING, AND TEACHING IN WORK, FAMILY, AND COMMUNITY. (3 cr, §HEEd 5002)

Theory and practice relevant to stimulating and supporting thinking and learning within and for the contexts of work, family, and community.

5010. TECHNOLOGY AND RESPONSIBLE CITIZENSHIP. (3 cr)

Nature of technology. Values and ethical issues relating to technology. Ways in which citizens can influence technological decisions in their communities.

5100. SPECIAL TOPICS IN INSTRUCTION. (1-6 cr [max 9 cr])

Topics vary, but course covers planning, providing, and/or evaluating instruction.

5101. SPECIAL TOPICS IN CURRICULUM. (1-6 cr [max 9 cr])

Topics vary, but course covers development and evaluation of curricula and/or curriculum materials.

5102. SPECIAL TOPICS IN ADMINISTRATION. (1-6 cr [max 9 cr])

Topics vary, but course covers leadership and management of vocational education programs.

5200. EVALUATION OF LOCAL VOCATIONAL EDUCATION PROGRAMS. (3 cr) Krueger

Procedures and experience in use of instruments for conducting program evaluations for teachers, administrators, and state department personnel.

5204. READING IN WORK SETTINGS. (3 cr, §AdEd 5204)

Overview of concepts involved in integrating reading instruction into vocational training programs and work settings: diagnosis and methods of assessing needs of vocational students and workers on a job, techniques for building needs into training programs.

5274. TWO-YEAR POSTSECONDARY INSTITUTIONS. (3 cr, §EdPA 5274)

Present status, development, functions, organization, curriculum, trends in postsecondary but nonbaccalaureate institutions.

5284. LEADERSHIP SKILLS FOR VOCATIONAL EDUCATION. (1 cr)

Applying leadership theory to vocational education, industrial, and business settings; management of community development or youth work programs.

5286. MARKETING OF EDUCATION AND TRAINING PROGRAMS. (3 cr) Stone

Application of comprehensive marketing model to design and delivery of education and training programs for institutions, programs, and specific course offerings. Market research, market segmentation, product positioning, alternative marketing mix strategies, and marketing planning.

Graduate Programs

5300. PHILOSOPHY AND PRACTICE OF VOCATIONAL EDUCATION. (3 cr) Hopkins, Peterson

Interpretation of purposes of vocational education in varying socioeconomic contexts; analysis of vocational fields in regard to recipients, practices, legislation, and funding.

5310. ADVISING VOCATIONAL STUDENT ORGANIZATIONS. (2 cr) Leske

Value and purposes of vocational student organizations in curriculum. Tasks of adviser in designing, operating, and sustaining activities to enhance student leadership, personal development, and school-to-work transition.

5330. COORDINATION TECHNIQUES IN COOPERATIVE EDUCATION. (3-4 cr, §BME 5352, §HEd 5106, §Ind 5310, §AgEd 5071) Brown, Leske, Stone

Responsibilities of instructor-coordinator; guidance, selection, placement, supervision, and evaluation of students; articulation of related instruction; training sponsor identification, orientation, development, and evaluation; purposes and management of program.

5340. PRINCIPLES OF SUPERVISORY MANAGEMENT. (3 cr) Rossmann, Smith

Introduction to principles of personnel supervision for persons in vocational education, business, industry, or service organizations.

5400. EDUCATION FOR WORK. (3 cr; prereq 5300 or #) Bjorkquist, Copa

Examination of contextual bases underlying education for work; implications for practice.

5410. EXPERIENTIAL LEARNING: THEORY AND PRACTICE. (3 cr)

Analyzing students' own learning process; how experience is used in educational settings; shared decision making and group dynamics.

5420. YOUTH IN THE WORLD. (3 cr, §YoSt 5100; prereq 5410 or #)

Introduction to concepts for understanding youth, using "everyday life" and lived experience as levels of reality; range of ideas, social institutions, and organizations that reflect ordinary ways societies and cultures understand youth and seek to influence them.

5430. ORGANIZATIONAL APPROACHES TO YOUTH DEVELOPMENT. (3 cr, §EdPA 5340; prereq 5410 or #)

Defining youth development within framework of formal and informal organizations; organizational systems responsible for youth development in the community; policy issues surrounding these systems.

5440. ISSUES: YOUTH DEVELOPMENT IN WORK, FAMILY, AND COMMUNITY. (3 cr; prereq 5410 or #)

Healthy development of adolescents in relation to the family, community, and workplace; collaborative use of community resources to address these issues.

5450. CRITICAL PEDAGOGY. (3 cr, §AdEd 5450, §FE 5450)

Critical pedagogy in schools and adult education; application to education for family, work, and community; other topics.

5490. SEMINAR IN YOUTH DEVELOPMENT. (1-6 cr)

Concepts of healthy youth development used by youth workers as a framework for discussing personal experience, portfolio development, and other facets of their program work.

5500. INTRODUCTION TO VOCATIONAL EDUCATION ADMINISTRATION. (3 cr)

Basic concepts of structure, financing, program planning and evaluation, law and liability, personnel policies, and the management of vocational education programs.

5600. PLANNING VOCATIONAL EDUCATION. (3 cr; offered when feasible) Copa

5700. TEACHING ENTREPRENEURSHIP: SMALL BUSINESS MANAGEMENT. (3 cr) Persons
Organization, curriculum modification, and implementation of education programs.

5800. WORKING WITH SPECIAL NEEDS STUDENTS. (3 cr) Brown

Helps vocational instructors identify instruction for disadvantaged and handicapped students within regular classroom/laboratory settings.

5801. EDUCATING VOCATIONAL STUDENTS WITH LEARNING DISABILITIES. (1 cr)

Overview of nature of such students; instructional strategies for meeting their educational needs.

5804. WORK EVALUATION OF SPECIAL NEEDS LEARNERS. (3 cr)

Overview of techniques, systems, and organizations that evaluate such students entering vocational education programs.

5805. OCCUPATIONAL ANALYSIS FOR VOCATIONAL SPECIAL LEARNERS. (3 cr)

Overview of techniques, issues, and practices for analyzing and describing jobs and job settings into which vocational special needs learners may be placed or for which vocational training or vocational assessment systems may be developed.

5806. INTERAGENCY COOPERATION FOR AT-RISK POPULATIONS. (3 cr, §EdPA 5104, §EPsy 5714) Brown

Overview of interagency planning issues and practices for educational and human service organizations. Transition of students from school to work and community living, infant and preschool services, and use of locally based planning teams to achieve enhanced service coordination.

5808. DIVERSITY IN EDUCATION AND WORK SETTINGS. (3 cr, §HRD 5808)

Collaborative diversity-related issues among educators and human resource development personnel. Nature of diverse populations, their unique learning/training needs, and effective diversity-related practices.

5900. USING VOCATIONAL EDUCATION RESEARCH. (3 cr; prereq grad program admission or #)

Leske
Introduction to role of vocational education research in professional practice, significant problems of practice for research, alternative modes of research, and synthesis and application of results of research.

5920. INDEPENDENT STUDY. (1-6 cr; prereq Δ)**8100. VOCATIONAL EDUCATION TUTORIAL.** (1-18 cr)

Selected vocational education propositions.

8110. COMPARATIVE SYSTEMS IN VOCATIONAL EDUCATION. (3 cr; A-F only for PhD and EdD students in VoEd) Lewis, McClelland
Comparison of vocational education and training systems within United States and between United States and other countries.

8120. HISTORY AND PHILOSOPHY OF VOCATIONAL EDUCATION. (3 cr; A-F only for PhD and EdD students in VoEd) Thomas
Philosophical views of and historical influences on research and practice in vocational education and training.

8130. CRITICAL ISSUES IN VOCATIONAL EDUCATION. (3 cr; prereq 8110, 8120 or #; A-F only for PhD and EdD students in VoEd) Hopkins, Stone
Perennial issues in context of contemporary vocational education and training settings.

8810. INTERNSHIP IN VOCATIONAL EDUCATION. (1-15 cr [max 15 cr]; prereq Δ)
Student applies for position in professional practice of vocational education; individual arrangements describe specific responsibilities during internship period.

8910. POSITIVISTIC RESEARCH IN VOCATIONAL EDUCATION. (3 cr; prereq 5900 or equiv or #) Brown, Lambrecht
Assumptions of, procedures for, and considerations in planning and conducting positivistic research in vocational education.

8920. INTERPRETIVE AND CRITICAL SCIENCE RESEARCH IN VOCATIONAL EDUCATION. (3 cr) Copa, Plihal
Assumptions of, procedures for, and considerations in planning and conducting interpretive and critical science research in vocational education.

Water Resources (WRes)¹

Regents' Professor: Margaret B. Davis (ecology, evolution, and behavior); Eville Gorham (ecology, evolution, and behavior)

Professor: Patrick L. Brezonik (civil and mineral engineering), *director of graduate studies;* Ira R. Adelman (fisheries and wildlife); E. Calvin Alexander, Jr. (geology and geophysics); James L. Anderson (soil science); Roger E. A. Arndt (St. Anthony Falls Hydraulic Laboratory); Donald G. Baker (soil science); Paul R. Bloom (soil science); Kenneth N. Brooks (forest

resources); Dwight A. Brown (geography); Robert M. Carlson (chemistry²); H. H. Cheng (soil science); Yosef Cohen (fisheries and wildlife); Hollie L. Collins (biology²); K. William Easter (agricultural and applied economics); Steven J. Eisenreich (civil and mineral engineering); Cesar Farell (civil and mineral engineering); Luther P. Gerlach (anthropology); Philip J. Gersmehl (geography); Sagar M. Goyal (veterinary diagnostic investigation); Hans M. Gregersen (forest resources); David F. Grigal (soil science); Satish C. Gupta (soil science); Richard S. Hanson (microbiology); Andrew R. Klemer (biology²); Richard W. Lichty (economics²); Walter J. Maier (civil and mineral engineering); Donald C. McNaught (ecology, evolution, and behavior); Robert O. Megard (ecology, evolution, and behavior); Gary N. Parker (civil and mineral engineering); James A. Perry (forest resources); Hans-Olaf Pfannkuch (geology and geophysics); C. Ford Runge (agricultural and applied economics); Michael J. Semmens (civil and mineral engineering); Joseph Shapiro (Limnological Research Center); Richard H. Skaggs (geography); Charles C. S. Song (civil and mineral engineering); Heinz G. Stefan (civil and mineral engineering); Otto D. L. Strack (civil and mineral engineering); G. David Tiltman (ecology, evolution, and behavior); Melbourne C. Whiteside (biology²)

Associate Professor: Donald N. Alstad (ecology, evolution, and behavior); Sandra O. Archibald (public affairs); Randal J. Barnes (civil and mineral engineering); Charles J. Clanton (agricultural engineering); Dianne Dorland (materials processing engineering²); Efi Foufoula-Georgiou (civil and mineral engineering); Florence K. Gleason (plant biology); John S. Gulliver (civil and mineral engineering); Anne E. Hershey (biology²); Randall E. Hicks (biology²); Ralph W. Holzenthall (entomology); Anne R. Kapuscinski (fisheries and wildlife); Edward A. Nater (soil science); John L. Nieber (agricultural engineering); Christopher Paola (geology and geophysics); Rexford D. Singer (environmental and occupational health); Deborah L. Swackhamer (environmental and occupational health); Robert A. Young (agricultural engineering)

Assistant Professor: Raymond M. Newman (fisheries and wildlife); Mark A. Person (geology and geophysics); Bruce N. Wilson (agricultural engineering)

Research Associate: Carol A. Johnston (Natural Resources Research Institute²); LLoyd P. Queen (forest resources)

Course of Study—Minor in water resources, applicable to master's (M.A. and M.S.) and doctoral programs.

Curriculum—A structured interdisciplinary graduate curriculum is offered. The minor program focuses on three categories: aquatic biology, hydrologic sciences, and water engineering. Students are required to select courses in one of these areas for the master's or in one or two areas for the doctoral degree.

Prerequisites for Admission—Admission to the water resources graduate minor is

¹ A proposal to expand the water resources minor program into a graduate major (M.S. and Ph.D. degrees) is under administrative review. Approval of the degree program is expected fall 1994 for a starting date of fall quarter 1995.

² University of Minnesota, Duluth

Graduate Programs

contingent upon prior admission to a master's or doctoral degree-granting program within the Graduate School.

Minor Requirements—An introductory seminar on water resources management (2 credits), a course on water resources and institutions (water policy, law, management, and economics) (4 credits), one core course (3-4 credits), and elective course(s) are required. Completion of 13 credits is required for the master's degree and 21 credits for the doctoral degree. At least 11 credits must be selected from one of the three categories listed under Curriculum above, for the doctoral degree. The minor program must be approved by the director of graduate studies in water resources.

Language Requirements—None specific to the minor program.

For Further Information, Applications, and List of Courses—Contact the Water Resources Minor, Water Resources Research Center, University of Minnesota, 1518 Cleveland Avenue N., Suite 302, St. Paul, MN 55108.

5101. WATER RESOURCES: INDIVIDUALS AND INSTITUTIONS. (4 cr) Archibald, Brezonik, Brown, Easter

Hydrologic cycle and its responses to human intrusion; societal efforts to control its spatial and temporal variability. Development of U.S. water policy and water laws; administrative structure for water resource management at various levels of government.

8100. INTERDISCIPLINARY SEMINAR IN WATER RESOURCES. (2 cr; prereq admission to water res minor)

Central water resources topic chosen each year.

Wildlife Conservation (FW)

Professor: Yosef Cohen; Gary E. Duke; Donald B. Siniff; John R. Tester

Adjunct Professor: L. David Mech

Associate Professor: James R. Kitts, *director of graduate studies;* James A. Cooper; Francesca Cuthbert; Mary G. Henry; Peter A. Jordan; J. L. David Smith

Adjunct Associate Professor: David L. Garshelis; Richard O. Kimmel; Ronald L. Tilson; A. Richard Weisbrod

Assistant Professor: David E. Andersen

Adjunct Assistant Professor: Glenn D. Del Giudice; Terry J. Kreeger

Research Associate: John Pastor¹

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—This program is administered within the Department of Fisheries and Wildlife. The wildlife conservation graduate program is an applied program emphasizing resource-management applications. For the M.S. degree, emphasis is on wildlife biology and related areas in ecology, animal behavior, and physiology as these relate to resource management and conservation problem-solving. For many students, the M.S. is a terminal degree leading to employment with government resource-management agencies. For the Ph.D. program, emphasis is on basic biology and ecology with concentrated work in independent, original research generally relating basic science to management/conservation challenges.

Prerequisites for Admission—For the M.S. program, a bachelor's degree with a biological sciences background is required, preferably with emphasis on terrestrial or wetland vertebrates and with a natural-resource management orientation. A strong background in physical sciences and mathematics is expected; familiarity with statistics and computer use is desirable. For the Ph.D. program, a master's degree in wildlife science or a closely related field is normally required.

Special Application Requirements—Three letters of recommendation are required from persons able to evaluate the applicant's scholarship and professional experience. Also required are scores from the Graduate Record Examination (GRE) General Test. Applicants taking the examination should list the wildlife management major field code (0115). Applications are accepted at any time; however, because the faculty reviews most applications in late January for admission the following fall, applications should be sent before January 1.

¹ University of Minnesota, Duluth

Master's Degree Requirements—Plan A is recommended; Plan B is available under special circumstances. Students must become familiar with factors underlying wildlife population and habitat ecology, techniques in management, and the functioning of management agencies. Academic work includes graduate-level courses in animal ecology, wildlife management, and statistics. The Plan A thesis should involve at least one field season but no more than two. Plan B students undertake one to three projects involving field, laboratory, or planning work. An oral preliminary examination is required as well as a final seminar and oral defense of the thesis or Plan B papers.

Doctoral Degree Requirements—Programs include basic wildlife biology and development of analytical skills, and one or more additional areas of specialization. In addition to the final oral examination, students must give a public oral presentation describing the dissertation.

Language Requirements—For the M.S. degree, none. For the Ph.D. degree, a foreign language is required only when the advisory committee determines that a language is needed to support the student's research objectives. Symbolic language (computer programming) is recommended for all students.

Minor Requirements for Students Majoring in Other Fields—Programs are designed according to individual student needs, while insuring a comprehensive exposure to wildlife ecology and management.

For Further Information and Applications—Contact the Department of Fisheries and Wildlife, University of Minnesota, 200 Hodson Hall, 1980 Folwell Avenue, St. Paul, MN 55108 (612/624-3600).

FW 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

FW 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

FW 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

5129. MAMMALOLOGY. (5 cr, §EEB 5129; prereq Biol 1106 or 3011 or #) Birney
Recent families and orders of mammals of the world and genera and species of mammals of North America; emphasis on morphology, evolution, and zoogeographic history.

5278. SPECIAL LECTURES IN WILDLIFE. (Cr ar; offered when feasible)

5570. AVIAN CONSERVATION. (4 cr; prereq EEB 5134 or grad student or #; offered alt yrs) Andersen, Cooper, Cuthbert
Current problems in avian conservation and management, with equal emphasis on non-game, wetland, and game birds.

5601. ASSESSMENT AND MANAGEMENT OF VERTEBRATE POPULATIONS. (5 cr; prereq Math 1251 or Math 1142, Stat 3011 or equiv) Spangler
Conceptual models of populations, descriptions of population characteristics, and computer-assisted estimation of population parameters for purpose of management. Students select fisheries or wildlife laboratory.

5603. ECOLOGY AND MANAGEMENT OF FISH AND WILDLIFE HABITATS. (4 cr; prereq 5601, grad student or #) Jordan
Ecological analysis of environmental factors as they influence distribution, abundance, and productivity of terrestrial and aquatic vertebrates. Factors that humans do or can influence. Includes three or four afternoon or Saturday morning field trips.

5604. FISHERY AND WILDLIFE MANAGEMENT. (4 cr; prereq 5601 or #) Newman
Basic understanding of fisheries and wildlife management with emphasis on managed species of interest. Tactics and strategies. Role of strategic planning in directing and redirecting management actions; management tools and assessment of their efficacy.

5620. GEOGRAPHICAL INFORMATION SYSTEMS (GIS) FOR FISHERIES, WILDLIFE, AND BIOLOGICAL CONSERVATION. (4 cr; prereq Biol 5041) Cohen
Hands-on experience with GIS as tool for understanding, analysis, and management of ecological systems. ARC/INFO as applied to problems in fisheries, wildlife, and biological conservation.

5701f, 5702w. SENIOR PROJECT. (1, 2 cr; prereq FW sr or grad student or #) Cooper
Problem-solving training. Management problem identification and analysis design, information and data gathering and analysis, and oral and written problem reporting. Problem selection influenced by guest speakers, resource agency contacts, and group discussions; topic is contemporary fisheries and wildlife management issue.

8100. SEMINAR. (Cr ar) Staff
Lectures by and discussions with faculty members, visiting scholars, and graduate students on current topics.

8200. SEMINAR. (Cr ar)
Oral and written reports and discussion by students on selected topics from current literature in wildlife biology and management. Lectures by and discussions with faculty members and visiting specialists.

Graduate Programs

8377.* RESEARCH IN WILDLIFE BIOLOGY. (Cr ar; prereq wildlife conserv grad student) Staff

8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES. (3 cr; prereq intro genetics course or #) Kapuscinski, Smith
Seminar on current conservation biology issues; genetic, demographic, and environmental analysis and management of populations; ecosystem conservation; case studies of species conservation strategies.

8576. WILDLIFE MANAGEMENT: LARGE MAMMALS. (4 cr; prereq fisheries or wildlife conserv or ecol conserv biol grad student or #; offered alt yrs) Jordan
Comprehensive survey of ecology of ungulates and large carnivores, emphasizing North American species, with special reference to harvest, protection, and other management objectives.

8579. ECOSYSTEM ANALYSIS AND SIMULATIONS: A NUMERICAL APPROACH. (5 cr; prereq 1 qtr calculus, 1 qtr statistics; offered alt yrs) Cohen
Systems analysis methods (e.g., state-space models, transfer functions) and numerical simulations in ecology and fisheries/wildlife management. Presentation of data in time and frequency domains, interpretation of results.

NRES 5575. WETLANDS CONSERVATION. (4 cr; prereq Biol 5041, EEB 3001 or EEB 3101 or #) Cooper
Freshwater wetland classification, biota, current/historic status, value, and conservation strategies and the ecological principles used in wetland management. Meets concurrently with NRES 3575 plus one additional hour per week.

See Ecology (EEB) for other relevant courses.

Zoology (Zool)

Professor: Elmer C. Birney, *director of graduate studies;* Peter A. Abrams; Franklin H. Barnwell; Kendall W. Corbin; James W. Curtsinger; Robert P. Elde; Stanley L. Erlandsen; William S. Herman; Robert G. McKinnell; Frank D. McKinney; Craig Packer; Richard E. Phillips; Anne E. Pusey; Philip J. Regal; William D. Schmid; Akhouri Sinha; Donald B. Siniff; Bert E. Stromberg

Associate Professor: John H. Beatty; Robert C. Bright; Stuart F. Goldstein; Jay T. Hatch; Ralph W. Holzenthal; Peter W. Sorensen; Robert M. Zink

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.

Degrees Offered—M.S. (Plan A and Plan B) and Ph.D.

Curriculum—Emphases in areas of vertebrate and invertebrate zoology are available in the master's and doctoral programs.

Prerequisites for Admission—At least 15 credits of biological science, chemistry through organic, one year of physics, and mathematics through calculus are required for both programs. Deficiencies in the above work must be made up during the first year of graduate work.

Special Application Requirements—A statement of purpose, scores from the General (Aptitude) Test and the Subject (Advanced) Test in biology of the Graduate Record Examination, and three letters of recommendation should be sent to the director of graduate studies. Fall quarter entry is preferred.

Master's Degree Requirements—Requirements for the major are flexible, but breadth in coursework is encouraged. Requirements for the major as well as the minor or supporting program are determined in consultation with the adviser and the director of graduate studies. The final examination is oral.

Doctoral Degree Requirements—The program is planned in consultation with the adviser and the director of graduate studies. Competence in statistics and computer science is required and field experience is strongly recommended for all Ph.D. students.

Language Requirements—For the master's degree, none. For the doctoral degree, one foreign language is required.

For Further Information and Applications—Contact the Zoology Graduate Program, University of Minnesota, Ecology Building, 1987 Upper Buford Circle, St. Paul, MN 55108 (612/624-6770).

Zool 8666. DOCTORAL PRE-THESIS CREDITS. (max 18 cr per qtr; doctoral PhD student who has not passed oral prelims)

Zool 8777. THESIS CREDITS: MASTER'S. (16 cr required; Plan A only)

Zool 8888. THESIS CREDITS: DOCTORAL. (36 cr required)

For course descriptions, see Ecology and Molecular, Cellular, Developmental Biology and Genetics.

Related Courses



Related Courses

Graduate degree programs do not exist in the following fields. However, students may earn graduate credit in courses related to their program in these fields.

American Indian Studies (AmIn)

5251. AMERICAN INDIANS AND THE CINEMA. (4 cr, §AmSt 5251) Libertus

Images and stereotypes of tribal people in selected motion pictures, from silent documentaries to contemporary films.

Contemporary Issues

5341. CONTEMPORARY INDIAN MOVEMENTS. (4 cr)

Indian organizations and social movements during the 20th century.

5422. CHANGE AND DEVELOPMENT IN INDIAN COMMUNITIES. (4 cr; prereq 3112 or #)

Sources, nature, and consequences of social and economic development and change in Indian communities.

Tribal Development

5411. URBAN INDIAN COMMUNITIES. (4 cr)

Social science and historical analysis of the rapid cityward Indian migration since World War II.

Special Topics

5920. SEMINAR IN AMERICAN INDIAN STUDIES. (Cr ar; prereq in the *Class Schedule*) Staff

Topics in American Indian history, selected on a year-to-year basis.

5960. TOPICS IN AMERICAN INDIAN STUDIES. (Cr ar) Staff

Topics listed in the *Class Schedule*.

Tutorial

5970. DIRECTED STUDIES. (1-15 cr; prereq #, Δ or □)

5990. DIRECTED RESEARCH. (1-15 cr; prereq by petition only, #, Δ, CLA approval) Staff

Independent research under the guidance of a faculty member.

Anesthesiology (Anes)

Associate Professor: Ji-Chia Liao

Assistant Professor: Josephine Lo

5086. CLINICAL CURRICULUM DEVELOPMENT AND EVALUATION FOR NURSE ANESTHESIA. (3 cr; prereq CRNA, regis BS in nurs anes, #)

5186. CLINICAL PRACTICE IN ANESTHESIA. (15 cr; prereq CRNA, regis BS in nurs anes, 5086, #)

5386. EDUCATION IN NURSE ANESTHESIA. (1 cr; prereq CRNA, regis BS in nurs anes, #)

5486. NURSE ANESTHESIA: EDUCATION/MANAGEMENT, THE AFFECTIVE DOMAIN. (4 cr; prereq CRNA, regis BS in nurs anes, #)

8265f,w,s,su. GENERAL ANESTHESIA. (12 cr)

Instruction and experience in general anesthesia.

8266f,w,s,su. REGIONAL ANESTHESIA. (4 cr)

Observation, instruction, and administration of all types of local, regional, and spinal anesthesia.

8267f,w,s,su. PRE- AND POSTANESTHETIC EVALUATION. (2 cr)

Selection of proper anesthetic agent and technique, premedication, and observation of recovery from anesthesia.

8268f,w,s,su. SEMINAR: ANESTHESIOLOGY. (2 cr)

Review of literature, report of case problems, and discussion of research work in progress within the department.

8269f,w,s,su. RESEARCH IN ANESTHESIA. (Cr ar)

Anesthesia problems in experimental laboratory or in hospital.

It is recommended that fellows in anesthesiology also register for courses in other departments selected from the following offerings: MdBc 5053, 5100, 8150; Pubh 5450.

Biology (Biol)

5003f,w,s. GENETICS. (4 cr, §GCB 3022, §GCB 5022; prereq 5001 or BioC 3021 or BioC 5331)

Introduction to nature of genetic information, its transmission from parents to offspring, its expression in cells and organisms, and its course in populations.

5004f,w,s. CELL BIOLOGY. (3 cr; prereq 5001 or BioC 3021 or BioC 5331)

Structures and functions of membranes, organelles, and other macromolecular aggregates found in plant, animal, and bacterial cells. Cell form and movement, intercellular communication, transport, and secretion.

5013. MICROBIOLOGY. (5 cr, §MicB 3103, §MicB 5105, §VPB 3103; prereq 5001 or BioC 3021 or BioC 5331)

Taxonomy, anatomy, physiology, biochemistry, and ecology of microbes. Emphasis on molecular structure in relation to bacterial function.

5041. ECOLOGY. (4 cr, §5841; prereq 1103 or 1106 or 3011 or 3012, Math 1142 or Math 1211)

Interactions of plant and animal populations and their environments. Organization, functioning, and development of ecological systems; population growth and regulation. Human impact on biosphere in modern times.

5112. RHYTHMS AND CIRCADIAN

REGULATION. (5 cr, §3112; prereq 15 cr biology, 10 cr chemistry or #)

Timing mechanisms and rhythms of organisms in physiological processes, ecological adaptation, and health; current hypotheses concerning their cellular and molecular nature. Laboratory experience arranged.

5125. RECOMBINANT DNA LABORATORY.

(4 cr, §MicB 5125; prereq application, Δ) Hackett, Messing

Introduction to basic recombinant DNA techniques. Methods for growing, isolating, and purifying recombinant DNAs and cloning vectors.

5506su. BIOTRANSFORMATIONS OF ORGANIC

COMPOUNDS. (5 cr; prereq chem through organic, 1 yr biol, 1 yr physics, 1 qtr biochem; micro recommended) Lectures on microbiology, biochemistry, and genetics of bacteria that grow on or transform organic compounds.

5507su. BIOTRANSFORMATIONS OF ORGANIC

COMPOUNDS LABORATORY. (5 cr; prereq 5506 or §5506)

Laboratory course to accompany 5506.

5816. FIELD BIOLOGY PHOTOGRAPHY. (5 cr;

prereq beginning biol course, Δ; limited to 20 students) Applied photographic techniques for field documentation of biological subjects and events. Practical solutions to problems encountered in photographing living plants and animals in natural habitats.

5825. RECOMBINANT DNA LABORATORY. (4 cr,

§5125, §MicB 5125, §MicB 5425; prereq application, Δ) Introduction to basic techniques. Emphasizes methods for growing, isolating, and purifying recombinant DNAs and cloning vectors.

5841. ECOLOGY. (5 cr, §5041; prereq 1103 or 1106 or

3011 or 3012, Math 1142 or Math 1211, Δ) Growth, structure, and evolution of populations. Pairwise biotic interactions between species and their effect on the diversity and structure of natural communities. Nutrient dynamics, function, productivity, and temporal stability of ecosystems. More field experience than in 5041.

5870. ITASCA SEMINAR. (Cr ar; prereq #, Δ) Staff

Weekly seminar by faculty and visiting lecturers.

5890su. RESEARCH PROBLEMS AT ITASCA.

(Cr ar; prereq #, Δ) Staff Undergraduate and graduate students develop short-term research project during one or both summer terms.

5951. SOCIAL USES OF BIOLOGY. (4 cr; prereq 10

cr sciences; S-N only) Influence of biological science on quality of human life; agriculture, medicine, occupational health, environmental science, and theories of human nature. Responsibilities and roles of biologists in policy formulation in scientific and political world.

Chicano Studies (Chic)

Associate Professor: Guillermo Rojas, *chair*; Dennis N. Valdes

5901. CHICANO STUDIES: THEORY AND METHODOLOGY. (4 cr; prereq grad student or sr, #) Chicano studies scholarship in social sciences and humanities.

5920. TOPICS IN CHICANO STUDIES. (1-4 cr; prereq grad student or sr or #) Multidisciplinary themes. Topics vary each quarter.

5970. DIRECTED STUDIES. (Cr ar; prereq #, Δ, CLA approval)

Cultural Studies and Comparative Literature (CSCL)¹

Professor: Richard D. Leppert; Bruce Lincoln; Harvey Sarles; Jochen Schulte-Sasse

Associate Professor: John Archer; John W. Mowitz; Gianna Pomata; Gary C. Thomas

Assistant Professor: Peter Canning; Prabhakara Jha

5102. CULTURAL POLITICS. (4 cr, §Hum 5102; prereq jr or sr or grad student or #) Mowitz Examination of transformation of traditional domain of politics once legitimation and contestation of social power is conducted primarily within cultural sphere. How dynamics of marginalization, resistance, and reappropriation come to characterize cultural politics.

5152. CLASSIFICATION, HIERARCHY, AND SOCIAL BORDERS. (4 cr, §Hum 5152; prereq jr or sr or grad student or #)

Taxonomy as means of organizing knowledge and transmitting cultural preferences; symbolic recoding of hierarchic structures; representations of social forms as natural givens.

5154. THEORETICAL CONSTRUCTIONS OF SPACE. (4 cr, §Hum 5154; prereq jr or sr or grad student or #) Archer

Theories of space drawn from such disciplines as anthropology, architecture, geography, history, landscape design, philosophy, planning, and sociology. Areas of intersection and difference; new and developing areas of inquiry. Theoretical integration of social and aesthetic concerns.

5178. THE POLITICAL DISCOURSE OF SOCIAL CHANGE. (4 cr, §Anth 5157, §Hum 5178; prereq jr or sr or grad student or #) Josephides

Tension between tradition and innovation (of ideas, techniques, material development) in contexts of rapid social change, especially when local cultures come into contact with outside, politically more forceful ones. Tradition as an already politicized discourse.

¹ See *Comparative Literature and Comparative Studies in Discourse and Society in the Graduate Programs section of this bulletin for other graduate-level courses offered by the Cultural Studies and Comparative Literature Department.*

Related Courses

5256. SUBURBIA. (4 cr, §Hum 5256; prereq jr or sr or grad student or #) Archer
Ideology and practice of suburbia, from origins in mid-18th-century Britain to present-day America; characteristic architectural and spatial forms in relation to social and political relations.

5301. SOCIETY, IDEOLOGY, AND THE PRODUCTION OF ART. (4 cr, §CSDS 5301, §Hum 5301; prereq jr or sr or grad student) Leppert
Recent critical theories on relation of arts to social and ideological forces; selected artifacts from Western culture (Renaissance to 20th century; high, popular, and mass culture). Music, visual art, literature.

5302. AESTHETICS, IDEOLOGY, VALUATION OF ART. (4 cr, §CSDS 5302, §Hum 5302; prereq jr or sr or grad student) Leppert
Society, ideology, and aesthetic value in light of recent critical theories of visual art, music, and literature. Mediations of place, social class, gender, and ideology on aesthetic judgment in post-Renaissance Western culture.

5392. THE IDEOLOGY OF THE MASTER NARRATIVE. (4 cr, §Hum 5392; prereq jr or sr or grad student or #) Josephides
Totalizing frameworks of explanation as hegemonic discourses whose claim to objectivity and universality rests on excluding other possible discourses and representations. Usefulness and viability of polyphonic, postmodernist approach, especially in respect to ethnography.

5398. PHENOMENOLOGY AND ETHNOGRAPHY. (4 cr, §Anth 5394, §Hum 5398; prereq jr or sr or grad student or #) Josephides
Phenomenological/existentialist thought conceived as "the end of ideology"; its politicization during World War II; its use in reflexive anthropology conscious of its own colonial foundations; its use in attempts to understand The Other and in concepts of the person.

5711. INTERPRETATION OF MYTH. (4 cr, §CSDS 5711, §Hum 5711, §ReIS 5111; prereq jr or sr or grad student) Josephides, Lincoln
Structures and functions of myths. Myth as social charter, ideological system, and literary form. Readings in classic theories of myth and primary sources from India, Iran, Mesopotamia, Greece, Africa, North and South America.

5751. BASIC CONCEPTS OF CINEMA. (4 cr, §CLit 5221, §Hum 5751) Mowitz
Film, as a mass cultural phenomenon, in historical context; positions in current film theory; fundamentals of film analysis. Comparative perspective on mass culture employed throughout.

5835. RICHARD WAGNER'S DER RING DES NIBELUNGEN: MUSIC, MYTH, AND POLITICS. (4 cr, §Hum 5835; prereq jr or sr or #) Thomas
Literary and musical analysis of the four works composing Wagner's "Ring" cycle: *Das Rheingold*, *Die Walküre*, *Siegfried*, *Götterdämmerung*. Critical assessment of Wagner's achievement and influence.

5910. TOPICS IN CULTURAL STUDIES AND COMPARATIVE LITERATURE. (4 cr per qtr [max 15 cr]; prereq jr or sr or grad student)
Topics specified in the *Class Schedule*.

5910H. TOPICS IN CULTURAL STUDIES AND COMPARATIVE LITERATURE: HONORS. (4 cr; prereq jr or sr or grad student, #)

5970. DIRECTED STUDIES. (Cr ar; prereq jr or sr or grad student, #, Δ, CLA approval)
Guided individual reading or study.

5970H. DIRECTED STUDIES: HONORS. (Cr ar; prereq jr or sr or grad student, #, Δ, CLA approval)

Dermatology (Derm)

Professor: Mark V. Dahl

Assistant Professor: J. Corwin Vance

8225f,w,s,su. CLINICAL DERMATOLOGY. (Cr ar) Dahl, Lynch, Vance, staff
Wards and outpatient departments of University Hospital, Veterans Administration Medical Center, Hennepin County Medical Center, and St. Paul-Ramsey Medical Center.

8226f,w,s,su. CLINICAL SEMINAR: DERMATOLOGY. (Cr ar) Dahl, Lynch, staff
Conference twice weekly on diagnosis and treatment of skin conditions.

8227f,w,s,su. HISTOLOGY OF THE SKIN. (Cr ar) Kaye, Orkin, Peterson
Histopathology, histochemistry, and fluorescent microscopy.

8230f,w,s,su. FUNCTIONAL BIOLOGY OF THE SKIN. (Cr ar) Dahl, Lynch, staff

Humanities (Hum)¹

Assistant Professor: George Kliger

5304. THEORIES OF IDEOLOGY: PHILOSOPHICAL VIEWS. (4 cr; prereq jr or sr or grad student or #) Kliger
Nature and function of ideology, including theories of Marx, Nietzsche, Freud, Mannheim, Althusser, Foucault, Habermas, and feminists.

5837. NIETZSCHE AS CULTURAL CRITIC. (4 cr; prereq jr or sr or grad student or #)
Nietzsche's contributions to philosophy, psychology, and criticism of religion, culture, and society.

¹ See *Cultural Studies and Comparative Literature above and Comparative Studies in Discourse and Society in the Graduate Programs section of this bulletin for other graduate-level courses formerly offered by the Humanities Department.*

International Relations (IntR)

5701. THEORIES OF INTERNATIONAL DEVELOPMENT. (4 cr; prereq IntR major or #) Interdisciplinary approaches to understanding contemporary development theory and practice. Selected theoretical framework and case studies illustrating complexities of development planning and implementation.

5900. TOPICS IN INTERNATIONAL RELATIONS. (1-4 cr; prereq 12 cr social science; offered when feasible)

5910. TOPICS IN INTERNATIONAL POLICY ANALYSIS. (4 cr; prereq IntR major or #; offered when feasible)

5920. TOPICS IN INTERNATIONAL DECISION MAKING. (1-4 cr; prereq Δ; offered when feasible)

5930. TOPICS IN INTERNATIONAL DEVELOPMENT. (4 cr; prereq IntR major or #; offered when feasible)

Jewish Studies (JwSt)

Professor: Bernard Bachrach; Hyman Berman; David Cooperman; Tzvee Zahavy; Jack Zipes

Associate Professor: Jonathan Paradise; Riv-Ellen Prell; Daniel Reisman; Philip Sellew

5900. TOPICS IN JEWISH STUDIES. (4 cr, §ReIS 3900)

Historical, religious, sociological, anthropological, humanistic study of Judaism and the Jewish people. Approach and method of study vary with topic.

5970. DIRECTED READINGS. (1-12 cr; prereq #, Δ, CLA approval)
Guided individual reading or study.

Language, Teaching, and Technology (LgTT)

5101. TECHNOLOGY IN THE LANGUAGE CLASSROOM. (2 cr)
Theoretical background, application, and demonstration.

Latin American Studies (LAS)

5131. COLONIAL MEXICO AND THE CARIBBEAN. (4 cr, §Geog 5131) Barrett
Exploration, discovery, settlement, livelihood, and circulation to about 1800.

5132. SOUTH AMERICA. (4 cr, §Geog 5132) Weil
Physical resources, population, agriculture, manufacturing, and transportation in South America.

5479. LATIN AMERICAN GOVERNMENT AND POLITICS. (5 cr, §Pol 5479) Sikkink
Latin American political heritage, political processes, and contemporary public policy issues; problems of social, economic, and political change in selected countries.

5820. THE MULTINATIONAL CORPORATION. (3 cr, §PA 5820; prereq intermediate microecon, adult spec or grad student or Δ) Schuh
Economic, political, social, and legal significance of multinational corporation; major policy options open to both individual and international bodies.

5865. HOUSING IN WORLD PERSPECTIVE I. (4 cr, §Hsg 5865; prereq Hsg 3863 or equiv) Morris
Indigenous housing forms from around the world, with emphasis on village and rural housing; cultural differences; nature and quality of forms; application and implications for housing locally and nationally.

Area Studies (Area)

5930. TOPICS IN LATIN AMERICAN STUDIES. (2-4 cr) Staff

5970. DIRECTED STUDIES. (1-15 cr per qtr; prereq #, Δ, □)
Tutorial for qualified seniors and graduate students.

5990. DIRECTED RESEARCH. (1-15 cr per qtr; prereq #, Δ, □)
Tutorial for qualified seniors and graduate students.

Middle Eastern Languages and Cultures

For courses on the medieval and modern Middle East, see Middle Eastern Languages and Cultures (MELC) courses under South Asian and Middle Eastern Languages and Cultures in the Graduate Programs section.

Ophthalmology (Oph)

Professor: Donald J. Doughman; William Knobloch; Jonathan D. Wirtschafter

Associate Professor: J. Douglas Cameron; Edward J. Holland; Robert D. Letson; J. Daniel Nelson; William B. Rathbun; C. Gail Summers

8101f,w,s,su. CLINICAL OPHTHALMOLOGY. (8 cr) Krachmer, staff

8103. PEDIATRIC OPHTHALMOLOGY, STRABISMUS, AND HEREDITARY DISORDERS. (3 cr; prereq grad physician or vet med grad student) Summers

8106. STRABISMUS MANAGEMENT. (1 cr; prereq MD or vet med grad student) Summers

Related Courses

8110. OPTICS, REFRACTION, AND CONTACT LENS. (3 cr) Tani

8111. INTRAOCULAR INFLAMMATION, UVEITIS, OCULAR TUMORS. (3 cr; prereq MD or vet med grad student; offered alt yrs) Holland

8112. RETINA AND VITREOUS. (3 cr; prereq MD or vet med grad student; offered alt yrs) Knobloch

8113. BASIC AND CLINICAL NEURO-OPHTHALMOLOGY. (3 cr; prereq MD or vet med grad student; offered alt yrs) Wirtschafter

8116. GLAUCOMA, LENS, AND ANTERIOR SEGMENT TRAUMA. (3 cr; prereq MD or vet med grad student; offered alt yrs) Wright

8117. ORBIT, PLASTICS, AND TRAUMA. (3 cr; prereq MD or vet med grad student; offered alt yrs) Wirtschafter

8118. GENERAL MEDICAL PROBLEMS. (3 cr; prereq MD or vet med grad student; offered alt yrs) Krachmer

8119. CLINICAL PATHOLOGICAL CORRELATIONS IN OPHTHALMOLOGY. (1 cr; prereq MD or vet med grad student) Cameron

8120. SCOPE OF OPHTHALMIC PATHOLOGY. (2 cr; prereq MD or vet med grad student) Cameron

8125, 8126. DISEASES OF THE CORNEA AND EXTERNAL EYE. (3 cr; prereq MD or vet med grad student; offered alt yrs) Nelson

8131f,w,s,su. PRACTICAL OCULAR SURGERY. (3 cr) Krachmer, staff

8142f,w,s,su. OPHTHALMIC PATHOLOGY LABORATORY. (2 cr) Cameron

8152. OPHTHALMOLOGY LABORATORY. (15 cr) Staff

8153. RESEARCH IN OPHTHALMOLOGY. (Cr ar) Staff

8154. SEMINAR: OPHTHALMOLOGY. (Cr ar) Staff

8155. SPECIAL TOPICS IN OPHTHALMOLOGY. (Cr ar) Staff

8701. NEURO-OPHTHALMOLOGY. (1 cr) Wirtschafter

Pediatrics (Ped)

Regents' Professor: Alfred F. Michael, *head*; Paul G. Que; James G. White

Professor: David M. Brown; C. Carlyle Clawson; Patricia Ferrieri; Alfred J. Fish; G. Scott Giebinck; Edward L. Kaplan; William Krivit; Russell V. Lucas, Jr.; S. Michael Mauer; James H. Moller; Mark E. Nesbit; Harvey L. Sharp; Kenneth F. Swaiman; Robert W. ten Bensel; Homer D. Venters; Robert L. Vernier; Warren J. Warwick

Associate Professor: Bruce R. Blazar; Amos Deinard; Rolf R. Engel

8204f,w,s,su. RESIDENCY IN PEDIATRICS. (Cr ar; prereq #) Michael, staff
One- to two-month rotations on the outpatient, inpatient, and special pediatric services of University Hospitals, Hennepin County Medical Center, Children's Hospital of St. Paul, St. Paul-Ramsey Medical Center, and Minneapolis Children's Health Center.

8206f,w,s,su. PEDIATRIC SPECIAL INTEREST. (Cr ar; for grads who have completed at least 1½ yrs general grad pediatric training; prereq #) Staff
Advanced clinical and basic training in one or more of the following special fields: neurology, cardiology, pathology, endocrinology and metabolism, hematology, immunology, nephrology, infectious diseases, and community pediatrics. Clinical training is obtained in the inpatient and outpatient services of University and affiliated hospitals. Training in basic sciences related to these fields may be obtained in preclinical divisions of the Medical School.

Psychiatry

Professor: Paula J. Clayton, *head*; Marilyn E. Carroll; Elke D. Eckert; Judith M. Garrard; Lawrence M. Greenberg; James A. Halikas; John T. Kelly; Jerome L. Kroll; David T. Lykken; James E. Mitchell; Michael K. Popkin

Clinical Professor: Faruk S. Abuzzahab

Associate Professor: Gerald J. August; Barry D. Garfinkel; William M. Grove; Dorothy K. Hatsukami; Harold R. Ireton; Thomas B. MacKenzie; George M. Realmuto

Assistant Professor: William H. Frey; Harry M. Hoberman; Norman G. Hoffmann; Matt G. Kushner

Associate Psychologist: Beth R. Troutman

Adult Psychiatry (AdPy)

5800. CASE CONFERENCE: PSYCHIATRY IN MEDICINE. (1 cr; prereq MD or #) Colón

5920. ADULT PSYCHOPATHOLOGY I. (3 cr; prereq #)
Overview of major psychiatric illnesses, including affective, eating, and organic mental disorders; chemical dependency; schizophrenia; obsessive-compulsive disorder; dementia.

5921. PHYSIOLOGICAL TREATMENTS I. (3 cr; prereq #)
Overview, including ECT, psychotropic medication use, pharmacokinetics, and toxicity of psychopharmacological agents.

5922. PSYCHIATRIC INTERVIEWING STYLES. (3 cr; prereq #)
Overview, emphasizing psychodynamic and psychoanalytic aspects of psychiatric interview; type of empirical interviewing stressed by DSM-III-R and necessary for completion of oral board examinations.

5923. PHYSIOLOGICAL TREATMENTS II. (3 cr; prereq 5921, #)

Pharmacological treatment of eating disorders, chemical dependency, organic mental disorder, schizophrenia, anxiety disorders, bipolar and schizoaffective disorders; drugs and memory; drug treatment of children and adolescents.

5924. PRACTICAL PSYCHOTHERAPY, CRISIS INTERVENTION, AND EMERGENCY MANAGEMENT. (3 cr; prereq #)

Introduction to "dos and don'ts" of beginning therapy, supportive and confrontive short-term crisis intervention psychotherapy, and practical aspects of handling psychiatric crises in emergency room.

5925. BIOLOGICAL PSYCHIATRY I. (3 cr; prereq #)

Concepts in neuroanatomy, neurophysiology, and neuropsychopharmacology that relate to biological psychiatry.

5926. PSYCHOANALYTIC PSYCHOTHERAPY. (3 cr; prereq #)

Basics of psychoanalytic theory and psychodynamic practice. Designed to provide foundation for future coursework and therapy supervision in practical psychodynamic therapy.

5927. BIOLOGICAL PSYCHIATRY II. (3 cr; prereq 5925, #)

Continuation of 5925.

5940. FORENSIC PSYCHIATRY. (6 cr; prereq #)

Current concepts in area of psychiatry and law, including civil commitment, patient rights, criminal responsibility, competency to stand trial, disability determination, potential fitness in custody determinations, and mentally disordered sex offenders.

5942. ADVANCED PSYCHOANALYTIC PSYCHOTHERAPY. (6 cr; prereq 5926, 5936, #)

Theory course taught by practicing psychoanalysts. Builds on previous psychoanalytic psychotherapy courses; advanced readings and psychoanalytic case presentations.

5944. ADMINISTRATIVE PSYCHIATRY. (6 cr; prereq #)

Administration of psychiatric health care organizations, including accreditation, licensing and federal standards, medical staff organization, peer review, systems of reimbursement and third party payment, types of organizations, personnel issues, cost of health care.

5946. HUMAN SEXUALITY: THERAPY AND COUNSELING. (6 cr; prereq #)

Intensive seminar: normal sexual functioning, psychosexual disorders, and counseling and treatment options.

8205. SPECIAL ASSIGNMENTS IN PSYCHIATRY. (1 cr; prereq MD, 8201, 8203) Staff**8221. SEMINAR: CURRENT LITERATURE.** (1 cr; prereq #) Simon**8239. CONTINUOUS CASE SEMINAR: PSYCHOANALYTICALLY ORIENTED PSYCHOTHERAPY.** (1 cr; advanced psychiatric residents and psychology interns only; prereq #) Staff**8244. COMPARATIVE THEORIES OF PSYCHOTHERAPY.** (3 cr; prereq #) Staff**8970. DIRECTED STUDIES.** (Cr ar [max 9 cr]) Staff**Child and Adolescent Psychiatry (CAPy)****5201. DIAGNOSTIC PRACTICUM IN CHILD AND ADOLESCENT PSYCHIATRY.** (Cr ar; prereq #)

Experiences in psychological assessment with children, adolescents, and families in child and adolescent psychiatric care setting.

5203. CHILD AND ADOLESCENT PSYCHIATRY FOR PSYCHOLOGY INTERNS. (1-5 cr; prereq #)

Experience in assessment and therapeutic interventions with children, adolescents, and families in an outpatient child and adolescent psychiatric care setting.

5204. DIAGNOSTIC METHODS IN CHILD AND ADOLESCENT PSYCHIATRY. (1 cr; prereq med student, #)

Multidisciplinary evaluations of children, adolescents, and their families presented for discussion, dynamic and diagnostic formulations, and disposition planning in a conference setting.

5520. OUTPATIENT CLINICAL CHILD AND ADOLESCENT PSYCHIATRY FOR PRIMARY CARE TRAINEES. (4.5-9 cr; prereq med student, #)

Supervised diagnostic and therapeutic experiences in an outpatient setting.

5602. INTRODUCTORY READINGS IN CHILD, ADOLESCENT, AND FAMILY PSYCHIATRY AND RESEARCH METHODS. (Cr ar; prereq med student) Staff

Readings in clinical, diagnostic, and research methods. Practical application of these methods; potential to work on research paper in related topic.

5603. INPATIENT CLINICAL CHILD PSYCHIATRY FOR PRIMARY CARE**PHYSICIANS.** (9 cr for 6 wks full-time; option: 18 cr for 12 wks full-time; prereq med student, #)

Diagnosis and treatment of children referred for comprehensive evaluation and treatment planning to the inpatient child psychiatric unit. Broad range of childhood disorders. Students responsible for patient management. Emphasis on involvement of family.

5608. INTRODUCTION TO FAMILY THERAPY: THEORY AND PRACTICE. (3 cr; prereq MD and/or #, satisfactory completion of course in basic psychopathology [or its equiv], current supervised involvement with treatment of cases, #) Staff

Introduction to the ideas and treatment approaches of some of the major figures in the current clinical practice of psychotherapy with families: Carl Whitaker, Salvador Minuchin, Lyman Wynne, Jay Haley, Murray Bowen, Virginia Satir, David Olson, and others. Provides practice training experience in the problems and techniques for beginning family therapists through review and discussion of videotapes of current treatment cases of course participants.

Related Courses

5609. INTRODUCTION TO CHILD PSYCHIATRY.

(3 cr; prereq MD or #) Staff

Seminar relating to practice of child and adolescent psychiatry.

5620. ATTENTION-DEFICIT HYPERACTIVITY DISORDER: DIAGNOSTIC CONSIDERATIONS AND PRACTICAL MANAGEMENT. (1 cr)

Workshop covers traditional definitions, theories of causation, and long-term consequences of attention-deficit hyperactivity disorder, a leading cause of behavioral and educational problems in children and adolescents. Treatment approaches, including parent management and educational intervention. Role of medication in overall care.

5623. AFFECTIVE DISORDERS AND SUICIDE IN CHILDREN AND ADOLESCENTS: PERSPECTIVES ON PREVALENCE, ETIOLOGY, AND PREVENTION. (1 cr)

Characteristics of depression and suicidal behavior in children and adolescents. Methods of crisis intervention, treatment, and prevention.

5624. EATING DISORDERS IN CHILDREN AND ADOLESCENTS: MEDICAL AND PSYCHOLOGICAL PERSPECTIVES. (1 cr)

Clinical characteristics of obesity, anorexia, and bulimia nervosa in children and adolescents. Etiological factors and multi-dimensional treatment approaches.

5627. THE DEVELOPMENT AND TREATMENT OF CHILDHOOD AGGRESSIVE AND ANTISOCIAL BEHAVIOR. (1 cr)

Current crisis regarding prevalence of violence and crime in United States. Rates of aggressive and antisocial behavior across age span. Developmental pathways to serious conduct disorder. Risk and vulnerability factors associated with progression of aggressive/antisocial behavior; protective factors and resiliency associated with its desistance. Current theories and methods of treatment. Role of prevention, focusing on ecological-based models of comprehensive intervention.

5630. PSYCHOTHERAPY IN CHILDREN AND ADOLESCENTS. (1 cr)

Short-term treatment, including dynamic psychotherapy, cognitive-behavior therapy, structural-strategic family therapy, and group psychotherapy. Importance of multi-dimensional assessment for intervention of youth clients.

5631. DEVELOPMENTAL NEUROPSYCHIATRY: IMPLICATION FOR ASSESSMENT OF BEHAVIORAL AND COGNITIVE DISORDERS.

(1 cr)
Workshop on major developmental, behavioral, and emotional childhood disorders from neuropsychiatric perspective, including infantile autism, attention deficit disorder, specific learning disabilities, language disorder, conduct disorder, and depression.

5632. COMPETENCE-ENHANCEMENT TRAINING PROGRAMS FOR CHILDREN WITH DISRUPTIVE BEHAVIOR. (1 cr)

Workshop focusing on skill-building approaches to treatment of behavioral, emotional, and academic problems in children. Such approaches teach children to "stop and think" and examine behavioral alternatives. Environmental engineering, contingency management, self-monitoring and self-instructional training, and problem-solving training. Application of comprehensive competence enhancement program to treatment of impulsivity in children with attention deficit disorder.

5633. ANXIETY DISORDERS IN CHILDHOOD AND ADOLESCENCE. (1 cr)

School phobia, panic attack, separation anxiety, obsessive-compulsive disorder. Strategies for prevention; biological, social, and psychodynamic influences; intervention approaches.

5634. DEVELOPMENTAL DYSLEXIA: THEORY, RESEARCH, AND CLINICAL DIFFERENTIATION. (1 cr)

Dyslexia as major cause of educational failure in school children. Definition; neuropsychological and cognitive processes in relation to dyslexia. Interpreting deficits and assessing methods.

5635. COGNITIVE-BEHAVIORAL THERAPY FOR CHILDREN AND ADOLESCENTS. (1 cr)

Cognitive-behavioral procedures regarding externalized behavioral and internal emotional disorders. Problem-solving techniques, verbal self-instruction training, rational-emotive therapy, attributional retraining and stress inoculation procedures, models for working with families and school systems.

5636. SCREENING AND ASSESSMENT STRATEGIES FOR CHILDREN WITH DISRUPTIVE BEHAVIORAL DISORDERS. (1 cr)

Review of screening techniques. Applying functional-based diagnostic assessment model to children with attention-deficit hyperactivity disorder. Utility of behavior-rating scales, structured interview schedules, general abilities tests, and neuropsychological measurement procedures.

5638. COMMUNITY-BASED PREVENTION FOR CHILDREN WITH SERIOUS BEHAVIORAL AND EMOTIONAL PROBLEMS. (1 cr)

Framework for identifying children at risk for serious psychopathology; designing preventive and promotive interventions for enhancing psychological well-being of children. Child psychopathology from developmental perspective: early experiences and their effects, risk, and vulnerability factors; competence; and resiliency in early childhood. Classifying and assessing children's emotional/behavioral problems, emphasizing methods for screening, diagnosis, and prescription. Comprehensive model for design and evaluation of community-based prevention and promotion programs.

5639. BEHAVIOR PROBLEMS IN PRESCHOOL CHILDREN. (1 cr)

Behavior and emotional characteristics of infants and preschool children. Problems discussed include disturbances in regulation, attachment, sleep, and social development. Various approaches to assessment and intervention.

5640. PSYCHIATRIC TREATMENT OF THE DISRUPTIVE DISORDERS. (1 cr)

Primary and associated behaviors of conduct disorder, oppositional defiant disorder, and attention deficit hyperactivity disorder. Specific psychiatric, behavioral, and innovative treatment strategies described in detail.

5641. PREVENTION SCIENCE: A CONCEPTUAL FRAMEWORK FOR COMMUNITY MENTAL HEALTH. (1 cr)

Utility of prevention science for children's mental health care. Optimum research methods and techniques. Types of interventions for prevention trials; personnel needed for implementation. Integrated service delivery infrastructure for coordination of community resources for mental health care promotion and prevention of serious mental and public health problems.

8100. READINGS IN CHILD, ADOLESCENT, AND FAMILY PSYCHIATRY. (1 cr; prereq MD, #)

Comprehensive review of classical and contemporary literature in the field of child, adolescent, and family psychiatry including growth and development, diagnostic and therapeutic techniques, and psychopathology with supplemental coursework in other departments and schools.

8110. DIAGNOSTIC METHODS IN CHILD, ADOLESCENT, AND FAMILY PSYCHIATRY. (1 cr; prereq MD, #)

Multidisciplinary evaluations of children, adolescents, and their families presented for discussion, dynamic and diagnostic formulations, and disposition planning in a conference setting.

8120. THERAPEUTIC METHODS IN CHILD AND ADOLESCENT PSYCHIATRY. (1 cr; prereq MD, #)

Therapeutic techniques used in child, adolescent, and family psychiatry reviewed through presentation and discussion of ongoing cases.

8200. OUTPATIENT CLINICAL CHILD AND ADOLESCENT PSYCHIATRY. (3 cr; 15 hrs per wk; prereq MD, #)

Supervised diagnostic and therapeutic experiences in an outpatient setting.

8212. CLINICAL INPATIENT CHILD PSYCHIATRY. (3 cr; 15 hrs per wk ar; prereq MD, #)

Supervised diagnostic and therapeutic experiences in an inpatient, multidisciplinary child psychiatry unit with emphasis on group and milieu therapies.

8214. INPATIENT CLINICAL ADOLESCENT PSYCHIATRY. (3 cr; prereq MD, #)

Supervised diagnostic and therapeutic experiences in an inpatient, multidisciplinary adolescent psychiatry unit with emphasis on group and milieu therapies.

8216. PEDIATRIC PSYCHIATRY LIAISON. (3 cr; prereq MD, #)

Supervised consultation, diagnostic, and short-term therapy experiences in pediatrics and pediatric neurology.

8223. FAMILY THERAPY. (1 cr; prereq MD, #)

Readings and illustrative family therapy examples reviewed to complement the concurrent clinical experiences.

8228. RESEARCH IN CHILD AND ADOLESCENT PSYCHIATRY. (1 cr; prereq MD, #)

Research design and methodology and current research projects reviewed with faculty and invited guests.

8301. SEMINAR: CHILD, ADOLESCENT, AND FAMILY PSYCHIATRY. (1 cr; prereq MD, #) Staff

Current diagnostic, therapeutic, and theoretical issues in child, adolescent, and family psychiatry reviewed through clinical and didactic presentations and discussions by students, faculty, and invited guests.

Radiology (Rad)

Professor: Kurt Amplatz; Robert J. Boudreau

Associate Professor: Marvin E. Goldberg; Donovan B. Reinke

Diagnostic Roentgenology

5110. RESEARCH PROBLEMS IN RADIOLOGY. (Cr ar)

Background and knowledge of radiologic research; in-depth study of one aspect of radiology. Research project (arrangements must be made with course director at least two weeks before course begins).

5174s. PHYSICS OF DIAGNOSTIC RADIOLOGY. (3 cr) Ritenour

Physics of diagnostic imaging; CAT scanning and ultrasound.

Nuclear Medicine

5170f. BASIC RADIOLOGICAL PHYSICS. (3 cr; prereq #) Khan

Theoretical and experimental aspects of radiological physics.

5171w. PHYSICS OF NUCLEAR MEDICINE. (3 cr; prereq 5170 or #) Ritenour

Theoretical and experimental applications of radionuclides in medicine and biology.

5172s. RADIATION BIOLOGY. (3 cr; prereq 5170 or #) Song

Effects of ionizing radiations on cells.

For additional coursework in radiology, see Therapeutic Radiology.

Related Courses

Therapeutic Radiology (TRad)

Professor: John H. Kersey; Faiz M. Khan; Seymour H. Levitt; Mark E. Nesbit; Chang W. Song

5170f. BASIC RADIOLOGICAL PHYSICS. (3 cr; prereq #) Khan, staff

Theoretical and experimental aspects of radiological physics. Physical properties of various ionizing radiations; interactions of ionizing radiations with matter; methods of radiation dose measurement.

5171w. MEDICAL NUCLEAR PHYSICS. (3 cr; prereq 5170 or #) Loken, Morin

Theoretical and experimental applications of radionuclides in medicine and biology. Imaging devices and techniques, dynamic tracer analysis; internal emitter dosimetry. Radioimmunoassay and the statistics of counting.

5172s. RADIATION BIOLOGY. (3 cr; prereq 5170 or #) Song, staff

Effects of ionizing radiations on cells, tissues, and organisms; biochemical and physiological basis of radiation effects, biological rationale for radiation therapy practices.

5173w. PHYSICS OF RADIATION THERAPY. (3 cr; prereq 5170 or #) Khan, staff

High energy and teletherapy machines. Measurements of radiation quality, output and depth dose distributions for clinical use. Calculation of treatment parameters. Beam modification and shaping. Treatment planning for fixed field and rotational therapy. Physics of intracavitary and interstitial therapy. Computer applications in treatment planning. Principles and criteria for radiation protection.

5340f,w,s,su. SPECIAL PROBLEMS IN RADIATION THERAPY. (Cr ar) Kim, Lee, Levitt, Potish

5512f,w,s,su. DOSIMETRY OF INTERNAL AND EXTERNAL RADIATION. (1 cr) Khan
Basic principles of radiation dosimetry discussed in detail; clinical applications.

5540f,w,s,su. SPECIAL PROBLEMS IN RADIOLOGICAL PHYSICS. (Cr ar) Khan, staff

8300f,w,s,su. RADIATION THERAPY. (Cr ar) Kim, Lee, Levitt, Potish
In-service training in treatment and management of patients with malignant diseases.

8310f,w,s,su. FUNDAMENTALS OF RADIATION THERAPY. (1 cr) Kim, Lee, Levitt, Potish
Lectures on physical and clinical aspects of radiation therapy. Techniques of radiation therapy including radium and other isotopic implants.

8315f,w,s,su. RADIATION THERAPY PATHOLOGY. (1 cr) Staff

Weekly ½- to 2-hour seminar relating microscopic and gross anatomy of tumors to clinical findings, diagnostic workup, and therapy of patients receiving radiation therapy. Includes clinical descriptions of patients followed by comprehensive discussion of the microscopic, gross pathology, and overview of tumor pathology. Offered in conjunction with the Department of Laboratory Medicine and Pathology.

8320f,w,s,su. RADIATION THERAPY TREATMENT PLANNING PROBLEMS. (1 cr) Staff

Weekly ½- to 2-hour seminar. Treatment planning, computer treatment planning, treatment fields of patients under treatment, and treatment planning programs discussed with staff of the clinical and physics sections.

8350f,w,s,su. RESEARCH IN RADIATION THERAPY. (Cr ar)

8450f,w,s,su. RESEARCH IN RADIATION BIOLOGY. (Cr ar) Staff

Graduate Offerings, Duluth Campus



Graduate Offerings, Duluth Campus

General Information

At the University of Minnesota, Duluth, the Graduate School offers programs for the *master of arts* degree in art (emphases in art studies and studio art), communication disorders, education, education (emphasis in music education), educational psychology (emphasis in counseling), and English (emphases in literary studies and English studies). Programs for the *master of science* degree are offered in applied and computational mathematics, biology, chemistry, computer science, geology, and physics. In addition, the *master of business administration*, *master of liberal studies*, and *master of social work* degrees are offered.

An all-University M.S./Ph.D. program in toxicology is offered jointly with the Twin Cities campus. In addition, several graduate programs operate at the University of Minnesota, Duluth, under the aegis of the graduate program of their related department on the Twin Cities campus. Cooperative programs offered at both the master's and doctoral levels include interdisciplinary archaeological studies, biochemistry, microbiology, pharmacology, and physiology. Cooperative arrangements offered solely at the doctoral level include chemistry and geology. Students interested in these programs should see the listing for each program in the Fields of Instruction section of this bulletin.

All programs are under the jurisdiction of the dean of the Graduate School and have admission, candidacy, and degree requirements comparable to their counterpart programs on the Twin Cities campus. General Graduate School regulations, including those for minimum degree requirements, apply to programs offered on the Duluth campus (see the General Information section at the beginning of this bulletin).

Financial Aid and Other Assistance

A limited number of fellowships and scholarships are available through the Graduate School. Forms for applying for these awards may be obtained in the Graduate School Office—Duluth, 431 Darland Administration Building, Duluth.

Assistantships are normally granted through the individual departments subject to the stipulations described in the General Information section at the front of this bulletin. Information about these assistantships can be obtained by writing to the department director of graduate studies. With an assistantship appointment of 25% or more, hospitalization and medical insurance coverage is provided at no additional cost.

Some residence counseling positions may be available. For information, write to the Housing Office, 149 Lake Superior Hall, University of Minnesota, Duluth, MN 55812.

Inquiries regarding loan funds, living accommodations, employment, and placement should be addressed to the Vice Chancellor for Academic Support and Student Life, 297 Darland Administration Building, University of Minnesota, Duluth, MN 55812.

Program Statements

Brief descriptions of the various degree programs are listed below. Further details are available from the directors of graduate studies designated. Course offerings are listed in the *Duluth Bulletin*. General information concerning graduate work on the Duluth campus may be obtained from the Graduate School Office—Duluth, 431 Darland Administration Building, University of Minnesota, Duluth, MN 55812.

Applied and Computational Mathematics

Director of Graduate Studies—Associate Professor Barry R. James.

Degree Offered—M.S. (Plan A and B).

Prerequisites for Admission—

Undergraduate degree with major in mathematics, statistics, or a field with a substantial background in mathematics or statistics (e.g., computer science or engineering). If certain prerequisites for graduate courses are lacking, they may be made up concurrently with graduate work within the first year. Scores from the General (Aptitude) Test of the Graduate Record Examination (GRE) are required of all applicants. Scores of the Test of English as a Foreign Language are required if the native language is not English.

Thesis Emphases—For Plan A: applied mathematics, statistics, mathematical modeling and simulation techniques.

Major Requirements—For Plans A and B: 25 credits of approved mathematics courses or seminars and demonstrated competence in basic material through a written examination. For Plan A: a thesis and a final oral examination on the thesis. For Plan B: a project and 16 additional credits from approved graduate-level mathematics or related courses.

Related Field Requirements—For Plans A and B: 8 credits in a related field(s) outside mathematics. Plan A students may choose minor requirements instead of related field requirements.

Minor Requirements—For Plan A: 9 credits from the same prefix area in a related field outside mathematics and statistics.

Language Requirement—None.

Other Requirements—Demonstrated intermediate-level competence in a modern scientific computer programming language such as FORTRAN, Pascal, or C.

Art

Director of Graduate Studies—Assistant Professor James Klueg.

Degrees Offered—M.A. (Plan B only) emphasis art studies; M.A. (Plan B only) emphasis studio art.

Prerequisites for Admission—The normal prerequisites for admission are an interest in personal development in studio; an interest in related areas such as art history, museum studies, humanities, or teaching; and a B.A., B.S., or B.F.A. degree in art. Individuals with undergraduate degrees in other disciplines who have completed a substantial number of art courses may be considered for admission. Students with minor deficiencies may be admitted with the provision that equivalent coursework or approved substitutions be completed during the first year of graduate study.

A sheet of slides (15 to 20) of original work is required as part of the application. Other relevant visual material in the form of videotape or film may also be included. Applicants may be requested to submit actual work. All supporting materials should be sent or hand-delivered to the director of graduate studies, Department of Art, at the time the application form is submitted to the Graduate School office. When feasible, applicants should schedule an on-campus interview.

Full-time attendance for three quarters and summer work is necessary in most cases to complete this degree.

Emphasis Art Studies—Candidates may focus on one studio area or pursue work in several related studio areas. Art history is part of the related field requirement, and other approved courses may be elected from the humanities, education, or internships in museum practice or arts administration. Candidates will complete an approved 6- to 9-credit project and supporting paper, will participate in the graduate review studio sessions, and complete the oral examination. At least 44 quarter credits are required in the following areas: 20 to 29 credits in art, 9 credits in art history (related field), and 6 to 15 credits in other related areas, including the final project and supporting paper.

Emphasis Studio Art—Candidates work under the direction of a faculty member in the appropriate studio area and with faculty having related expertise. Participation in the periodic graduate reviews, a satisfactory

exhibition of the student's work in the Tweed Museum of Art, and completion of an approved supporting paper are major requirements. An oral examination covering coursework and the area of the supporting paper is the final step toward completing the degree.

While students should have a major focus for their studio work, experience in a related studio area may be desirable. At least 44 quarter credits are required: 32 credits in studio art and 12 credits in art history (related field).

Biology

Director of Graduate Studies—Professor Anne Hershey.

Degree Offered—M.S. (Plan A and B).

Prerequisites for Admission—Introductory biology plus at least 24 additional quarter credits of approved coursework in biology, inorganic and organic chemistry, introductory calculus, and a sequence in general or introductory physics are required. Students with deficiencies may be admitted with the provision that equivalent coursework or approved substitutions be completed during the first year of graduate study. Students must submit test scores, not more than two years old, from the Graduate Record Examination (GRE) General Test (verbal, quantitative, and analytical sections) and from the Subject (Advanced) Test in biology as part of their application materials. If appropriate, scores from the biochemistry, cell and molecular biology Subject Test may be substituted for biology Subject Test scores.

Prior coursework and GRE scores will be used to ascertain proficiency in the areas of general biology, genetics, cell biology, and ecology. Such proficiency will be considered in the admission deliberations.

Language Requirement—None.

Degree Requirements—Candidates following either plan must present a department seminar near the end of their

studies and must pass a written and/or oral final examination. For Plan A, 8 credits must be completed in a related field(s) or 9 credits in a minor field. For Plan B, 8 credits must be completed in a related field(s).

Business Administration

Director of Graduate Studies—Professor Stephen A. Rubinfeld.

Degree Offered—M.B.A. (Plan B only).

Language Requirement—None.

Credit Requirements—A minimum of 45 credits.

Major Requirements—A total of 27 credits in the M.B.A. core is required. In addition, 9 credits in an M.B.A. research project are required, including coursework in research methodology.

Related Field Requirements—A total of 9 credits minimum in supporting fields.

Chemistry

Director of Graduate Studies—Professor Thomas J. Bydalek.

Degree Offered—M.S. (Plan A and B).

Prerequisites for Admission—Undergraduate chemistry major, including a junior-senior level course in inorganic chemistry, one year of physical chemistry, mathematics through calculus, and one year of college physics, preferably taught using calculus. Students lacking some of these prerequisites may make up deficiencies concurrently with graduate work.

Thesis Emphases—For Plan A, analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, physical chemistry.

Major Requirements—The specific program is worked out to best serve the interests of the student. All students will complete at least three of the five core courses: Chem 5710, 5720, 5730, 5740, and 5750.

Other Requirements—The final examination for Plan A is oral, and the final examination for Plan B is either oral or written, at the discretion of the examining committee. For both Plan A and Plan B, proficiency examinations must be taken before initial registration, and attendance and presentation at the chemistry seminar are required. For Plan B, preparation of three papers in the major and related fields is required.

Communication Disorders

Director of Graduate Studies—Associate Professor Faith C. Loven.

Degree Offered—M.A. (Plan B only).

Prerequisites for Admission—Bachelor's degree in communication disorders or 50 quarter credits in speech/language pathology, audiology, speech/language/hearing science, or related areas. Three letters of recommendation are also required. Submission of Graduate Record Examination (GRE) General Test scores is strongly recommended.

Language Requirement—None.

Major Requirements—53 credits in communication disorders are required, including CD 5060, 5076, 5276, 5375, 5472 or 5476, 5500, 5505, 5550, 5575, 5600, 5956, 8100, 8176, 8205, 8305, and 8900.

Other Requirements—8 credits of coursework outside of communication disorders. Final written and oral examinations are required. Plan B projects must be completed in conjunction with CD 8900. All such projects must be planned and carried out in consultation with a faculty member from the department.

Computer Science

Director of Graduate Studies—Professor Clark Thomborson.

Degree Offered—M.S. (Plan A and B).

Prerequisites for Admission—Applicants

should have completed an undergraduate major in computer science. Other undergraduate majors who have substantial background in mathematics and basic core computer science may be considered for admission. Applicants lacking prerequisites may be admitted with the understanding that deficiencies be made up concurrently with graduate work within the first year. The Graduate Record Examination (GRE) General Test is required.

Language Requirement—None.

Major Requirements—A minimum of 49 credits of graduate coursework are required, which must include CS 8021, 8022, 8023, and 1 credit of the CS 8900 seminar, and 8 credits from one or more related fields outside of computer science (or 9 credits from a single related field to form an outside minor), as approved by the director of graduate studies.

Other Requirements—Plan A: 16 credits of CS 8777 (thesis); 12 credits from graduate-level courses in computer science, as approved by the director of graduate studies; and presentation of thesis results at a department colloquium. Plan B: a minimum of 20 credits from graduate-level courses in computer science, as approved by the director of graduate studies; completion of an approved Plan B project (usually a significant programming project); and presentation of a department colloquium based on Plan B project work. All students must pass a final oral examination on their thesis or project, supporting area(s), and graduate-level computer science as reflected in the required courses and prerequisites.

Education

Director of Graduate Studies—Professor Thomas G. Boman.

Degree Offered—M.A. (Plan A and B).¹

Prerequisites for Admission—Applicants must have taken a minimum of 15 quarter

¹ For information about the master of education (M.Ed.) degree program, contact the dean of the College of Education and Human Service Professions at Duluth.

credits in education. Additionally, Plan A applicants should submit Graduate Record Examination General Test scores and a statement of personal goals.

Language Requirement—None.

Major Requirements—Students must complete 44 credits in approved coursework including 20 credits in the major field and either 8 credits (Plan A) or 24 credits (Plan B) of electives. Plan A students also must take 16 thesis credits (Educ 8777).

Other Requirements—Both plans require a final oral examination.

Education with Emphasis in Music Education

Director of Graduate Studies—Professor Judith Kritzmire.

Degree Offered—M.A. (Plan B only).

Prerequisites for Admission—

Undergraduate degree with a major emphasis in music. Ordinarily, applicants should qualify for teaching licensure. Diagnostic placement tests in music theory and music literature are required for all entering students. The Graduate Record Examination (GRE) General Test is required.

Major Requirements—A minimum of 27 credits in music education and education is required (the Plan B research project for 9 credits is included as part of the 27 credits); the core courses Mu 5222 and Mu 5601 must be included in these 27 credits.

Related Field(s) Requirements—A minimum of 12 credits is required in the related field of music. Five credits outside of music education and music may be added to the 18 credits in music education/education and the 9 credits of the Plan B project to complete the 44 credits for the degree.

Educational Psychology

Director of Graduate Studies—Associate Professor Kristelle E. Miller.

Degrees Offered—M.A. (Plan B) with emphasis on school or community counseling.

Prerequisites for Admission—A minimum of 9 quarter credits in psychology or education, including an undergraduate statistics course, the Graduate Record Examination (GRE) General Test, evidence of social service experience, and three letters of recommendation. The application deadline for the following fall is March 15.

Applications submitted after March 15 will be considered only if space is available.

Language Requirement—None.

Major Requirements—The program is two years of full-time study totaling 72 credits. This includes 36 graduate credits in core courses, including counseling theories and skills, group procedures, ethics, developmental guidance, cross-cultural counseling, family counseling, learning, consultation, tests and measurement, statistics, and research methods; a Plan B paper (3-9 credits); and three quarters (720 hours) of practicum (9 credits).

Related Field Requirements—A minimum of 8 credits must be taken outside the psychology department.

Other Requirements—A final written comprehensive examination on core and related coursework and an oral examination on the Plan B paper are required. School counselors are advised to take different electives than community counselors. Most individuals pursuing elementary, middle, or secondary school counseling licensure have a teaching license. However, the State of Minnesota accepts a one-year internship beyond the M.A. in lieu of a teaching license.

English

Director of Graduate Studies—Associate Professor Carol A. Bock.

Degrees Offered—M.A. (Plan B) with emphases on literary studies and on English studies.

The M.A. in English has two tracks. The M.A. (Plan B) with emphasis on literary studies is a traditional literary program. The M.A. (Plan B) with emphasis on English studies provides broad, balanced training in literature, linguistics, and rhetoric and composition. This major (both tracks) deals with subject matter appropriate for preparing to teach English.

Prerequisites for Admission—Students applying for admission to either of these programs must submit scores from the General Test of the GRE, two writing samples such as course papers, and three letters of recommendation. The entering student should have completed 44 credits in English (these may include credits in literature, language, and advanced composition), including 28 upper division credits.

M.A. (Plan B) with Emphasis on Literary Studies

Course Prerequisites—Students must have completed, or complete as graduate students, upper division courses in Chaucer, Shakespeare, Milton, and the English language or English linguistics. Some course prerequisites may be taken concurrently with graduate work and used toward degree requirements.

Language Requirement—A reading knowledge of Latin, Greek, French, German, Italian, Spanish, Russian, or another approved language is required.

Degree and Major Requirements—A minimum of 44 credits is required. The major must have at least 36 credits, including 12 credits in English proseminars and 4 credits of Engl 8906.

Related Field Requirements—Students must complete at least 8 credits in one or

more related fields outside the major. Linguistics can be taken as a related field or as a designated minor.

Other Requirements—Students must complete a two-day, five-hour written examination containing the following sections: (1) analysis of a text selected before the examination; (2) discussion of questions on a reading list prepared by the candidate and approved by the examining committee; and (3) discussion of questions dealing with a related field.

Before taking the examination, the student must submit Plan B papers (normally three) or projects totaling 120 hours of effort. These projects will normally be completed in connection with graduate courses in English or in a related field. A completed project must be approved by a member of the graduate faculty.

M.A. (Plan B) with Emphasis on English Studies

Language Requirement—Candidates may choose certification in a foreign language or complete 8 credits of graduate coursework in addition to the minimum required 44 credits. Certification is gained by demonstrating a reading knowledge of a foreign language appropriate for the candidate's area of study and approved by the English Graduate Committee. Candidates whose professional objectives are best served by completing the additional 8 credits will select graduate courses from the categories of literature and literary analysis, linguistics, and rhetoric and composition, or graduate courses closely related to the field of concentration chosen for the degree.

Degree and Major Requirements—A minimum of 44 credits is required. The major has 36 credits, consisting of 4 credits in Engl 8906; 8 credits in literature and literary analysis; 8 credits in linguistics, including Ling 5842; 8 credits in rhetoric and composition; and 8 credits of electives offered by the English or composition departments at the 5xxx or 8xxx level. Students in residence during the regular academic year must take 12 credits in 8xxx-level courses.

Related Field Requirements—Students must complete at least 8 credits in one or more related fields outside the major. Linguistics can be taken as a related field or as a designated minor.

Other Requirements—Candidates will take a comprehensive examination, which will include both written and oral sections. The examination will test the student's knowledge in the following areas: literature and literary analysis, linguistics, rhetoric and composition, and the related field(s).

The Plan B project requirement is the same as that for the M.A. (Plan B) with emphasis on literary studies.

Geology

Director of Graduate Studies—Professor Ronald L. Morton.

Degree Offered—M.S. (Plan A and B).

Prerequisites for Admission—An undergraduate major in geology, geophysics, or a related earth science with a summer field camp (full time for at least five weeks) and one year each of college mathematics including two terms of calculus, college chemistry, and college physics. Scores from the Graduate Record Examination (GRE) General Test are required.

Language Requirement—None.

Other Requirements—A written candidacy examination during the second quarter and an oral final examination are required.

Liberal Studies

Director of Graduate Studies—Professor Fred E. H. Schroeder.

Degree Offered—M.L.S. (Plan B only)

Prerequisites for Admission—Applications must include a narrative letter stating the reasons for wanting to pursue the M.L.S. and describing educational and career experiences.

Language Requirement—None.

Major Requirements—Completion of 44 credits in approved coursework, including 20 credits of required core courses and 24 credits of electives. The individually designed plan of study can include graduate courses in the humanities, social sciences, and natural sciences that meet personal and educational aims of the student.

Related Field Requirements—Because the program is interdisciplinary and composed of courses from several departments, the related field requirement is waived.

Other Requirements—Three research papers or projects in an approved area of interest must be submitted in addition to passing a final oral presentation/examination.

Physics

Director of Graduate Studies—Associate Professor John R. Hiller.

Degree Offered—M.S. (Plan A and B).

Prerequisites for Admission—Undergraduate degree in physics or equivalent.

Language Requirement—None.

Major Requirements—At least 20 credits in six approved physics courses numbered above 5103, including at least 8 credits chosen from Phys 5123 or 5124 or 5125 (no more than one of these three courses), and 5109, 5166, 5174, 5176, 5177, and 5178.

For a more interdisciplinary concentration—for example, in geophysics—an individualized program can be planned by the student and his or her adviser to suit the student's needs and interests. Such a program must be approved by the director of graduate studies.

Related Field Requirements—8 credits in related fields outside of physics, such as biology, chemistry, geology, or mathematics. A student who wants to complete a minor must complete 9 credits in a single department outside physics.

Social Work

Director of Graduate Studies—Associate Professor Melanie Shepard.

Degree Offered—M.S.W. (Plan B only).

Prerequisites for Admission—Applicants for the 81-credit program must meet the following five prerequisites:

- the bachelor's degree must be from an accredited college or university;
- applicants must have at least 3 quarter credits in each of the following areas: human biology, sociology or anthropology, economics, political science, psychology, and statistics (courses in up to two of these areas may be taken during the first year after admission, but they cannot be applied toward the M.S.W. program requirements);
- strong academic performance as demonstrated by the undergraduate grade point average;
- preference will be given to applicants with professional experience in human service settings; and
- demonstrated interest in becoming a social worker is required.

Applicants with a B.S.W. degree from a Council on Social Work Education accredited program may apply for the 69-credit advanced standing program. All other

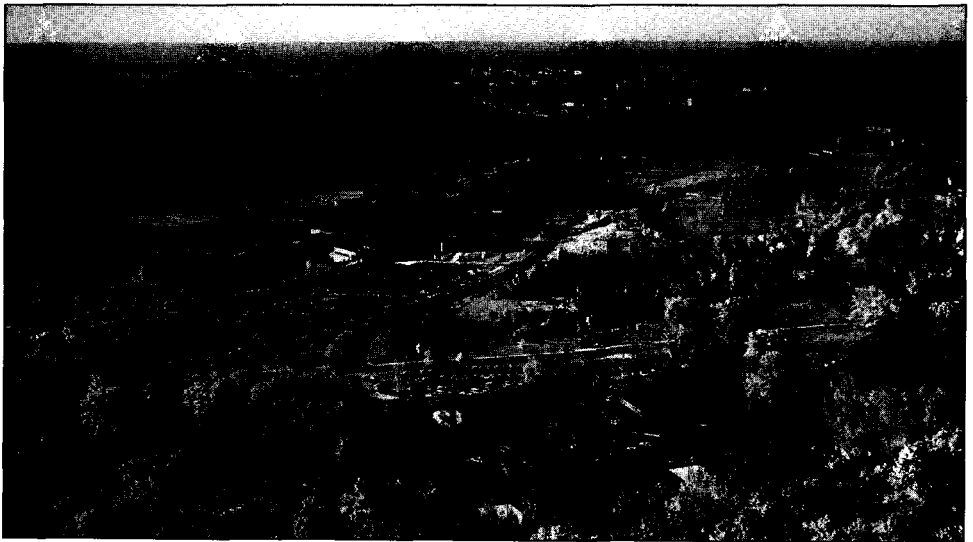
admission requirements are the same as in the 81-credit program.

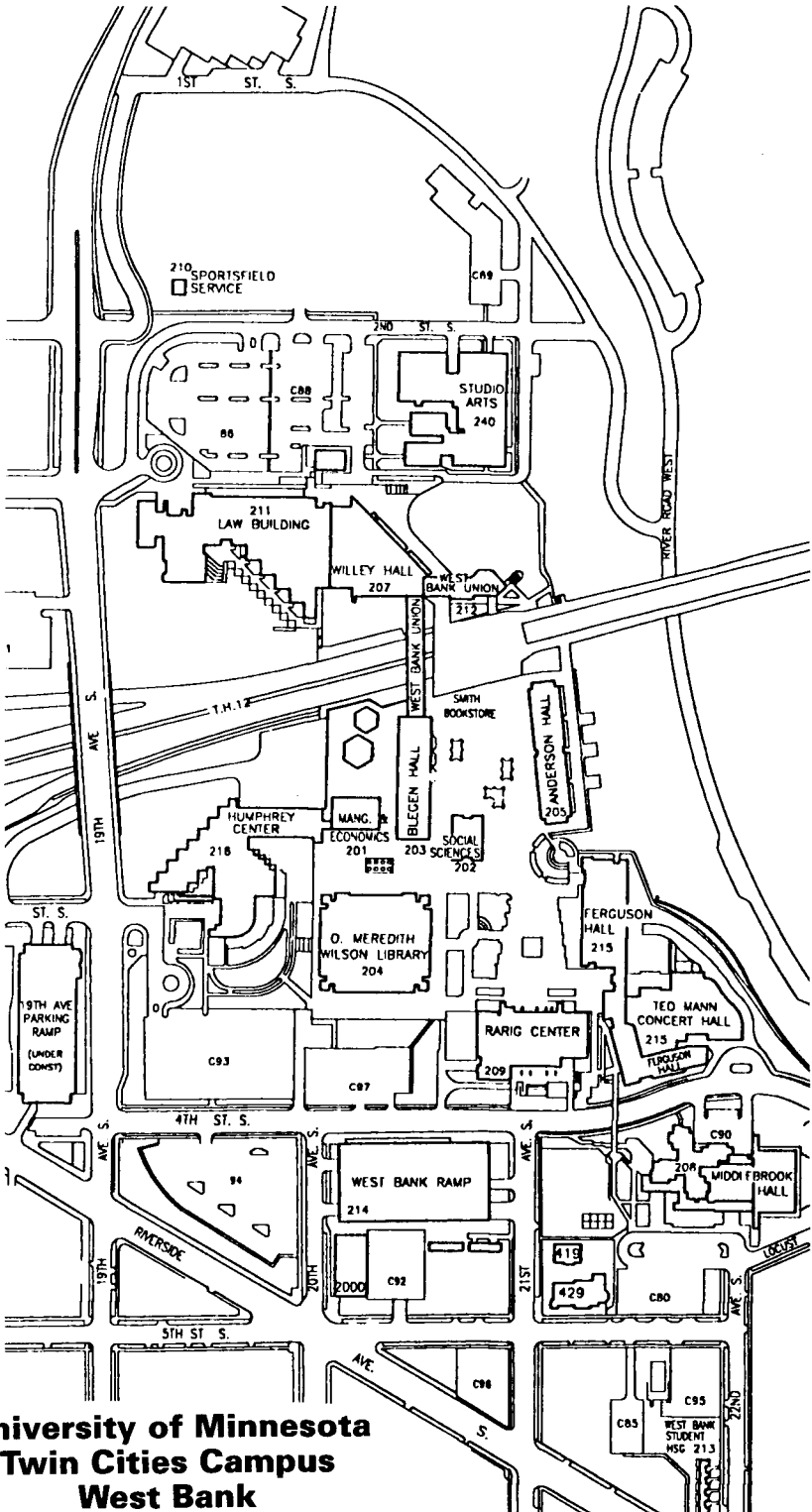
Language Requirement—None.

Degree Requirements—A total of 81 credits of graduate-level work (69 credits for students admitted with advanced standing) is required. A minimum of 69 credits must be completed in social work courses (50 for students with advanced standing).

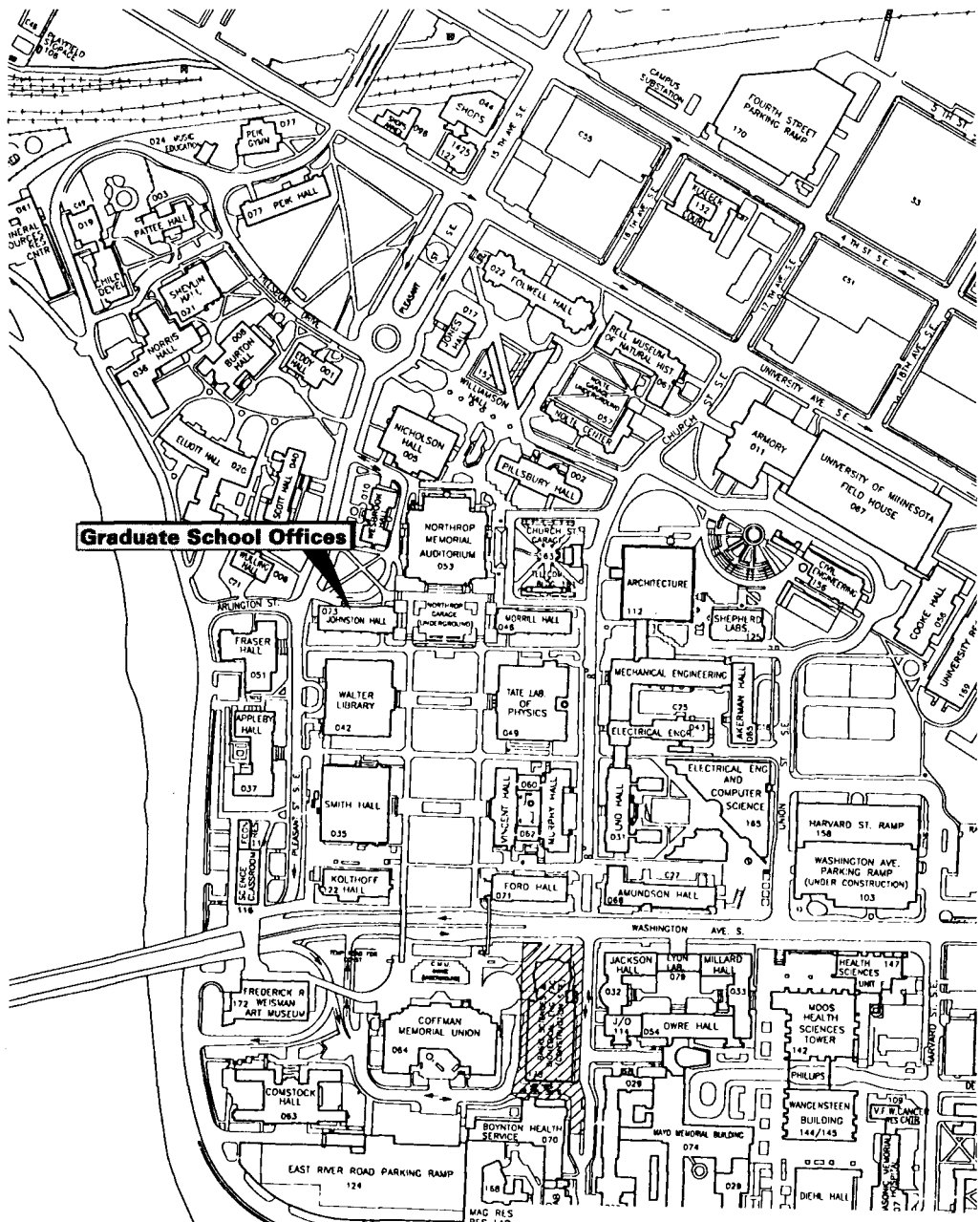
Related Field Requirements—At least one graduate elective course from outside the Department of Social Work is required.

Other Requirements—Included as part of both the 81-credit and 69-credit programs are 24 credits (960 hours) of field placement in human services agencies. Advanced standing students with a year or more of paid social work practice may request a waiver of 12 credits of field placement and substitute an additional 12 elective credits. Plan B projects are to be completed in conjunction with SW 8750. A final oral examination is required. A level of personal and professional competence, considered satisfactory for entrance into the profession of social work in the field of human services, as indicated by class evaluations and field placement evaluations, is required.



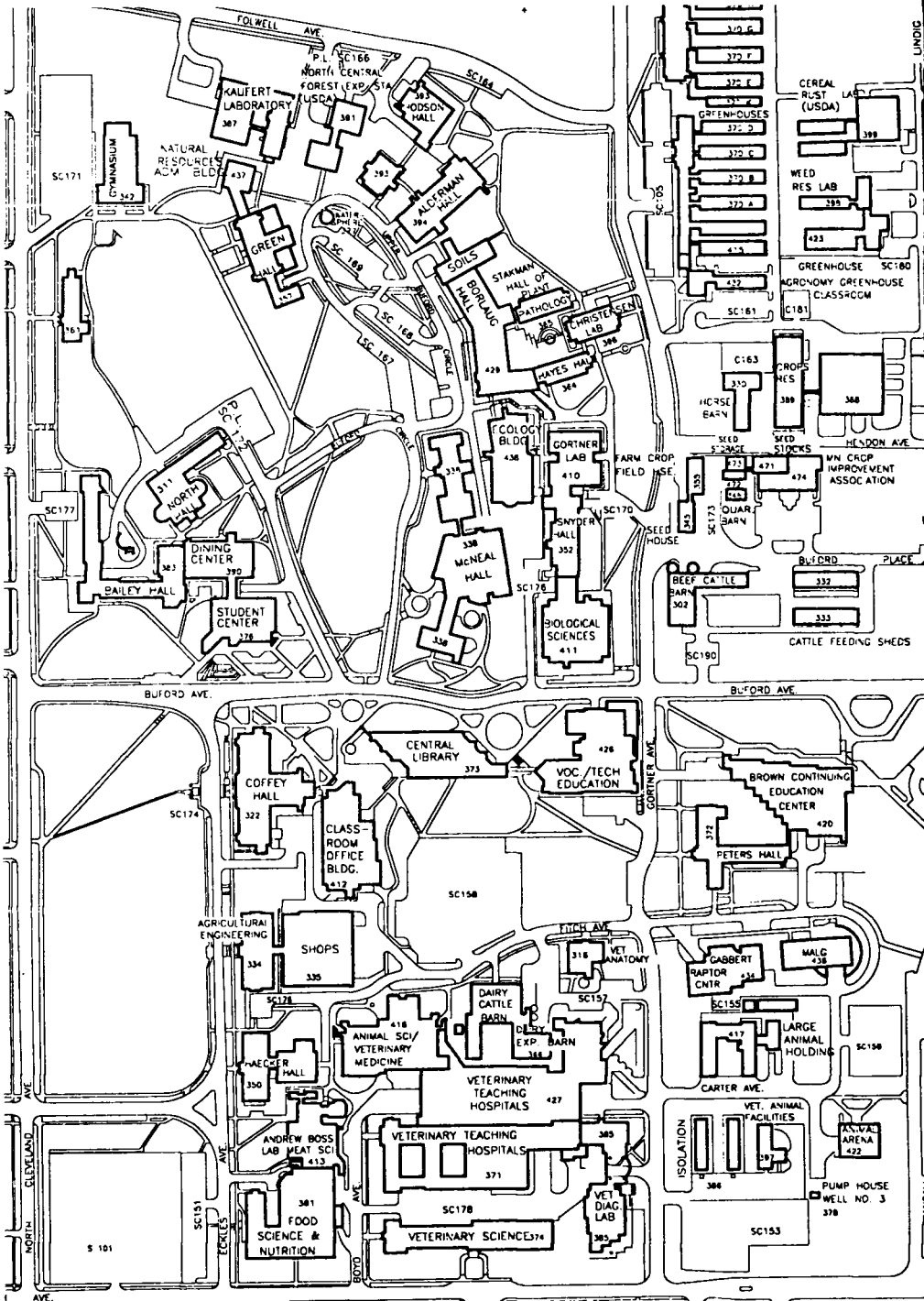


**University of Minnesota
Twin Cities Campus
West Bank**

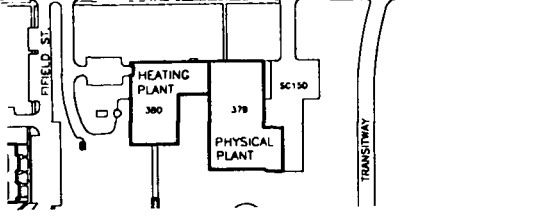


Graduate School Offices

**University of Minnesota
Twin Cities Campus
East Bank**



**University of Minnesota
Twin Cities Campus
St. Paul**



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Course Designators

Below is an alphabetical listing of the designators under which courses are organized within the Graduate Programs and Related Courses sections of this bulletin. The listing is provided to help students find the full description of prerequisite courses and courses that are only partially described under interdisciplinary program listings that include courses from other fields.

Directly following each designator below is its referent, followed by a "see" note in cases where the program or unit name under which the courses are listed differs from the

referent. For example, courses in Chinese (Chn) and in Japanese (Jpn) are found under East Asian Languages, Literatures, and Linguistics. Some designators below are used only for thesis credits, as when a program has no single identifying designator; for example, Business Administration uses twelve designators for its courses, but BA is used only for thesis credits. *Note*—Some designators that appear after the equivalent course marker § in prerequisite statements may not be found below, because they refer to a previous designator for that program.

Acct	Accounting—see Business Administration	Biol	Biology—under Related Courses	DHA	Design, Housing, and Apparel
AdEd	Adult Education—see Vocational and Technical Education	BLaw	Business Law—see Business Administration	Dnce	Dance—see Theatre Arts
AdPy	Adult Psychiatry—see Psychiatry under Related Courses	Bldg	Building Science	Dtch	Dutch—see German
AEM	Aerospace Engineering and Mechanics	BME	Business and Marketing Education—see Vocational and Technical Education	EAS	East Asian Studies
Afro	Afro-American Studies—under Related Courses	BMEEn	Biomedical Engineering	Econ	Economics
AgEc	Agricultural and Applied Economics	BMSc	Biomedical Science	EdAd	Educational Administration—see Educational Policy and Administration
AgEd	Agricultural Education—see Vocational and Technical Education	BPhy	Biophysical Sciences and Medical Physics	EdPA	Educational Policy and Administration
AgEn	Agricultural Engineering	CAPS	Clinical and Population Sciences—see Veterinary Medicine	Educ	Education—see Curriculum and Instruction; Kinesiology and Leisure Studies; Vocational and Technical Education
AgET	Agricultural Engineering Technology—see Agricultural Engineering	CAPy	Child and Adolescent Psychiatry—see Psychiatry under Related Courses	EE	Electrical Engineering
Agro	Agronomy and Plant Genetics—see Agronomy	CAS	Central Asian Studies—see Russian Area Studies	EEB	Ecology, Evolution, and Behavior—see Ecology
Akka	Akkadian—see Classical and Near Eastern Studies	CBio	Conservation Biology	Endo	Endodontics—see Dentistry
Amln	American Indian Studies—under Related Courses	CBN	Cell Biology and Neuroanatomy—see Anatomy	Engl	English Language and Literature—see English
AmSt	American Studies	CDis	Communication Disorders	EngW	English: Creative and Professional Writing—see English
ANE	Ancient Near Eastern—see Classical and Near Eastern Studies	CE	Civil Engineering	Ent	Entomology
Anes	Anesthesiology—under Related Courses	CgSc	Cognitive Science	Entr	Entrepreneurship—see Business Administration
AnPh	Animal Physiology	Chem	Chemistry	EPsy	Educational Psychology
AnPI	Animal and Plant Systems—see Agronomy	ChEn	Chemical Engineering—see Chemical Engineering and Materials Science and Engineering	ESL	English as a Second Language
AnSc	Animal Science	Chic	Chicano Studies—under Related Courses	FE	Family Education—see Vocational and Technical Education
Anth	Anthropology	Chn	Chinese—see East Asian Languages, Literatures, and Linguistics	FIMe	Fluid Mechanics
Arab	Arabic	ChPh	Chemical Physics	ForP	Forest Products—see Forestry
Arch	Architecture	CI	Curriculum and Instruction	Fors	Forestry
Area	Area Studies—see East Asian Studies; Russian Area Studies; Latin American Studies under Related Courses	CIE	Center for Interfacial Engineering—see Interfacial Engineering	FPCH	Family Practice and Community Health
Arm	Aramaic—see Classical and Near Eastern Studies	Clas	Classics—see Classical and Near Eastern Studies	FR	Forest Resources—see Forestry
Arth	Art History	CLit	Comparative Literature	Fren	French—see French and Italian
Arts	Art	CLS	Clinical Laboratory Science	Frit	French and Italian
Ast	Astronomy—see Astrophysics	Copt	Coptic—see Classical and Near Eastern Studies	FScN	Food Science and Nutrition—see Food Science; Nutrition
BA	Business Administration	CPsy	Child Psychology	FSoS	Family Social Science
BFin	Finance—see Business Administration	CSci	Computer Science—see Computer and Information Sciences	FW	Fisheries and Wildlife—see Fisheries; Wildlife Conservation
BGS	Business, Government, and Society—see Business Administration	CSCL	Cultural Studies and Comparative Literature—under Related Courses	GCB	Genetics and Cell Biology—see Molecular, Cellular, Developmental Biology and Genetics
BIE	Business and Industry Education—see Vocational and Technical Education	CSDS	Comparative Studies in Discourse and Society	Geo	Geology and Geophysics
BioC	Biochemistry (College of Biological Sciences)—see Biochemistry, Molecular Biology, and Biophysics	CSDy	Control Science and Dynamical Systems	GeoE	Geological Engineering
		CVM	Veterinary Medicine	Geog	Geography
		Dent	Dentistry	Ger	German
		Derm	Dermatology—under Related Courses	GPhl	Germanic Philology
				Grk	Greek—see Classical and Near Eastern Studies
				HE	Human Ecology—see Design, Housing, and Apparel
				Hebr	Hebrew—see Classical and Near Eastern Studies
				HInf	Health Informatics

Course Designators

Hist	History	MeSt	Medieval Studies	Rad	Radiology—under Related Courses
HMed	History of Medicine—see History of Medicine and Biological Sciences	MeE	Metallurgical Engineering—see Mineral Engineering	RAS	Russian Area Studies
Hndi	Hindi—see South Asian and Middle Eastern Languages and Cultures	Mgmt	Management—see Business Administration	Rec	Recreation, Park, and Leisure Studies—see Kinesiology and Leisure Studies
Hort	Horticultural Science—see Horticulture	MicB	Microbiology	RelS	Religious Studies
HRD	Human Resources Development—see Vocational and Technical Education	MicE	Microbial Engineering	Rhet	Rhetoric—see Rhetoric and Scientific and Technical Communication
HSci	History of Science and Technology	MinE	Mining Engineering—see Mineral Engineering	Russ	Russian—see Russian Area Studies
Hum	Humanities—under Related Courses	Mktg	Marketing—see Business Administration	SACS	Small Animal Clinical Sciences—see Veterinary Medicine
IDSc	Information and Decision Sciences—see Business Administration	MLS	Master of Liberal Studies—see Liberal Studies	SALC	South Asian Languages and Cultures—see South Asian and Middle Eastern Languages and Cultures
IEOR	Industrial Engineering/Operations Research—see Mechanical Engineering and Industrial Engineering	MOT	Management of Technology	SAPh	Social and Administrative Pharmacy—see also Hospital Pharmacy
InAr	Interdisciplinary Archaeological Studies	MSt	Mathematics Education—see Curriculum and Instruction	Scan	Scandinavian—see Scandinavian Languages and Literature
Ind	Industrial Education—see Vocational and Technical Education	MtE	Music Education—see Music	SciC	Scientific Computation
Ins	Insurance—see Business Administration	Mus	Music	Skt	Sanskrit—see South Asian and Middle Eastern Languages and Cultures
IntR	International Relations—under Related Courses	MusA	Music Applied—see Music	Slav	Slavic—see Russian Area Studies
IR	Industrial Relations	NRES	Natural Resource and Environmental Studies—see Forestry	Soc	Sociology
IRel	Interpersonal Relationships Research	NSc	Neuroscience	Soil	Soil Science
Ital	Italian—see French and Italian	NSu	Neurosurgery	Span	Spanish—see Hispanic and Luso-Brazilian Literatures and Linguistics
Jour	Journalism and Mass Communication—see Mass Communication	Nurs	School of Nursing—see Nursing	Spch	Speech-Communication
Jpn	Japanese—see East Asian Languages, Literatures, and Linguistics	Nutr	Nutrition	SpPt	Spanish-Portuguese—see Hispanic and Luso-Brazilian Literatures and Linguistics
JwSt	Jewish Studies—under Related Courses	OBio	Oral Biology	SPSE	Social and Philosophic Studies of Education
Kin	Kinesiology—see Kinesiology and Leisure Studies	Obst	Obstetrics and Gynecology	SST	Studies of Science and Technology
LA	Landscape Architecture	OMS	Operations and Management Science—see Business Administration	Stat	Statistics
LAS	Latin American Studies—under Related Courses	OPat	Oral Pathology—see Dentistry	Sum	Sumerian—see Classical and Near Eastern Studies
Lat	Latin—see Classical and Near Eastern Studies	Oph	Ophthalmology—under Related Courses	Surg	Surgery
LgTT	Language, Teaching, and Technology—under Related Courses	ORad	Oral Radiology—see Dentistry	SW	Social Work
Ling	Linguistics	OSur	Oral and Maxillofacial Surgery—see Dentistry	Tgen	Theriogenology—see Veterinary Medicine
LM	Logistics Management—see Business Administration	Otho	Orthodontics—see Dentistry	Th	Theatre Arts
Mar	Marathi—see South Asian and Middle Eastern Languages and Cultures	Otol	Otolaryngology	TRad	Therapeutic Radiology—under Related Courses
Math	Mathematics	PA	Public Affairs	Txcl	Toxicology
MatS	Materials Science—see Chemical Engineering and Materials Science and Engineering	Path	Pathobiology	Urdu	Urdu—see South Asian and Middle Eastern Languages and Cultures
MBA	Master of Business Administration—see Business Administration	PBio	Plant Biology—see Plant Biological Sciences	VB	Veterinary Biology—see Veterinary Medicine
MCDG	Molecular, Cellular, Developmental Biology and Genetics	Ped	Pediatrics—under Related Courses	VDM	Veterinary Diagnostic Medicine—see Veterinary Medicine
MdBc	Biochemistry (Medical School)—see Biochemistry, Molecular Biology, and Biophysics	Pedo	Pediatric Dentistry—see Dentistry	VMed	Veterinary Medicine
MdGk	Modern Greek—see Classical and Near Eastern Studies	Per	Persian—see South Asian and Middle Eastern Languages and Cultures	VMic	Veterinary Microbiology—see Veterinary Medicine
ME	Mechanical Engineering—see Mechanical Engineering and Industrial Engineering	Pero	Periodontics—see Dentistry	VoEd	Vocational Education—see Vocational and Technical Education
MedC	Medicinal Chemistry	Phcl	Pharmacology	VPB	Veterinary Pathobiology—see Veterinary Medicine
MELC	Middle Eastern Languages and Cultures—see South Asian and Middle Eastern Languages and Cultures	Phil	Philosophy	VSRA	Veterinary Surgery, Radiology, and Anesthesiology—see Veterinary Medicine
		Phm	Pharmaceutics	WoSt	Women's Studies—see Feminist Studies
		Phmc	Pharmaceutics Undergraduate—see Pharmaceutics	WRes	Water Resources
		Phst	Physiology—see Cellular and Integrative Physiology	YoSt	Youth Development and Research—see Social Work
		Phys	Physics	ZooI	Zoology
		PIBr	Plant Breeding		
		PIPa	Plant Pathology		
		Plsh	Polish—see Russian Area Studies		
		PMed	Physical Medicine and Rehabilitation—see also Physical Therapy		
		PNI	Psychoneuroimmunology		
		Pol	Political Science		
		Port	Portuguese—see Hispanic and Luso-Brazilian Literatures and Linguistics		
		Pros	Prosthodontics—see Dentistry		
		Psy	Psychology		
		PubH	Public Health—see also Biostatistics; Environmental Health; Epidemiology; Health Services Research and Policy; Health Services Research, Policy, and Administration		

Course Numbers and Symbols

Course Numbers—Courses numbered from 5000 to 5999 (listed as 5xxx if individual course number unspecified) are open to juniors, seniors, and graduate students except in the School of Dentistry and a few departments of the Medical School. Those numbered 8000 or above (8xxx) are open to graduate students only. Courses at the 1000 (1xxx) and 3000 (3xxx) levels are for undergraduates and may not be applied to graduate programs. Courses numbered 0000 to 0999 do not carry credit.

Sequence Courses—A hyphen between course numbers (e.g., 5121-5122-5123) indicates a sequence of courses that must be taken in the order listed.

Series Courses—A comma between course numbers (e.g., 8301, 8302, 8303) indicates a series of courses that may be entered any quarter.

Department Designators—In conjunction with course numbers, departments and programs are identified by a 2-, 3-, or 4-designator prefix (e.g., CE for Civil Engineering, Pol for Political Science, WoSt for Women's Studies). When no department designator precedes the number of a course listed as a prerequisite, that prerequisite course is in the same department as the course being described.

Course Symbols—The following symbols are used throughout the course descriptions of all University bulletins to denote common and recurring items of information.

- * Courses in which graduate students may prepare Plan B projects.
- ! Work for this course will extend past the end of the term. A grade of K will be assigned to indicate that the course is still in progress.
- † All courses preceding this symbol must be completed before credit will be granted for any quarter of the sequence.
- § Credit will not be granted if credit has been received for the course listed after this symbol.

- ¶ Concurrent registration is required (or allowed) in the course listed after this symbol.
- # Registration Override Permit, completed and signed by the instructor, is required for registration.
- Δ Registration Override Permit, completed and signed by the department offering the course, is required for registration.
- Registration Override Permit, completed and signed by the college offering the course, is required for registration.
- f,w,s,su . Fall, winter, spring, summer (follows the course number).
- H Honors course (follows the course number).
- x Course is offered more than one quarter.
- , In prerequisite listings, comma means "and."

Faculty Names—When more than one faculty name is listed after a course prerequisite statement, the course is taught on an alternating basis, not team taught, by the faculty listed.

Postal Statement

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