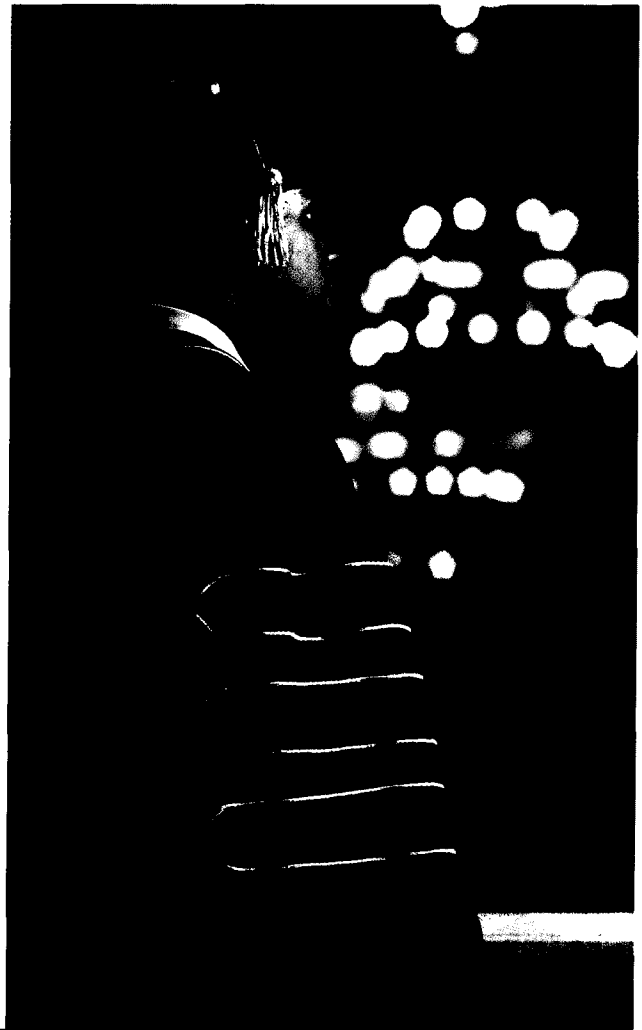
Graduate School University of Minnesota Bulletin 1988-90



Graduate School

Introduction

Location

The Graduate School is based on the East Bank of the University of Minnesota's Twin Cities campus. Its main administrative offices are 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, Fields of Instruction, 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 and an extensive Index. The last page, Course Key, explains the numbering system, punctuation, department prefixes, and symbols used throughout the course descriptions.

Other Bulletins—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 Information Center on the upper concourse of Williamson Hall.

Policies

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

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, religion, color, sex, national origin, handicap, age, veteran status, or sexual orientation. In adhering to this policy, the University abides by the requirements of Title IX of the Education Amendments of 1972; by Sections 503 and 504 of the Rehabilitation Act of 1973; by Executive Order 11246, as amended: 38 U.S.C. 2012; by 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 addressed to Patricia A. Mullen, Director, Office of Equal Opportunity and Affirmative Action, 419 Morrill Hall, University of Minnesota, 100 Church Street S.E., Minneapolis, MN 55455 (612/624-9547); to the Director of the Office of Civil Rights, Department of Education, Washington, DC 20202; or to the Director of the Office of Federal Contract Compliance Programs, Department of Labor, Washington, DC 20210.

Services for Students with Disabilities—The Office for Students with Disabilities (OSD) provides services to ensure equal physical and program access to the University. Services include problem-solving assistance, advocacy information, referral, classroom relocation, academic accommodations, counseling, and adaptive equipment. The OSD office is in 16 Johnston Hall, Minneapolis campus (612/624-4037 TTY or voice).

Postal Statement

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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 the Hubert H. Humphrey Metrodome on the edge of downtown Minneapolis, the other just west of the State Fairgrounds a couple 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, its weighty pillars softened in summer by nearby umbrella-topped tables. On the other end of the Mall, Coffman Union beckons anyone in need of a break between classes. On the fringes are futuristic underground structures 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 Ferguson Music Hall.

Several 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. Also close are newly renovated festival markets like St. Anthony Main, Riverplace, and Bandana Square.

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 million people, the two downtowns offer myriad opportunities for entertainment, research, volunteer or part-time work, internships, and eventual careers.

Arts and Entertainment—The Twin Cities are renowned for 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 or the summertime Showboat. Or they can savor the University Art Museum or the Minneapolis Institute of Arts, the Apple Valley or Como Park zoo, the Renaissance Festival or Valleyfair, the Aquatennial or Winter Carnival.

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 Dome, North Stars hockey at the Met Sports Center, and professional horse racing at Canterbury Downs. Numerous 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, roller or ice skating, cross-country or downhill skiing, or simply sitting and staring. The Boundary Waters Canoe Area, one of the most unsullied wilderness treasures in the entire nation, is only a few hours drive to the north.

The gentle warmth of spring, sunny greenery of summer, and bright crisp colors of autumn do give way to at least three months of winter snow, but even then, daytime temperatures generally average a quite bearable and invigorating 10 to 30 degrees above.

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John T. Hatten, Ph.D., Assistant Dean of the Graduate School, Duluth

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Four student representatives
One civil service representative

General Information

General Information

The central purposes of the Graduate School are the advanced training of men and women in a wide variety of fields and the promotion of research in an atmosphere of freedom of inquiry.

The Graduate School administrative structure includes six policy and review councils, consisting of faculty and students, in the areas of education and psychology; health sciences; language, literature, and the arts; physical sciences; plant and animal sciences; and social sciences. These councils, together with an Executive Committee, are responsible for making general policy for the Graduate School. The Executive Committee is composed of the dean of the Graduate School; chairpersons of the policy and review councils, the Graduate Research and Advisory Committee, and the Fellowship Committee; and representatives from the Duluth Graduate Faculty Committee, the Graduate School administration and staff, and the Council of Graduate Students.

Libraries and Research Opportunities

The University of Minnesota-Twin Cities Libraries, with a collection of more than 4 million catalogued volumes and 44,000 serials, ranks 15th in size among American universities. Included in the system are the *Biomedical Library* (health sciences); *Institute of Technology Libraries* (engineering, architecture, mathematics, physics, geology); *St. Paul Libraries* (agriculture, biological sciences, veterinary medicine); and *Humanities and Social Sciences Libraries* (social sciences, humanities, archives, special collections). In addition to strong comprehensive research collections, the system offers a full range of reference and information services, including specialized reference assistance, data base literature searching, and library user instruction.

Among the University's many research facilities are:

Agricultural Experiment Station
Archaeology Laboratory
(Charles) Babbage Institute for the History of Information Processing
Biomedical Ethics Center
CENSHARE (Center to Study Human-Animal Relations and Environments)
Center for Advanced Feminist Studies
Center for Alternative Crops and Products
Center for Ancient Studies
Center for Austrian Studies
Center for Community Studies
Center for Death Education and Research
Center for Early Education and Development
Center for Economic Research
Center for Educational Policy Studies
Center for Humanistic Studies
Center for Interest Measurement Research
Center for International Food and Agricultural Policy
Center for Long-Term Care Administration
Center for Microelectronic and Information Sciences
Center for Natural Resources Policy and Management
Center for Northwest European Language and Area Studies
Center for Research in Learning, Perception, and Cognition
Center for Research on Developmental Disabilities
Center for Transportation Studies
Center for Urban and Regional Affairs
Center for Western European Area Studies
Center for Youth Development and Research
Center on Population Analysis and Policy
Center on Women and Public Policy
Chronobiology Laboratories
Clinical Research Center
Coordinating Centers for Biometric Research
Corrosion Center
Dairy Foods Research Center
Gray Freshwater Biological Institute
Health Services Research and Policy
Herbarium
Hormel Institute
Horticultural Research Center
Immigration History Research Center
Immunobiology Research Center
Industrial Relations Center
Institute for Advanced Studies in Biological Process Technology
Institute for Disabilities Studies
Institute for Mathematics and Its Applications
Institute of Human Genetics
Institute of International Studies
Jewish Studies Center
Laboratory for Research in Social Relations
Lake Itasca Forestry and Biological Station
Life Course Center
Limnological Research Center
Magnetics and Information Technologies Center
Management Information Systems Research Center
Midwest Center for Occupational Health and Safety
Mineral Resources Research Center
Minnesota Center for Low-Vision Research
Minnesota Center for Philosophy of Science
Minnesota Center for Survey Research
Minnesota Center for Twin and Adoption Research
Minnesota Cold Climate Building Research Center
Minnesota Geological Survey

Minnesota Landscape Arboretum
Minnesota Research and Development Center for Vocational Education
Minnesota Sea Grant College Program
MRFIT Coordinating Center
Natural Resources Research Institute
Plant Molecular Genetics Institute
Plasma Chemistry Center
Productivity Center
Raptor Research and Rehabilitation Program
Regional Daylighting Center
Remote Sensing Laboratory
Soudan Underground Research Site
State and Regional Research Center
Statistical Center
Strategic Management Research Center
Training and Development Research Center
Underground Space Center
Water Resources Research Center
Williams Laboratory for Nuclear Physics
Women in International Development Research and Information Center

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 $6 million annually to students and faculty. In terms of federal research money awarded, the University ranks in the top 11 among public and private institutions.

Basic Admission Requirements

Any student with a bachelor's degree or its foreign equivalent 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 dean of the Graduate School.

The faculty and staff of the Graduate School encourage applications from persons belonging to minority 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.

University of Minnesota undergraduates 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.

Application Procedure

Requests for application materials should be sent to the director of graduate studies in the individual program (see Fields of Instruction 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.

Application Fee—The fee for Graduate School applicants is $25 for each major they wish to be considered for. This application fee is subject to change.

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 who have attended universities that issue official, original transcripts of records upon request must submit such credentials. Attested true copies of such records are not accepted. Applicants from schools in Bangladesh, India, Nepal, Pakistan, and France, and from schools outside of North America that are on the French system, may submit certified or attested credentials. These should be in the form of mark sheets or examination reports showing the detailed results of all exams taken. These credentials may be certified by university personnel or government officials; they should bear the original signature of the certifying official. Applicants may not certify their own credentials. If an applicant is uncertain about what documents are required, early inquiry is recommended.

Test Data—One or more of the following tests may be required as part of the application process:

Miller Analogies Test—A graduate-level form of the Miller Analogies Test is required of applicants for some 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 Fields of Instruction. 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)—This test is required of all international applicants whose native language is not English, except those who will have completed an academic year in residence as a full-time student at a recognized institution of higher learning in the United States prior to entering the University of Minnesota. These 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 Educa-

tional 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

Coursework Only—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 "coursework only." Applicants for coursework only must complete the usual application materials and meet existing deadlines and admission standards. Since 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.

Transient Graduate Students—Students who have registered within the last year in a graduate degree program at another recognized graduate school in the United States and wish to enroll for a summer session or single quarter in the Graduate School of the University of Minnesota to earn credits to apply toward their degree program may be admitted as transient graduate students. They are required to ask the dean of their graduate school to complete the Transient Application form (G.S. Form 57) and return it to the Graduate School, 307 Johnston Hall, University of Minnesota, 101 Pleasant Street S.E., Minneapolis, MN 55455. Submission of a transcript of credits is not required.

Under no circumstances will students be permitted to register for more than one quarter or summer session as transient 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 "coursework only."

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 form (G.S. Form 72), available from the Graduate School office, 306 Johnston Hall.

Readmission—Persons who have not registered in the Graduate School of the University of Minnesota for two consecutive years will be considered to have withdrawn. Students who subsequently wish to resume graduate work must request readmission on the Change of Status form.

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 this change on the Change of Status form.

Change of Campus—Students currently enrolled in the Graduate School on one campus who wish to complete their studies on another campus should initiate this request through the Change of Status form. Graduate study is currently available on the Twin Cities campus and on the Duluth campus.

Office of Equal Opportunity in Graduate Study

This office in 415 Johnston Hall provides prospective minority and disadvantaged students with information on graduate education. It assists students with the admissions process and identifies financial aid sources available to minority graduate students. The office also administers a number of fellowships available to minority and disadvantaged students and maintains statistics on minority students.

Orientation to the Twin Cities Campus

Information about the resources and services of the University is available to all incoming graduate students through activities offered during the first week of each quarter. Orientation programs introduce students to University policies and procedures, facilities and services, and the Twin Cities community. Social and cultural programs provide opportunities for graduate students to meet each other, faculty and staff, and special guests. Panels and workshops on such topics as writing and research are offered periodically. All incoming graduate students (except those with foreign addresses) are mailed a brochure outlining the orientation schedule. For more information and additional copies of the brochure, contact the program coordinator, Graduate Student Information Program, 324 Coffman Memorial Union, University of Minnesota, 300 Washington Avenue S.E., Minneapolis, MN 55455 (612/624-1483).

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

Registration

The Graduate School operates on a quarter system, and registration ordinarily begins about six weeks before the opening of the term. Students registering after the beginning of classes will be charged a late fee. Students may not register after the last day of classes. Work is also offered in a variety of fields during two summer terms of five weeks each. For the University calendar and registration information, refer to the University's *Summer Session Bulletin* or quarterly *Class Schedule*.

Students must receive notification of admission from the Graduate School before registration is permitted.

Registration Requirements—Registration requirements for the various graduate degrees are specified in the subsections on degree requirements in this bulletin. In addition, the following requirements apply as appropriate.

1. The University requires that graduate students holding appointments as teaching assistants, research assistants, and administrative fellows register each term that an appointment is held. This does not apply to summer terms.
2. 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.
3. Students receiving other types of financial aid from the University or other agencies, international students with certain types of visas, and students wishing to use various University services and facilities may have to meet specific registration requirements of other agencies or University units; they are responsible for securing information about such requirements from the appropriate offices.

Graduate students need not register for the *sole* purpose of taking final written or oral examinations for the master's degree, or for taking the preliminary written or oral examinations for the doctorate.

Varieties of Registration—There are currently four kinds of registration:

1. *Registration for Coursework*—The maximum number of credits for which a graduate student may register in a single quarter during the academic year is 18; in a single term during the summer session, 11. Exceptions are granted by the Graduate School office only in unusual circumstances.

2. *Thesis Credit Registration*—This type of registration is for students entering the Graduate School in fall quarter 1983 and later. Students completing a Plan A master's thesis or a professional master's degree in engineering are required to enroll for 16 master's thesis credits before receiving the degree. Students completing a doctoral degree are required to enroll for 36 doctoral thesis credits before receiving the degree; 8 master's thesis credits, either from the University of Minnesota or transferred from another graduate institution, may be used toward this requirement. Thesis credit registration replaces doctoral candidate registration for students first registering in the Graduate School fall quarter 1983 and later. Students entering before fall quarter 1983 should not register for thesis credits.

3. *Student Status Registration*—This category is for students who are required to register for institutional reasons (e.g., to fulfill the registration requirement for a graduate assistantship). Students should check with the offices requiring registration to determine whether or not Student Status fulfills their registration requirements.

4. *Doctoral Candidate (Continuous) Registration*—This option is restricted to and required of doctoral students who entered the Graduate School before fall quarter 1983 and who have passed their preliminary oral examinations. (See *Thesis Credit Registration* above for the registration requirement for students entering fall quarter 1983 and later.) Doctoral Candidate Registration bears a special tuition rate. Students must begin their registration in the quarter following the successful completion of their preliminary oral examinations. (Eligibility must be established prior to the official opening of the quarter or term in which the student proposes to register in this category.) Doctoral students in the final quarter of registration are required to pay the final quarter fee, in addition to registering as doctoral candidates, in order to take the final oral examination. If the student does not submit the final examination form in the quarter or term in which the final oral examination is passed, he or she must resume doctoral candidate registration at the special tuition rate.

Note—Beginning fall quarter 1990, all students, regardless of their initial date of entry to the Graduate School, will be subject to the thesis credit requirement. This will include all students who are readmitted after a two-year absence, who change their major or degree objective, or who request an extension of time.

Changes in Registration—The addition, deletion, or change of a course registration up to the sixth week of a quarter requires the approval of only the adviser. Any change after the sixth week requires approval of the adviser and the instructor. Students are not permitted to register or to change their registration after the last day of classes of a quarter.

Registration Holds—Reminders to students to file official programs and thesis proposals at appropriate times are generated as a part of registration, as are warnings and registration holds when students fail to meet Graduate School and major field standards for scholastic achievement and progress. If a student registers late or not at all, a notice may not be generated. However, this does not absolve the student from responsibility for complying with these requirements.

Tuition and Fees

Rate Structure—For the 1988-89 academic year, quarterly tuition for full-time enrollment (7-15 credits) is $891.16 for residents and $1,782.32 for nonresidents.

Per-credit rates for enrollment below 7 credits or above 15 credits vary. The quarterly student services fee is $103.91. For tuition and fees for academic year 1989-90, see the quarterly *Class Schedule*. For summer session tuition and fees, see the current *Summer Session Bulletin*.

Students admitted to the Graduate School fall 1983 or later may register at half the full-time or part-time rate after completing a four-quarter Graduate School residency requirement for the master's, a six-quarter requirement for the specialist certificate, and a nine-quarter requirement for the doctorate. Master's students who register at the half rate may not use those quarters to meet the six-quarter specialist or nine-quarter doctoral residency requirement. Specialist students who register at the half rate may not use those quarters to meet the nine-quarter doctoral residency requirement. However, courses taken during quarters of half-rate registration may be used to meet credit and distribution requirements for higher degrees.

"Coursework only" students register for courses at half the full-time or part-time rate. If they are later admitted to a graduate degree program, quarters registered for at the half rate may not be used to meet residency requirements.

Residency—For the doctoral degree, a residency requirement of nine quarters of full-time registration (7 credits or more per quarter) is required. Doctoral thesis credits may be used to fulfill this requirement.

For the master's degree, a residency requirement of four quarters of full-time registration (7 credits or more per quarter) is required. Plan A thesis credits may be used to fulfill this requirement.

Students registering for 1 to 6 credits in a quarter accumulate one-tenth of a quarter's residency for each credit taken. Graduate students registering for 1xxx and 3xxx courses may use them to meet residency requirements.

Students registering during the summer session accumulate one-tenth of a quarter's residency for each credit taken up to a maximum of one-half quarter's residency for each summer term.

Students transferring into a doctoral program fall quarter 1984 and after who have one or more master's degrees from another institution will be credited with four quarters of residency toward the nine-quarter doctoral residency requirement if the doctoral program recognizes their degree(s).

Students who enter the Graduate School fall quarter 1984 and after with authorized credit transfers may use them to meet residency requirements as follows: if entering a master's program—one-tenth of a quarter's residency for each authorized transfer quarter credit up to a maximum of one and eight-tenths quarters of residency; if entering a doctoral program—one-tenth of a quarter's residency for each authorized transfer quarter credit up to a maximum of three quarters of residency.

Grading System

The Graduate School uses two grading systems, A-B-C-D-F and S-N. Except in courses in which grading has been restricted to one system or the other with approval of the Graduate School, students have the option of choosing the system under which they will be graded. Students must declare a choice of grading system as part of their initial registration. Changes in grading options must be made at a Registration Center by the end of the second week of class (end of the first week during the summer sessions). 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 Doctor of Philosophy Degree below).

Incomplete Grades—Course instructors may, at their discretion, place 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 department for its majors.

Retaking Courses—The Graduate School discourages the retaking of courses to improve grades. Permission of the course instructor and the major adviser is required. If a course is retaken, all registrations for the course will remain on the student's record.

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. Independent study courses, workshops, clinics, and practicums are also assigned credit on this basis. So, 1 quarter credit involves three hours of student work per week for ten weeks, or thirty hours total.

Student Records

The Office of the Registrar of the University maintains and releases the official student transcripts. Requests must be submitted in person or in writing, accompanied by a fee, to the Certification Service, 155 Williamson Hall, 231 Pillsbury Drive S.E., Minneapolis, MN 55455.

Majors and Degrees

Twin Cities Campus

Major	*Degree*
Aerospace Engineering	M.S.Aero.E., M.Aero.E., Ph.D.
Agricultural and Applied Economics	M.S., Ph.D.
Agricultural Education	M.A.
Agricultural Engineering	M.S.Ag.E., M.Ag.E., Ph.D.
Agronomy	M.S., Ph.D.
American Legal Institutions	M.A.
American Studies	M.A., Ph.D.
Anatomy	M.S., Ph.D.
Ancient Studies	M.A., M.S., Ph.D.
Anesthesiology	M.S.Anes.
Animal Physiology	M.S., Ph.D.
Animal Science	M.S., Ph.D.
Anthropology	M.A., Ph.D.
Arabic	M.A.
Architecture	M.Arch.
Art Education	M.A.
Art History	M.A., Ph.D.
Astronomy	M.S.
Astrophysics	Ph.D.
Biochemistry	M.S., Ph.D.
Biomedical Engineering	M.S., Ph.D.
Biometry	M.S., Ph.D.
Biophysical Sciences	M.S., Ph.D.
Botany	M.A., M.S., Ph.D.
Business Administration	M.B.A., Ph.D.
Business Education	M.A.
Business Taxation	M.B.T.
Cell and Developmental Biology	M.S., Ph.D.
Chemical Engineering	M.S.Ch.E., M.Ch.E., Ph.D.
Chemical Physics	M.S., Ph.D.
Chemistry	M.S., Ph.D.
Child Psychology	M.A., Ph.D.
Chinese	M.A., Ph.D.
Civil Engineering	M.S., M.S.C.E., M.C.E., Ph.D.
Classical Studies	M.A., Ph.D.
Classics	M.A., Ph.D.
Clinical Laboratory Science	M.S.
Communication Disorders	M.A., Ph.D.
Comparative Literature	M.A., Ph.D.
Comparative Studies in Discourse and Society	M.A., Ph.D.
Computer and Information Sciences	M.S., Ph.D.
Control Science and Dynamical Systems	Ph.D.
Dentistry	M.S.
Dermatology	M.S.Derm.
Design, Housing, and Apparel	M.A., M.S. Ph.D.
East Asian Studies	M.A.
Ecology	M.S., Ph.D.
Economics	M.A., Ph.D.
Education[1]	M.A., Ph.D.
Educational Administration[1]	M.A., Ed.D., Ph.D.
Educational Psychology[1]	M.A., Ph.D.
Electrical Engineering	M.S.E.E., M.E.E., Ph.D.
Elementary Education	M.A.
English	M.A., Ph.D.
English as a Second Language	M.A.
Entomology	M.S., Ph.D.
Environmental Health	M.S., Ph.D.
Epidemiology	M.S., Ph.D.
Experimental Surgery	M.S.Exp.Surg.
Family Practice and Community Health	M.S.
Family Social Science	M.A., Ph.D.
Fisheries	M.S., Ph.D.
Fluid Mechanics	M.S., Ph.D.
Food Science	M.S., Ph.D.
Forestry	M.S., M.F., Ph.D.
French	M.A., Ph.D.
Genetics	M.S., Ph.D.
Geo-Engineering	M.S., M.S.Geo.E., M.Geo.E., Ph.D.
Geography	M.A., Ph.D.
Geology	M.S., Ph.D.
Geophysics	M.S., Ph.D.
Geotechnology	M.Geo.T.
German	M.A., Ph.D.
Germanic Philology	M.A., Ph.D.

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

Greek	M.A., Ph.D.
Health Informatics	M.S., Ph.D.
Health Services Research, Policy, and Administration	Ph.D.
Hispanic Linguistics	M.A.
Hispanic Literature	M.A.
Hispanic and Luso-Brazilian Literatures and Linguistics	Ph.D.
History	M.A., Ph.D.
History of Medicine and Biological Sciences	M.A., Ph.D.
History of Science and Technology	M.A., Ph.D.
Home Economics Education	M.A.
Horticulture	M.S., Ph.D.
Hospital Pharmacy	M.S.
Industrial Education	M.A.
Industrial Engineering	M.S.I.E., M.I.E., Ph.D.
Industrial Relations	M.A., Ph.D.
Italian	M.A.
Japanese	M.A., Ph.D.
Landscape Architecture	M.L.A.
Latin	M.A., Ph.D.
Linguistics	M.A., Ph.D.
Luso-Brazilian Literature	M.A.
Marketing Education	M.A.
Mass Communication	M.A., Ph.D.
Materials Science and Engineering	M.S., M.S.Mat.S. E., M.Mat.S. E., Ph.D.
Mathematics	M.A., M.S., Ph.D.
Mathematics Education[1]	M.A.
Mechanical Engineering	M.S.M.E., M.M.E., Ph.D.
Mechanics	M.S., Ph.D.
Medicinal Chemistry	M.S., Ph.D.
Microbial Engineering	M.S.
Microbiology	M.S., Ph.D.
Mineral Engineering	M.S., M.S.Min.E., M.Min.E., Ph.D.
Music	M.A., M.M., D.M.A., Ph.D.
Music Education	M.A.
Neurology	M.S., M.S.Neur., Ph.D.Neur.
Neuroscience	Ph.D.
Neurosurgery	M.S., M.S.Nsurg., Ph.D.Nsurg.
Nursing	M.S., Ph.D.
Nutrition	M.S., Ph.D.
Obstetrics and Gynecology	M.S., M.S.Obs. & Gyn.
Ophthalmology	M.S., M.S.Ophthal.
Oral Biology	M.S., Ph.D.
Orthopedic Surgery	M.S., M.S.Orth.Surg.
Otolaryngology	M.S., M.S.Otol., Ph.D.Otol.
Pathobiology	Ph.D.
Pediatrics	M.S., M.S.Ped.
Pharmaceutics	M.S., Ph.D.
Pharmacology	M.S., Ph.D.
Philosophy	M.A., Ph.D.
Physical Education	M.A., Ph.D.
Physical Medicine and Rehabilitation	M.S., M.S.P.M. & Rehab., Ph.D.P.M. & Rehab.
Physical Therapy	M.S.
Physics	M.S., Ph.D.
Physiology	M.S., Ph.D.
Planning	M.Plan.
Plant Breeding	M.S., Ph.D.
Plant Pathology	M.S., Ph.D.
Plant Physiology	M.S., Ph.D.
Political Science	M.A., Ph.D.
Psychiatry	M.S.Psychiat.
Psychology	M.A., Ph.D.
Public Affairs	M.A.
Public Health	M.S.
Radiology	M.S., M.S.Rad.
Recreation, Park, and Leisure Studies	M.A.
Religious Studies	M.A.
Russian Area Studies	M.A.
Scandinavian Studies	M.A., Ph.D.
Social and Administrative Pharmacy	M.S., Ph.D.
Social and Philosophical Foundations of Education	M.A.
Social Work	M.S.W., Ph.D.
Sociology	M.A., Ph.D.
Soil Science	M.S., Ph.D.
South Asian Languages	M.A., Ph.D.
Speech-Communication	M.A., Ph.D.
Statistics	M.S., Ph.D.
Studio Arts	M.F.A.
Surgery	M.S.Surg., Ph.D.Surg.
Technical Communication	M.S.
Theatre Arts	M.A., M.F.A., Ph.D.
Therapeutic Radiology	M.S.Ther.Rad.
Theriogenology	M.S., Ph.D.
Urology	M.S., M.S.Urol.
Veterinary Biology	M.S., Ph.D.
Veterinary Medicine	M.S., Ph.D.
Veterinary Microbiology	M.S., Ph.D.
Veterinary Parasitology	M.S., Ph.D.
Veterinary Pathology	M.S., Ph.D.
Veterinary Surgery, Radiology, and Anesthesiology	M.S., Ph.D.
Vocational Education	Ed.D.
Wildlife	M.S., Ph.D.
Zoology	M.S., Ph.D.

Certificate of specialist in education

Counseling
Elementary School Administration
General Curriculum Supervision
General Educational Administration
Intermediate Unit in Educational Administration
Mathematics Education
School Business Administration
School Psychological Services
Secondary School Administration
Special Education

Freestanding Minors

Cognitive Science
Feminist Studies

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

Gerontology
Interfacial Engineering
Law
Microbial Ecology
Museum Studies
Quaternary Paleoecology
Water Resources

Duluth Campus

Major	*Degree*
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 Administration	Cert. of Spec.
Educational Psychology	M.A.
English	M.A.
Geology	M.S.
Physics	M.S.
Social Work	M.S.W.

Transfer of Credits

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 tuition rate in effect at the time the credits are transferred. Once CEE courses are transferred, the Graduate School will not approve any petition to remove the courses from the degree program and transcript to avoid paying the tuition differential charge.

For the Master's Degree—Unless otherwise specified in Fields of Instruction, 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 (excluding thesis credits) for their official degree programs (see Master's Degree below) as registered Graduate School students. With the approval of the adviser and director of graduate studies in the major (and the director of graduate studies in the minor if the courses are for a designated minor), the transfer of up to 40 percent of the degree coursework from any combination of the following is permitted:

1. Other recognized graduate schools;
2. Adult special, summer session, and CEE status at the University of Minnesota.

Individual graduate programs may, at their option, specify 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. CEE courses must bear the special CEE transcript entry verifying that they were completed for graduate credit. Credits transferred from other institutions must appear on official graduate school transcripts of the institutions. Credit for courses completed through independent (correspondence) study, completed through extension or special categories at other institutions, or taken before the awarding of the baccalaureate degree cannot be transferred.

The transfer of credits is accomplished by the inclusion of the courses on the proposed degree program.

For the Doctoral Degree—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 the baccalaureate degree. In the following cases, transfer of credits is accomplished by inclusion of the courses on the proposed degree program; official transcripts of the work must be attached.

From Adult Special or Summer Special Status—Students admitted to and registered in the Graduate School may transfer to their graduate programs the graduate-level credits earned in their first academic quarter as adult special students, or in their first summer session (both terms in the same calendar year) as summer special students 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 graduate 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.

From Other Graduate Institutions—Graduate credits (including up to 8 thesis credits) from a master's degree earned at other recognized graduate institutions may be applied to doctoral degrees if credits appear on official graduate school transcripts.

For the Specialist Certificate—For education fields, see Specialist in Education below.

Master's Degree

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

Registration Requirement—At least 60 percent of the coursework for the master's degree must be completed while registered in the Graduate School; individual programs may require a higher percentage.

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.

Registration Requirement for the Clinical Medical Fields—For the master's degree in a clinical subject with designated field, (e.g., M.S.Surg.), a minimum of three calendar years are required. For the master's degree in a clinical subject without a designated field, a minimum of two calendar years are required. Registration requirements for each clinical medical field appear in Fields of Instruction. Thesis credits cannot be used to satisfy any of the above registration requirements.

Time Requirement for the Master's Degree—All requirements for the master's degree must be completed 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.

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 proposed program for the degree. The program form is available in the Graduate School office. On it students list all coursework, completed and proposed, that will be offered in fulfillment of degree requirements; this includes transfer work (see Transfer of Credits above). If a foreign language is required, the one to be offered is specified. If the degree is being completed under Plan A, students also include the thesis proposal. *On the basis of this program, the members of students' final examining committees, and the thesis reviewers for Plan A, are appointed.*

The minimum credit requirements for the program are specified below under the two plans for the degree.

Official Program for the Degree in the Clinical Medical Fields—Students are encouraged to submit their programs and thesis titles before the end of the second year of registration. Approval by the pro-

gram faculty and 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 program must be fulfilled in every detail to meet graduation requirements. Alterations in the program that are found necessary or desirable should be requested by completing the Petition Form.

Minimum Grade Requirements—The minimum grade point average required by the Graduate School for courses included on the official program for any master's degree is 2.80 (on a 4.00 scale). Grades of A, B, C, and S are acceptable, but grades of S are not calculated in the grade point average. *At least two-thirds of the credits taken in the Graduate School and included on any degree program must be taken under the A-F system.*

Individual major fields may set higher grade requirements, and students should be familiar with special requirements in their major field.

Language Requirement for the Master's Degree—See Fields of Instruction to determine the language requirement, if any, for a specific field. The Graduate School monitors the fulfillment of language study when a department requires a language. Information about how to demonstrate proficiency and the conditions under which proficiency will be recorded on the official transcript is available from the Graduate School office.

Clearance for Graduation—Degrees are granted at the end of each month. To qualify for graduation for a particular month, students must pay the degree application fee on or before the first workday of that month and must complete the examination and all other requirements (including 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 name appears in the program distributed at the commencement ceremony, graduates must pay the degree application fee by the deadline specified in the Graduate School section of the *Class Schedule*.

Plan A: Master's Degree With Thesis

Minimum Credit Requirements—Students must complete 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 to constitute the minimum of 44 quarter credits required for the degree.

Students who wish to complete a designated minor (which will be certified on the transcript—unlike the related fields option, which will not be) 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 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.

Master's Thesis—The thesis title is submitted for approval as a part of the student's official degree program. Instructions for preparation of the thesis should be obtained from the Graduate School office.

Language of the Thesis—Theses must normally be written in English, the language of instruction. However, in some fields of study, a language other than English may be used provided there is a

scholarly reason for its use. When the degree program is submitted, a justification for the use of a foreign language, signed by the adviser and director of graduate studies, should be attached. The statement should attest that the recommended thesis reviewers (including the outside reviewer) are qualified to read, comprehend, and criticize a thesis in the foreign language.

Thesis Credits—Students first registered in the Graduate School fall quarter 1983 or later must enroll for 16 master's thesis credits before receiving the degree. Students cannot include thesis credits in the total program credits when determining maximum transfer allowed (see Transfer of Credit 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.

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 will provide the student with the Thesis Reviewer's Report form and the other forms and information necessary to graduate.

Thesis Reviewers—The thesis will be read by a committee of at least three members, as appointed by the dean of the Graduate School on recommendation of the program faculty at the time of approval of the student's official degree program. All members of the examining committee must have at least two weeks to read the thesis. The examining committee will ordinarily include at least two representatives from the major field and one from the minor or a related field. *This committee must be unanimous* in certifying that the thesis is ready for defense.

Thesis Binding—Two copies of the thesis must be bound in maroon and submitted to the Graduate School office.

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 examination covers the major and minor or related fields and may include any work fundamental thereto. This examination is coordinated by the chair of the student's examining committee. *A majority vote* of the committee, all members present and voting, is required for a pass. Results are reported to the Graduate School on a Final Examination Report form, which is issued to the student when the form certifying that the thesis is ready for defense is submitted. In case of failure, unanimous consent of the examining committee is required to retake the examination.

Plan B: Master's Degree Without Thesis

Minimum Credit Requirements—Students must complete 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 will be 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.

Students who wish to complete a designated minor (which will be certified on the transcript—unlike the related fields option, which will not be) 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 field.

Plan B Project(s)—Students must demonstrate familiarity with the tools of research or scholarship in their field, the ability to work independently, and the ability to present the results of their in-

vestigation 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 approximately three nominal weeks or 120 hours 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. A committee of at least three examiners is appointed by the dean of the Graduate School upon recommendation of the program faculty at the time of the approval of the official degree program. The committee will include one member from outside the major field. Students will make the Plan B project(s) available to the examining committee for its review. *A majority vote* of the committee, all members present and voting, is required to pass the examination. The vote is reported to the Graduate School on a form the student must obtain from the Graduate School office before taking the examination. In case of failure, unanimous consent of the examining committee is required to retake the master's final examination.

Master of Architecture

See Architecture under Fields of Instruction for requirements.

Master of Business Administration

See Business Administration under Fields of Instruction for requirements.

Master of Business Taxation

See Business Administration under Fields of Instruction 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 B.S. in engineering graduates from Engineers' Council for Professional Development (ECPD) accredited programs. Full-time students should be able to complete a program in one calendar year.

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.

Credit Requirements—Students must complete 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 to constitute the minimum of 44 quarter credits required for the degree.

If students wish to complete a designated minor (which will be certified on the transcript—unlike the related fields option, which will not be), they must complete 9 or more quarter credits in a single field (making the minimum requirement for a degree with a designated minor 45 credits, including thesis credits). Credits must be in graduate-level courses in which a minimum grade point average of 2.80 is maintained. A designated minor must be approved by the director of graduate studies in that field.

Design Project—A design project is a major component of the master of engineering program. It emphasizes problem

solving based on engineering design criteria used in industry. Performance of professional caliber, which can be subjected to the critique of senior design engineers in industry as well as engineering faculty members, is expected. Approximately 20 weeks are spent on the project.

Registration of the Design Project Title—Students must register the design project *title* with the Graduate School, 316 Johnston Hall, by submitting a copy of the design project title page as it will appear in the final document. Upon submission of the design project title, the Graduate School provides the students with the Reviewer's Report form and other forms and information necessary to graduate.

Examination—Students must pass a project examination given by a committee appointed by the dean of the Graduate School.

Project Binding—Two copies of the design project report must be bound and submitted to the Graduate School.

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

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 Studio Arts and Theatre Arts under Fields of Instruction.

Course Requirements—Candidates must normally complete from 65 to 90 credits, depending upon their previous preparation. At least 45 credits must be earned at the University of Minnesota. A minimum of 9 credits in the history or literature of art or theatre and a minimum of 8 credits in areas of study outside of the major department are required.

Creative Project—Students must complete a creative project (production or exhibition), which will be accompanied by a supporting paper that deals with the planning or execution of the creative work.

Final Examinations—Candidates will take a final oral examination, a final written examination, or both, at the discretion of the graduate faculty in the major field. The examination(s) will be administered by a committee appointed by the dean at the time of approval of the official degree program. A *majority vote* of the examining committee, all members present and voting, is required for a pass. The results are reported to the Graduate School on a form students obtain from the Graduate School office before taking the examination.

Master of Forestry

See Forestry under Fields of Instruction for requirements.

Master of Geotechnology

See Geo-Engineering under Fields of Instruction for requirements.

Master of Landscape Architecture

See Landscape Architecture under Fields of Instruction for requirements.

Master of Music

See Music under Fields of Instruction for requirements.

Master of Planning

See Public Affairs under Fields of Instruction for requirements.

Master of Science (Designated) in Clinical Medicine

See Master's Degree above for requirements.

Master of Social Work

See Social Work under Fields of Instruction for requirements.

Specialist 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 Fields of Instruction section for specific fields and program descriptions). These programs require completion of a minimum of 90 credits. Students 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.

Students who transfer credits from other institutions may be required by their major advisers and the department faculty to take qualifying examinations in specific areas. Such examinations are designed to aid students and their advisers in planning the program for the specialist in education certificate and will be taken before students file their program.

With the approval of the adviser and director of graduate studies, the transfer of up to 50 percent of the certificate coursework from any combination of the following is permitted:

1. Other recognized graduate schools;
2. Adult special, summer session, and CEE status at the University of Minnesota.

The program can be completed in two years but must be completed in 12 years. Graduate credits earned previous to the 12-year span will be 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 granted chiefly in recognition of high attainment and ability in a special subject field as demonstrated, first, by passing the required examinations covering both a candidate's general and special subject fields and, second, by the preparation of a thesis that is based on original research and makes a significant contribution to knowledge in the student's field.

Registration Requirement for the Doctoral Degree—Registration in the Graduate School for at least nine quarters is required. The following registration requirements also apply to doctoral students:

1. Students first registered in the Graduate School before fall quarter 1983 must maintain candidacy by registering continuously and paying candidacy fees during the academic year (fall, winter, spring quarters) from the quarter after passing the preliminary oral examination until the doctorate is awarded. Registration for the first or second summer term (or both terms) fulfills the candidate registration requirement for the academic quarter(s) immediately following [see Doctoral Candidate (Continuous) Registration under Registration above].
2. Students first registered in the Graduate School fall quarter 1983 or later are required to enroll for 36 doctoral thesis credits before receiving the degree (see Thesis Credit Registration under Registration above).

Official Program for the Degree—Students are expected to file their official programs for the degree in the second year of study; the specific quarter depends upon individual major field requirements. Students should submit their programs at least two quarters prior to the term in which they plan to take the preliminary oral examination. The program form is available in the Graduate School office. It

should contain all coursework, completed and proposed, that will be offered in fulfillment of degree requirements in the major field and in the minor or supporting program fields; this includes transfer work (see Transfer of Credits above). Students should also specify the foreign languages, if any, that will be offered in fulfillment of the department requirement. *On the basis of the program, the members of the students' preliminary oral examining committees will be appointed by the dean of the Graduate School.*

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

Minimum Grade Requirements—Grades of A, B, C, and S are acceptable, but grades of S are not calculated in the grade point average. *At least two-thirds of the credits completed in the Graduate School and included on any degree program must be taken under the A-F system.*

Major Work—There is no minimum number of credits specified for the major by the Graduate School. Frequently, depending on previous preparation, the length of programs for individual students, even within the same field, may vary considerably.

Minor or Supporting Program Work—At least 18 quarter credits must be offered in the minor or supporting program. With a traditional minor, this work will be in a single field related to the major. If the student is offering a supporting program, it must be composed of a coherent pattern of courses possibly embracing several disciplines. Students electing the supporting program option may be required to take written preliminary examinations in the fields included, but will not be 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 or supporting programs 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 Fields of Instruction to determine the language requirement, if any, for a specific program. The Graduate School monitors the fulfillment of language study when a department requires a language. Information about how to demonstrate proficiency and the conditions under which proficiency will be recorded on the official transcript is available from the Graduate School office.

Official Doctoral Candidacy—Candidacy is established when students have passed the preliminary oral examination.

Time Limit for Earning the Doctoral Degree—Doctoral candidates must complete all requirements and receive the degree within a maximum of five calendar years after passing the preliminary oral examination. Failure to receive the doctoral degree within the five-year period will terminate candidacy; reinstatement of candidacy may require the setting of conditions for completion of the degree, including the possibility of retaking the preliminary oral examination. Petitions for extension of the time limit must be submitted before the expiration of the five years. The graduate faculty in the degree programs may establish more stringent time limitations.

Preliminary Written and Oral Examinations

Preliminary Written Examination—A written examination in the major subject will be given by the graduate faculty in the major field, before the preliminary oral examination is given. This examination covers all work completed in the major field and may include any work fundamental thereto. It is the student's responsibility to ensure that the results of

the written examination are reported immediately to the Graduate School office. A form for this purpose, available in the Graduate School office, requires the signatures of the adviser and the director of graduate studies in the major field.

Preliminary Oral Examination—The student will take the preliminary oral examination after completing a substantial part of the coursework and passing the preliminary written examination (except in those instances where the written follows the oral), but prior to writing the dissertation. The examination will be administered by the committee appointed by the dean, upon recommendation of the program faculty, on the basis of the official doctoral program.

Preliminary Oral Examining Committee—The examining committee will include a minimum of five members, three from the field of the major and two from the field of the minor or supporting program.

Changes in the Preliminary Oral Examining Committee—Substitutions on the examining committee, which may be necessitated, for example, by the departure or absence on leave of a faculty member, must be requested by the adviser or the director of graduate studies through the Graduate School office *well in advance* 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 office* at least one week in advance. *In certain of the health science areas, however, one month's notice must be given.* The Graduate School must have on file an approved degree program and a report that the student passed the preliminary written examination before the oral examination can be scheduled.

The Graduate School issues the report form for the preliminary oral examination to the student's adviser, and informs both the student and the adviser if the language requirement or coursework on the official program has not yet been completed. The preliminary oral will be authorized in spite of such deficiencies, but deficiencies must be completed before the final oral may be scheduled.

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.

Preliminary Oral Examination Content and Outcome—The preliminary oral examination covers the major field, the minor field or supporting program, and any work fundamental thereto, including possible plans for thesis research.

Immediately prior to the preliminary oral examination, the committee chair will clearly stipulate the objectives of the examination and, in consultation with other members of the examining committee, determine how the examination is to be conducted. Immediately after the preliminary oral examination, the candidate will be excused from the room and a written vote will be taken before discussion of the examination. Following discussion, a second and final vote will be taken, and the participants will sign in the appropriate place on the report form.

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

Reporting the Results—The examining Committee will report the results of the preliminary oral examination to the Graduate School office. If the committee decides that a student passed the examination with reservations, it must inform the student immediately. The committee has one week, however, to send the student a letter that clearly stipulates the reservations and the steps required to remove them. A copy of this letter must be forwarded to the Graduate School. A second letter informing the student that the reservations have been satisfied is also required; again, a copy must be forwarded to the Graduate School. The chair of the preliminary oral examination committee should write both letters on the committee's behalf. The final oral examination cannot be scheduled until the Graduate School receives a copy of the second letter.

Failure of the Examination—Students failing the preliminary oral (a) may be allowed, on unanimous recommendation of the examining committee, to retake the examination or (b) may be excluded from candidacy for the degree. In no case may the reexamination take place before at least one full academic quarter has passed. No more than two preliminary oral examinations are allowed.

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 title form and statement in the Graduate School office. The thesis title form is available from that office. The statement, approximately 250 words in length, must describe the research to be undertaken and the methods to be employed in carrying it out.

On the basis of the thesis proposal, the thesis reviewers and other members of the final oral examining committee will be appointed by the dean of the Graduate School upon recommendation of the program faculty.

Changes in the Thesis Title—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 Timely Delivery of the Thesis to Thesis Reviewers below). If the substance of the proposal should change markedly in the course of the research, a revised proposal should be submitted immediately.

Language of the Thesis—Theses must normally be written in English, the language of instruction. However, in some fields of study, a language other than English may be used provided there is a scholarly reason for its use. When the thesis statement is submitted, a justification for the use of a foreign language, signed by the adviser and director of graduate studies, should be attached. The statement should attest that the recommended thesis reviewers (including the outside reviewer) are qualified to read, comprehend, and criticize a thesis in the foreign language.

Preparation of the Thesis—Instructions for the preparation of the thesis should be obtained from the Graduate School office.

The Use of Published Work in 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. The adviser should notify the Graduate School in writing of the intention to publish a part of the material, but no approval is required.

Registration of the Thesis Title and Timely Delivery of the Thesis to Thesis Reviewers—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 will provide the student with the Thesis Reviewer's Report form and the other forms necessary to graduate.

At the time the candidate submits the thesis to the thesis reviewers, copies must also be provided to all other members of the final oral examining committee. All members of the committee must have at least two weeks to read the thesis, which assures sufficient time to decide whether the thesis is ready for defense.

The thesis abstract must be included with the thesis when it is distributed to the committee. It also must be signed by the adviser before it is submitted to the Graduate School, which will forward it to University Microfilms.

The final oral must be scheduled with the Graduate School at least one week before the proposed examination date.

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

The designated thesis reviewers will consist of the adviser and at least two other members of the final oral examining committee, including at least one representative from the minor or supporting program. The committee to certify that the thesis is ready to defend shall at least partially be made up of individuals other than those on the thesis advisory committee, when such committees are used by programs. The committee must be unanimous in certifying that the thesis is ready for defense before the student can take the final oral examination.

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.

Final Oral Examination

To be eligible for the final oral examination, the student must have completed all work on the official doctoral program including the language requirement (if any) and must have passed both the written and oral preliminary examinations. In addition, the thesis must have been certified by the readers as ready for defense. The examination will be conducted by a committee appointed at the time of approval of the thesis proposal and consisting minimally of the adviser, two additional thesis reviewers, and two other members of the graduate faculty. The examination shall be limited to the candidate's thesis subject and relevant areas. It will not exceed three hours.

Scheduling the Final Oral with the Graduate School—*The examination must be scheduled by the student one week in advance* (see Clearance for Graduation below) *with the committee and with the Graduate School. In certain of the health science fields the faculty requires 30 days' notice of the date of the final oral.*

When the examination is scheduled the file will be checked to determine that the student is clear to take the examination as stipulated above, and, if so, the report form for the final oral examination will be forwarded to the adviser.

If time permits, the date of the examination will be publicly announced, and any member of the scholarly community may attend (see Form of the Final Oral Examination below).

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—Although the student's adviser will serve as a member of the final oral examining committee, another member of the committee will be designated as the chair and will function in this capacity at the final oral examination. The chair must be a full

member of the graduate faculty, and may be from the minor or supporting program. The Graduate School dean will appoint the chair and other members of the final oral examining committee upon recommendation of the director of graduate studies in the major field. The final oral examining committee should consist minimally of five members, three from the major and two from the minor or supporting program, at least two of whom normally represent a graduate program and budgetary unit other than that of the student's major.

Changes in the Final Oral Examining Committee—See Changes in the Preliminary Oral Examining Committee above.

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. 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 she or he passed the examination. The seminar may take place only after the thesis has been judged ready for defense. The final oral examination is limited to the thesis subject and relevant areas.

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.

Reporting the Results of the Final Oral—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.* The results must be reported to the Graduate School on the Final Oral Examination Report form.

Clearance for Graduation—Degrees are granted at the end of each month. To qualify for graduation for a particular month, students must pay the degree application fee 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 pay the degree application fee by the deadline specified in the Graduate School section of the *Class Schedule*.

Doctor of Education Degree

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, in general, 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.

Field Problem—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 department 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 will be appointed by the dean of the Graduate School upon recommendation of the program faculty. It will consist 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. Programs are offered in the areas of piano, voice, trumpet, clarinet, and organ. Standards and procedures for admission and expectations for scholastic performance are, in general, 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 Fields of Instruction.

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 Fields of Instruction for requirements.

Termination of Graduate Student Status

When performance is unsatisfactory in terms of grades or normal progress, 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 will be measured for purposes of continuation. Students are encouraged to check with their major departments for complete information about their procedures and requirements.

Council of Graduate Students

The Council of Graduate Students (COGS) is the official 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 provides 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 418 Johnston Hall, University of Minnesota, 101 Pleasant Street S.E., Minneapolis, MN 55455 (612/626-1612).

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 11 participating universities are the members of the "Big Ten" and the University of Chicago.

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 306 Johnston Hall.

Use of Human Subjects in Research

All Twin Cities, Duluth, and Morris campus research that involves the use of human subjects must be reviewed and approved by the University Committee on the Use of Human Subjects in Research. This policy, approved by the University Senate and Board of Regents, applies to both funded and nonfunded faculty and student research. Any individual student research project (e.g., Plan B project, thesis, dissertation) that involves human subjects must be approved by this committee prior to initiation of the research. For additional information, visit or contact the committee office at 1919 University Avenue, St. Paul, MN 55104 (612/624-9829).

Grievance Procedures

Academic Freedom and Responsibility—Grievance procedures relating to academic freedom and responsibility are governed by the University Senate statement on Academic Freedom and Responsibility of December 17, 1970, and the Revised Report of the University Appeals Committee on Academic Freedom and Responsibility of April 18, 1974. As a consequence of these policies, each department or program has available a set of operating procedures to deal with both the formal and informal aspects of possible grievance matters; often these procedures are spelled out in a department's or program's handbook for graduate students or are available upon request in the department or program office. Also as a consequence of the two senate policies, each department or program has established a standing committee on grievances to conduct hearings and make recommendations in those cases that reach the formal grievance stage. In general, it is best for graduate students with a potential grievance to seek the advice and assistance of their adviser or director of graduate studies and the department or program chairperson. In the event that the nature of the potential grievance precludes such inquiry and discussion, graduate students may wish to seek advice from the Graduate School grievance officer by contacting the Graduate School dean's office. There is a Graduate School Grievance Committee, but its function is essentially limited to hearing appeals from department or program grievance committees.

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 Patricia A. Mullen, Entry-Level Officer for Sexual Harassment, 419 Morrill Hall. All inquiries will be held in strictest confidence.

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 duties of a specialized nature connected with administration.

To be eligible to hold one of these appointments, a student must have been admitted to the Graduate School; for appointments of at least 12½ percent or 65 hours, a student must also be registered in the Graduate School each quarter the appointment is held during the academic year. Registration during the summer session is not required. A student may be appointed for 75 percent time or less per academic quarter (or up to 100 percent time during the summer).

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, in one of the specific positions listed above. Two summer terms will count as one academic-year quarter.
2. After completion of the qualifying three quarters of appointment, the use of the privilege is extended on a quarter-for--

quarter basis up to a maximum of six quarters of use.

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.

All graduate assistants with appointments of at least 25% automatically receive tuition fellowships equal to twice the percentage of their appointments. Students with appointments of 50% or more receive 100% tuition fellowships, not including fees. (A similar policy exists for other fellowship programs administered by the University of Minnesota.)

Each department sets its own application deadline. Unless otherwise noted, applications must be received by February 15 for appointments for the ensuing academic year; applications received at other times will be considered for any available vacancies. All applications for graduate assistantship appointments should be returned to the head of the appropriate department —*not to the Graduate School.*

Stipends for graduate assistants are based on the level of appointment and percentage of time of the appointment. A schedule of current stipends for graduate assistantships is available from the Graduate Assistants 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.

Application forms and further information may be obtained from either the head of the department offering the appointment or from the Graduate Assistants Office. This office provides ombudsman services for and handles problems and information requests of graduate assistants. An administrative arm of the Office of the Vice President for Academic Affairs, it 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 Assistants Office, 411 Johnston Hall, University of Minnesota, 101 Pleasant Street S.E., Minneapolis, MN 55455 (612/626-1310).

General College Assistantships—Graduate students are eligible to apply for teaching assistantships in the General College. The General College program consists of developmental and general education courses in such areas as mathematics, natural science, social science, communications, and the humanities, as well as specialized courses in such career areas as business, health, and law. Inquiries about assistantships should be directed to the Office of the Dean, General College, 106 Nicholson Hall, University of Minnesota, 216 Pillsbury Drive S.E., Minneapolis, MN 55455.

Graduate Fellowships—Graduate fellowships, awards based on academic merit, are available to new and currently enrolled graduate students. The Graduate School Fellowship Office, 422 Johnston Hall, administers several fellowship programs, described in detail below; a number of individual academic departments also administer field-specific fellowships. Entering students must file their fellowship application with 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 holding fellowships and traineeships with stipends equivalent to that of a 25 percent time assistantship are entitled to the same resident tuition benefits as graduate assistants. The same privilege applies to members of their immediate families. See Graduate Assistantships above for details.

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 a stipend of approximately $9,000 plus tuition (fees not included) for the academic year. All applicants must be nominated by the graduate program they plan to enter. Applications must be submitted directly to the prospective graduate program by the program's specified deadline, but *no later than February 1.*

NORWEGIAN NATIONAL TORSKE KLUBBEN FELLOWSHIP—See Endowed Fellowships below.

FELLOWSHIPS AVAILABLE FOR MINORITY 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, 415 Johnston Hall (612/625-6858).

Minority and Disadvantaged Graduate Student Fellowships—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 $9,000 plus tuition (fees not included) for the academic year. Two years of departmental support following the fellowship year are included. All applicants must be nominated by the graduate program they plan to enter. Applications must be submitted directly to the prospective graduate program as soon as possible, because these fellowships are awarded on a first come, first served basis. Approximately 10 fellowships are awarded by the Graduate School each year.

The CIC Minorities Fellowship Program—Sponsored by 11 Midwestern universities, this program awards approximately 40 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 $7,500 per year plus tuition. The application deadline is in early January. For complete information, call 1-800-457-4420 toll free or write to CIC Minorities Fellowship Program, Kirkwood Hall 111, Indiana University, Bloomington, IN 47405.

Other Available Fellowships—The availability of other fellowships for minority graduate students, such as the Patricia Roberts Harris Fellowships and the Ford Foundation Doctoral Fellowships for Minorities, changes from year to year. Contact the Office of Equal Opportunity in Graduate Study, 415 Johnston Hall, for information. In addition, minority students should check all regular sources of support described in this bulletin.

For Currently Enrolled Graduate Students

GRADUATE SCHOOL DOCTORAL DISSERTATION FELLOWSHIPS—Available to Ph.D. candidates who will have completed all requirements except the dissertation by the end of the quarter in which they apply. Early May deadline; program nomination required. Approximately $10,000 for twelve months.

GRADUATE SCHOOL DOCTORAL DISSERTATION SPECIAL GRANTS—For dissertation research expenses for students who have passed preliminary written and oral examinations. Deadlines generally in December and May. Up to $1,500.

JESSAMINE-ALLEN GRADUATE SCHOOL DISSERTATION GRANTS FOR RACIAL MINORITIES—Available to minorities who are citizens or permanent residents, who are Ph.D. candidates who have completed preliminary examinations, and who have an approved program on file in the Graduate School. For dissertation-related expenses only, not to exceed $1,000. Contact the Office of Equal Opportunity in Graduate Study, 415 Johnston Hall, for an application. Minority students are encouraged to pursue nomination for the regular University-wide Doctoral Dissertation Fellowship competition.

TUITION SCHOLARSHIPS—Open to students who have been registered for at least three quarters in the Graduate School at the University of Minnesota. Must be U.S. citizen or permanent resident. One quarter award (partial or full), occasionally renewed for a second quarter. Application deadlines approximately eight weeks before the beginning of each quarter. Tuition only.

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 advanced students in the plant and animal sciences, including agronomy, biology, botany, cell and developmental biology, ecology, forestry, genetics, horticulture, plant breeding, plant pathology, plant physiology, and zoology. Preference to students involved in basic scientific research. Up to $1,500.

Charles J. Brand Fellowship—Offered to graduate students in botany, with preference to those nearing completion of the Ph.D. Approximately $6,000.

Class of 1890 Fellowship—Available to graduate students in the arts, sciences, or engineering. Relevant programs may nominate one candidate each. Up to $1,500.

Walter B. Cline Memorial Fellowship—For students pursuing graduate study in the language or cultural history of Asia or the Moslem world. Up to $1,500.

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 $1,500

Norman Johnston DeWitt Fellowship—Intended to support an advanced graduate student in the humanities, with preference to applicants engaged in interdisciplinary studies. Approximately $5,000.

Louise T. Dosdall 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. Approximately $8,000.

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. Average award $1,500.

Albert Howard Award—For graduates of the University of Minnesota. Each graduate program may nominate one candidate. Up to $1,500.

Stanwood Johnston Memorial Fellowship—For promising graduate students in geology, geophysics, physics, chemistry, biochemistry, or microbiology. Approximately $8,000.

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. Approximately $9,600.

Harold Leonard Memorial Film Study Grants—For students in good standing to conduct studies in film history, criticism, theory, 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. Approximately $8,000.

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 each nominate one candidate. Approximately $5,000.

William W. Stout Fellowship—Open to graduate students in the humanities and social sciences who are in the intermediate years of the Ph.D. Graduate programs in appropriate fields may nominate one candidate each. Approximately $8,000.

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. Graduate programs in appropriate fields may nominate one candidate each. Approximately $8,000.

Woman's Club of Minneapolis Fellowship—Available in alternate years to a woman graduate student with high scholarship and leadership qualifications. Must be U.S. citizen. Preference to women from Twin Cities area. Next award 1990-91. $2,200.

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 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. $500.

ARCHITECTURE

American Institute of Architects and American Institute of Architects Foundation, Inc., Scholarship Program —For graduate and undergraduate architecture students.

Architectural Alliance Education Fund—For graduate and undergraduate architecture students. Variable amount.

Derickson Award—For graduate architectural students. Variable amount.

Ellerbe Prize Award—For graduate and undergraduate architecture students. Variable amount.

Flour City Architectural Education Fund—For graduate and undergraduate architecture students. Variable amount.

Skidmore Owings Merrill Architectural Education Fund—For graduate and undergraduate architecture students. Variable amount.

Minneapolis Chapter, American Institute of Architects—For graduate and undergraduate students in architecture. $500 each.

Minnesota Society of Architects Scholarship—For graduate and undergraduate architecture students. Variable amount.

Wells H. Paschall Memorial in Architecture Fund—For graduate and undergraduate architecture students. Variable amount.

Poole Architectural Education Fund—For graduate and undergraduate architecture students. Variable amount.

Rapson and Associates Architectural Education Fund—For graduate and undergraduate architecture students. Variable amount.

Rhodes Robertson Education Fund in Architecture—For graduate and undergraduate students in architecture. Variable amount.

St. Paul Chapter, American Institute of Architects Award—For graduate architecture students. $1,000.

Wisconsin Architects Foundation—For graduate and undergraduate architecture students. Must be Wisconsin resident or have a hometown in Wisconsin. Variable, usually $500.

ART (Duluth Campus)

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

ART HISTORY

Art History Department Fellowships—For art history students working on doctoral dissertations. $500 to $2,000.

Elizabeth Roe Fellowship—For continuing art history graduate students, with preference to those in eighteenth-century art history. $500 to $2,000.

BIOCHEMISTRY

Chemical Bases of Cell and Molecular Biology Training Grant—To train doctoral students in biochemistry, chemistry, genetics and cell biology, microbiology, and physiology in a chemically based approach to cellular and molecular biology. U.S. citizenship required. $6,552 plus tuition and certain fees.

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.

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 Field Biology Program, Bell Museum of Natural History. $100 to $500.

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.

Wilkie Fund for Behavior and Evolution—To encourage graduate students to undertake research in behavior and evolution with priority to field studies. Apply through Bell Museum of Natural History. Variable amounts, usually $100 to $2,000.

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.

BIOMETRY

U.S. Public Health Service Traineeships in Public Health—For graduate students in biometry. U.S. citizenship or permanent residency required. Up to $6,552 plus tuition and fees.

BUSINESS ADMINISTRATION

American Assembly of Collegiate Schools of Business/Graduate Management Admission Council National Doctoral Fellowship Program in Business and Management (NDFP)—$10,000 fellowship awarded to the applicant and $5,000 grant to the school to cover student's first-year tuition and fees.

Carlson School of Management Associates Fellowships—For new graduate students in Carlson School of Management. Variable amount.

Carlson School of Management Alumni Fellowships—For new graduate students in the Carlson School of Management. Funded by annual gifts from alumni and friends. Variable amount.

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

Paul Goldsborough, Jr., Fellowship—Awarded to graduate students in the Carlson School of Management. Variable amount.

Ernest Heilman Award—An Outstanding Teacher Award for a Ph.D. student in accounting. $1,000.

Honeywell, Inc., Fellowships—Awarded to several two-year full-time M.B.A. students with undergraduate degrees in engineering and technology. Variable amount.

Honeywell, Inc., Fellowships—Awarded to two-year full-time minority/disadvantaged M.B.A. students. $4,000 per year for two years with summer internship option at Honeywell, Inc.

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

Minnesota Mining and Manufacturing Scholarship—Awarded to an outstanding graduate student in accounting. Variable amount.

Minority/Disadvantaged Fellowship—Awarded to two graduate minority/disadvantaged students annually. Variable up to $5,000.

Carl Nelson Doctoral Award—Awarded to a Ph.D. student in accounting. $1,000.

Price-Waterhouse Scholarship—Awarded to an outstanding graduate student in accounting. Variable amount.

Rosenberg Real Estate Equity Funds (RREEF) Minority/Disadvantaged Fellowship—Awarded to new full-time minority/disadvantaged M.B.A. students pursuing a career in real estate. $5,000.

J. Mearl Sweitzer (Wausau Insurance Companies) Scholarship—For an M.B.A. student concentrating in risk management and insurance. $5,000.

C. E. Tranter Scholarship—Awarded to an outstanding graduate student in accounting. $1,500.

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

CHEMICAL ENGINEERING AND MATERIALS SCIENCE

All chemical engineering and materials science graduate students are considered for fellowships and grants from the following organizations without further application. The criterion for selection is academic excellence.

Allied-Signal Foundation

AMOCO Corporation

Atlantic Richfield Company

Chevron

Dow Chemical Company

DuPont

Eastman Kodak

Exxon Corporation

Fridley Foundation

W.R. Grace Foundation

IBM

Minnesota Mining and Manufacturing Company (3M)

Owens Corning

Shell Companies Foundation

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.

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. $6,552 plus tuition and fees.

NIMH Research Service Award—To prepare continuing doctoral students in child psychology for research careers. Must be U.S. citizen, national, or permanent resident. $4,914 plus tuition and fees.

CIVIL ENGINEERING

Sommerfeld Fellowships—For outstanding graduate students in any branch of civil engineering. Coupled with research assistantship; variable amount.

CLASSICS

John C. Hutchinson Fellowship—To support promising classics students in the study of Greek and Latin language and literature at an advanced level. Typically $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. $6,552 plus tuition and fees.

U.S. Department of Education Assistantships in Audiology—For master's students in audiology. Must be U.S. citizen or national. Approximately $450 per month.

U.S. Department of Education Assistantships in Speech-Language Pathology—For master's and doctoral students in speech-language pathology. Must be U.S. citizen or national. Approximately $450 to $900 per month.

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

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.

COMPUTER SCIENCE

American Electronics Association (AEA) Fellowship/Loan—For doctoral students in computer science interested in a career in teaching. $10,000 a year plus tuition for four years (1st-year graduate student) or for three years (2nd-year graduate student). Forgiven after teaching three years in an accredited college or university.

General Electric Foundation Teaching Incentive Grant—For doctoral students in computer science interested in a career in teaching. Stipends vary. Forgiven after teaching four years in an accredited college or university.

COUNSELING

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

CREATIVE WRITING

See *ENGLISH* below.

DENTISTRY

U.S. Public Health Service-Postdoctoral Training in Dental Caries Research—For applicants who have earned D.D.S., M.D., Ph.D., or equivalent at time of appointment and wish to apply previous basic science or clinical training to learning research techniques appropriate to the study of dental caries. For three years, with stipends ranging from $15,996 to $30,000 (depending on experience).

ECONOMICS

Andreas Fellowships—For students who are citizens of Spain.

Harold Hardy Fellowship—Thesis support for doctoral students.

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

Kidder-Peabody Fellowship—For doctoral students in economics.

Korda Fellowships in the Economics of Public Policy—For incoming students or for support of thesis research in public policy economics.

EDUCATION

Applied Music Scholarship—For music education and music therapy students. Requires application and audition. $300 to $500.

Lois Cram Babcock Scholarship—For female post-baccalaureate and Master of Education (M.Ed.) students in social studies. Nomination by faculty member in social studies is required. $1,000.

Candle Fellowship—Awarded to master's level students in Division of Home Economics Education, Department of Vocational and Technical Education. $750.

Center for Research in Learning, Perception, and Cognition—To prepare doctoral students in child psychology, psychology, educational psychology, and communication disorders in developmental aspects of learning, perception, cognition, and related areas for research careers. Must be U.S. citizens, nationals, or permanent residents. Apply through the Psychology Department. $5,292 plus tuition and fees.

Coffman Alumni Scholarship Awards for Graduate Students—For students in graduate programs of the College of Education. Selection by the graduate faculty in the departments of Child Development, Curriculum and Instruction, Educational Policy and Administration, Educational Psychology, Music Education, Physical Education and Recreation, and Vocational and Technical Education. Deadlines and application procedures same as for Graduate School Fellowship competition (approximately May 1 each year). At least 15 awards. $2,000 each.

Department of Education Advanced Research Training—For graduate students in special education and school psychology for training in advanced research design. $9,104 for twelve months.

Department of Educational Psychology Graduate Student Tuition Grants—For all M.A., Ph.D., and Specialist Certificate students pursuing study in the Department of Educational Psychology. $100 to $300 per quarter.

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. $1,000.

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

Founders Fellowship—For advanced graduate students in the Division of Home Economics Education, Department of Vocational and Technical Education. $1,000.

Home Economics Education Graduate Fellowship—For doctoral level students in home economics education. $2,500.

Home Economists in Business—For graduate student majoring in home economics education with career goals oriented toward working in a business setting. $800.

NIMH School Psychology Traineeship—For graduate students in school psychology. $6,562.

J. Anna Norris Women in Physical Education Scholarship—For graduate or undergraduate women students. Approximately $1,500.

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. $3,000.

President's Research Fellowship—For master's or doctoral level students in the Division of Home Economics Education, Department of Vocational and Technical Education. $750.

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

Wilson Learning Doctoral Fellowship—For new doctoral students studying the role of technology-assisted learning for adults. $8,000 award for the first year, guaranteed graduate assistantship for the second year, opportunity to apply for a $5,000 dissertation fellowship the third year.

EDUCATIONAL PSYCHOLOGY (Duluth Campus)

Educational Psychology Fellowship—For graduate students in educational psychology who have strong academic records and financial need. $100 to $500.

ELECTRICAL ENGINEERING

Fellowships will be offered by this department only to students pursuing the Ph.D.

AEA Fellowship—For doctoral students interested in a career in teaching. $6,000 plus tuition and fees in first year; $10,000 plus tuition and fees in second, third, and fourth years.

Microelectronic and Information Sciences Center Doctoral Fellowships—To attract top doctoral students in electrical engineering specializing in areas related to microelectronic and information science. Must be U.S. citizen or permanent resident. $10,000 plus tuition and fees.

ENGLISH

Edelstein-Keller Teaching/Writing Fellowships—For outstanding writers entering or enrolled in the M.A. program in English with an emphasis in writing. Three appointments combining fellowship support with some work for a total stipend of approximately $8,000.

ENVIRONMENTAL HEALTH

National Institute for Occupational Safety and Health—For graduate students specializing in industrial hygiene and injury prevention. U.S. citizenship or permanent residency required. Up to $6,552 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. Up to $6,552 plus tuition and fees; partial awards also offered.

EPIDEMIOLOGY

Behavioral Aspects of Cardiovascular Diseases Fellowship—For pre- and postdoctoral scholars preparing for research careers. $6,200 to $30,000, 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.

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.

Bob Erickson Memorial Scholarship—Awarded to a graduate student in fisheries or wildlife who is the most outstanding with respect to coursework and research. $850.

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

FORESTRY

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

T. Schantz-Hansen Memorial Research Fellowship—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. Must be U.S. citizen with limited experience living in French-speaking cultures. Offered every other year. $8,500 plus tuition.

Summer Fellowship—Primarily for students in the Department of French and Italian preparing Ph.D. topics or the dissertation. Enables one or two students each summer to concentrate full time on research. Grant is the equivalent of teaching assistant salary for five-week summer session (approximately $2,337.50).

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.

GENETICS AND CELL BIOLOGY

Genetics and Cell Biology Departmental Fellowships—For outstanding new doctoral students in cell and developmental biology or genetics. $8,000 to $9,000 for academic year.

Behavioral Genetics Training Grant—For doctoral students in genetics and psychology to provide training in interdisciplinary research on the role of genetic factors in behavioral disorders and behavioral variation. Limited to U.S. citizens, nationals, and permanent residents. $6,552 plus tuition and fees.

GEOLOGY AND GEOPHYSICS

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

William Harvey Emmons Fund—In part for continuing graduate students in geology and geophysics who have strong academic records and financial need. Up to $2,000.

John W. Gruner Fellowship—For outstanding graduate students in geology and geophysics. Up to $5,000.

Maximillan N. Lando Scholarship—For continuing graduate students in geology and geophysics who have strong academic records and financial need. $500 to $5,000.

GERMAN

Bochum Fellowship—For graduate student in German literature to study for a year at the University of Bochum in West Germany. Approximately 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. Approximately M 1000 per quarter plus room.

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

GERONTOLOGY

All-University Council on Aging/CURA—One award for graduate research on aging related to Minnesota population. Contact All-University Council on Aging. $500.

HEALTH INFORMATICS

NLM Traineeship 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.

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.

William Sterns Davis Memorial Fund—Scholarships for graduate students in history. Variable amount.

History Department Fellowships—For new doctoral students. Approximately $8,000 plus tuition.

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

Robert S. Hoyt Memorial Fellowship—For continuing graduate students in history. Variable amount.

Lothrop Memorial Scholarship—Scholarship aid to deserving students in the Department of History. Variable amount.

Harriet Schoonover Memorial Fellowship—For graduate students in history. $500.

Albert Beebe White Memorial Fund—Graduate students majoring in English Constitutional, English, or American Colonial history. Variable amount.

John B. and Theta H. Wolf Fellowship—Variable amount.

INDUSTRIAL RELATIONS

Chrysler Corporation Fellowship in Industrial Relations—For a master's student in industrial relations. Variable, approximately $2,000.

Sander D. Genis Scholarship—For a graduate or undergraduate student in industrial relations who is focusing on collective bargaining and is interested in a career in the labor movement. Variable, approximately $500.

Herbert G. Heneman, Jr., Fellowship—For a graduate student in industrial relations. Preference to U.S. citizen. Variable, approximately $1,000.

Union Carbide Corporation Scholarship in Industrial Relations—For a master's student in industrial relations. $1,000.

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.

MASS COMMUNICATION

Carroll Binder Memorial Award—For currently enrolled undergraduate or graduate students in mass communication who show promise in reporting or in international news and who expect to go into newspaper work. Variable amount.

Grace Bliss Memorial Scholarship—For master's students in mass communication who show evidence of outstanding professional performance. Variable amount.

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.

Fred and Lucille Kildow Scholarship—For currently enrolled graduate students in mass communication. Amount varies.

F. Gerald Kline Memorial Scholarship—For graduate students in mass communication with primary emphasis on communication theory and research methodology. Amount varies.

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.

David Donhowe Shippee Memorial Scholarship—For undergraduate or graduate students in visual communication. Based on performance, potential, and financial need. Amount varies.

Silha Center Fellowship in Ethics and Law—For doctoral students in mass communication who have demonstrated interest and ability in mass communication ethics or law. Up to $10,000.

David Silverman Memorial Scholarship—For juniors, seniors, or graduate students in the news-editorial field who show evidence of special promise of outstanding professional performance. Amount varies.

WCCO Scholarship for Minorities in Broadcasting—For undergraduate and master's students in broadcast journalism. Available to U.S. citizens or permanent residents who are members of racial or cultural minorities. $2,700 for graduate students.

MATHEMATICS

Lando Fund—For doctoral students in mathematics for summer support. $1,700 to $2,100.

NSF Research Funds—For doctoral students in mathematics for summer support. $1,700 to $2,100.

Ella Thorpe Fund—For doctoral students in mathematics for summer support. $1,700 to $2,100.

MECHANICAL AND INDUSTRIAL ENGINEERING

Mechanical Engineering Departmental/Industrial Fellowships—Support from General Electric Foundation, Shell Oil Company Foundation, and McDonnell Douglas Corporation. Applicants must be involved in thesis research/writing. Variable amounts.

Microelectronic and Information Sciences Center Fellowship—For graduate students in mechanical engineering specializing in semiconductor manufacturing sciences. Must be U.S. citizen or permanent resident. Variable amounts.

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. $6,550 plus tuition and fees, supplemented by the department to a total stipend of approximately $10,000.

Dennis W. Watson Fellowship—For outstanding entering graduate student in honor of Regents' Professor Emeritus and former department head Dennis W. Watson. $12,000.

MICROELECTRONIC AND INFORMATION SCIENCES

American Electronics Association (AEA) Fellowship/Loan—For doctoral students in computer science or electrical engineering interested in a career in teaching. $10,000 a year plus tuition for four years (1st-year graduate student) or three years (2nd-year graduate student). Forgiven after teaching three years in an accredited college or university.

General Electric Foundation Teaching Incentive Grant—For doctoral students in computer science or electrical engineering interested in a career in teaching. Stipends vary. Forgiven after teaching four years in an accredited college or university.

Microelectronic and Information Sciences Center Fellowship—For graduate students in chemical engineering and materials science, electrical engineering, or mechanical engineering specializing in semiconductor manufacturing sciences. Must be U.S. citizen or permanent resident. Variable amounts.

MINERAL AND METALLURGICAL ENGINEERING

Mineral Institute Research Fellowships—To support graduate and postdoctoral research in a broad range of mineral-metallurgical engineering disciplines. Apply through Mineral Resources Research Center. Approximately $13,000.

MUSIC

Graduate Music Scholarship—For graduate students in all areas of music. Performance awards require audition. $300 to $1,500.

Paul Oberg Graduate Music Award—For graduate students in music who exhibit excellence in scholarly research. Variable amounts.

NURSING

Nan Dempster Scholarship—For a graduate student in nursing who has completed twelve credits of graduate study with a 3.50 GPA. $1,000 minimum.

PEDIATRICS

Pediatrics Fellowships—For master's students engaged in subspecialty post-residency training in pediatrics. Variable amounts.

PHARMACOLOGY

National Research Service Award—For doctoral students in pharmacology and toxicology. $10,000 plus tuition.

PHARMACY

American Foundation for Pharmaceutical Education Graduate Fellowships—For U.S. citizens. $5,000 plus fees.

S. W. Melendy Fellowship—For graduate students engaged in programs offered through the College of Pharmacy to provide summer support. Maximum $600.

National Institutes of Health National Research Service Awards—Predoctoral traineeships for graduate students in medicinal chemistry. For U.S. citizens. Requires one year of service for each year award is held. $5,040 plus tuition and fees.

Ted Rowell Fellowship—For graduate students engaged in programs offered through the College of Pharmacy. Variable amount.

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.

Physics and Astronomy Fellowships—For new graduate students in physics and astronomy.

IT Corporate Fellowships—For new graduate students in the Institute of Technology. Preference for U.S. citizens. $6,000 plus tuition and fees with 25 percent time teaching assistantship offered simultaneously.

Microelectronic and Information Sciences Center Doctoral Fellowship—For new graduate students in physics specializing in areas related to microelectronic and information sciences. Must be U.S. citizen or permanent resident. $10,000 plus tuition and fees.

PLANT PATHOLOGY

Thomas French Graduate Student Travel Award—For graduate students in plant pathology to attend special meetings in which they might not otherwise be able to participate. Variable amounts.

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. $100.

Hubert H. Humphrey Fellowship—For doctoral students with distinguished records in political science. Up to $8,000.

Clara H. Ueland Memorial Fellowship—For female doctoral student with distinguished record in political science. Up to $8,000.

Vernie Wolfsberg Fellowship—For female doctoral student with distinguished record in political science. Up to $8,000.

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. $6,552 plus tuition and fees.

Counseling Psychology-University Counseling Services—To provide APA-approved predoctoral internships for clinical and counseling psychology students. Internship is a 12 month full-time position for $13,000. Apply through Training Program Director, University Counseling Services. Typical deadline is December 15 for the following year.

Counseling Psychology-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. $10,000 for 1900 hours.

PUBLIC AFFAIRS

Gerald W. Heaney Fellowship or Scholarship—Award made on basis of academic merit. Applicants should be from Duluth, the Duluth area, or northeast Minnesota. Up to $9,000 plus tuition first year; with satisfactory performance, up to $3,700 plus tuition second year.

Hubert H. Humphrey Fellowships and Scholarships in Public Affairs—For outstanding graduate students preparing for careers in public service. Up to $9,000 plus tuition first year; with satisfactory performance, up to $3,700 plus tuition second year.

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

Albert R. Rathert Graduate Fellowship in Public Management—Award on basis of academic merit. Applicants must be U.S. citizens; must be a second-year graduate student or have held an administrative position at any level of government or in educational or nonprofit organizations for at least three years preceding the fellowship award. Full-time enrollment required. Approximately $3,700 per year plus tuition.

Joseph Robbie Fellowship 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.

PUBLIC HEALTH

Federally funded traineeships are available in all 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.

SOCIAL WORK

A small number of training fellowships from federally funded grants, paid field placements from local agencies, and assistantships are directly available from the School of Social Work. Number of awards and amounts vary from year to year; none available on recurring basis.

SOUTH AND SOUTHWEST ASIAN STUDIES

Foreign Language and Area Studies Fellowships—For graduate students in any department or professional school who study a language of South or Southwest Asia. $5,000 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.

THEATRE ARTS

Oscar W. Firkins Scholarship—For currently enrolled graduate students in theatre arts. Award based on service, potential in theatre, and need. Approximately $1,000.

Kenneth L. Graham Graduate Theatre Fellowship—For an outstanding graduate theatre major in residence. Approximately $600.

Elsie Kelley Lindquist Scholarship—For an outstanding undergraduate or graduate theatre major in residence. Award based on service, potential in theatre, and need. Approximately $400.

Frank M. Rarig, Sr., Graduate Fellowship in Oral Interpretation—For a currently enrolled, worthy graduate student with a major interest in oral interpretation. Approximately $500.

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 the area of technical theatre. Approximately $500.

Frank and Josinette Whiting Scholarship—For an outstanding undergraduate or graduate major in residence. Award based on service, potential in theatre, and need. Approximately $500.

WESTERN EUROPEAN STUDIES

Foreign Language and Area Studies Fellowships—Applications welcome from graduate students from any discipline or professional school with a research interest in Western Europe who are studying a modern Western European language (contact the Center for details regarding restrictions). Must be U.S. citizen. Apply through Western European Area Studies Center, 314 Social Sciences. Stipend plus tuition and fees.

OTHER FELLOWSHIPS

Foreign Language and Area Studies Fellowships—See South and Southwest Asian Studies and Western European Studies above.

Miscellaneous Assistance

Honorary Fellowships—Professors or other eminent scholars who are not candidates for degrees and who desire temporarily the privileges of using library or research facilities or attending seminars of the University may, upon recommendation of the dean of the Graduate School and approval of the president of the University, be appointed honorary fellows without stipend.

Honorary fellows are not required to pay any fees but are responsible for the cost of unusually expensive supplies or equipment.

Postdoctoral Associates—Postdoctoral fellows who are not already entitled to normal faculty privileges can be appointed by the Graduate School as postdoctoral associates. These positions carry no stipend from the Graduate School but do entitle associates to use University facilities, to purchase athletic tickets at the staff rate, and, if they have private health insurance, to join the Health Service plan for outpatient care.

Nomination forms for this appointment are available from the Office of the Dean, Graduate School, 321 Johnston Hall.

Visiting Scholars—Regular faculty members of Minnesota public and private colleges who are not studying for advanced degrees and who desire temporarily the privileges of using library facilities or attending day school courses (as auditors) can be appointed by the Graduate School as visiting scholars without stipend. Interested individuals will be granted appointments on receipt of a let-

ter to the dean of the Graduate School from their academic dean or vice president verifying their faculty status and field of specialization.

Student Employment—The University's Student Employment Center offers graduate students a wide range of nonacademic employment opportunities both on campus and throughout the Twin Cities area. To be eligible, graduate students must be registered for a minimum of 3 credits per quarter or be registered under "continuous registration" or "student status."

In addition to University employment services, the Center operates special programs for off-campus employment: the Job Location and Development Program helps locate career-related opportunities with private and public employers in the Twin Cities; the Community Service Program helps arrange employment with nonprofit organizations and agencies. Students who prefer more flexibility may apply through the Student Temporary Service and the Student Temporary Microcomputer Service. All jobs are posted outside the Student Employment Center, 120 Fraser Hall, 106 Pleasant Street S.E., Minneapolis, MN 55455 (612/624-8070).

Office of Student Financial Aid—To apply for financial aid, graduate students must complete the American College Testing Family Financial Statement (ACT-FFS), available from the financial aid office each year. Graduate students will be considered for funding from the University Loan (UL), Perkins Loan, College Work-Study (CWS), Guaranteed Student Loan (GSL), Supplemental Loan for Students (SLS, formerly ALAS), and Student Educational Loan Fund (SELF) programs.

Awards are based on financial need and full-time enrollment status. Aid from the UL, Perkins, and CWS programs is awarded as applications become complete and until all funds have been spent. You are encouraged to apply as soon after January 1 as possible 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, contact Graduate/Professional Programs, Office of Student Financial Aid, 210 Fraser Hall, University of Minnesota, 106 Pleasant Street S.E., Minneapolis, MN 55455, or 197 Coffey Hall, University of Minnesota, 1420 Eckles Avenue, St. Paul, MN 55108.

International Students and Scholars—Counseling, advising, and educational services are provided for students and scholars from other countries by the Office of International Education (OIE). 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, testing, and programs. The OIE coordinates a variety of special programs, including orientation, English as a second language, and cross-cultural training/programming for faculty, staff, students, and the community. All prospective international students and scholars are invited to address inquiries to the Office of International Education, University of Minnesota, 717 East River Road, Minneapolis, MN 55455.

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, 210 Delaware Street S.E., Minneapolis, MN 55455 (612/624-2994). Listings of apartments, duplexes, houses, sleeping rooms, shared units, and sublets are 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 at a minimal cost.

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

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 ROTC 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).

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. The policy also permits students to review their educational records and to challenge the contents of those records.

Some student information—name, address, telephone number, dates of enrollment and enrollment termination, college and class, academic awards and honors received, major, adviser, and degrees earned—is considered public or directory information. To prevent release of such information outside the University while in attendance at the University, a student must notify the records office on his or her campus.

Students are notified annually of their right to review their educational records. The regents' policy, including a directory of student records, is available for review at the Information Center in 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).

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 the placement office 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, student personnel work, and research. Non-education graduate students seeking college teaching positions are eligible to establish placement files. The address of the Education Student Affairs Office is 1425 University Avenue S.E., Minneapolis, MN 55414 (612/625-5545).

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

College of Agriculture
Career Services
272 Coffey Hall
University of Minnesota
1420 Eckles Avenue
St. Paul, MN 55108
612/624-2710

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

School of Dentistry
Minnesota Dental Placement Service
15-136 Moos Health Sciences Tower
University of Minnesota
515 Delaware Street S.E.
Minneapolis, MN 55455
612/625-5138

University of Minnesota, Duluth
Counseling, Career, and
Placement Services
255 Darland Administration Building
University of Minnesota
Duluth, MN 55812
218/726-7985

College of Forestry
Career Opportunities Coordinator's Office
135 Natural Resources Administration Building
University of Minnesota
2003 Upper Buford Circle
St. Paul, MN 55108
612/624-6247

College of Home Economics
Career Services Center
Jeanne Exline, Director
37 McNeal Hall
University of Minnesota
1985 Buford Avenue
St. Paul, MN 55108
612/624-6762

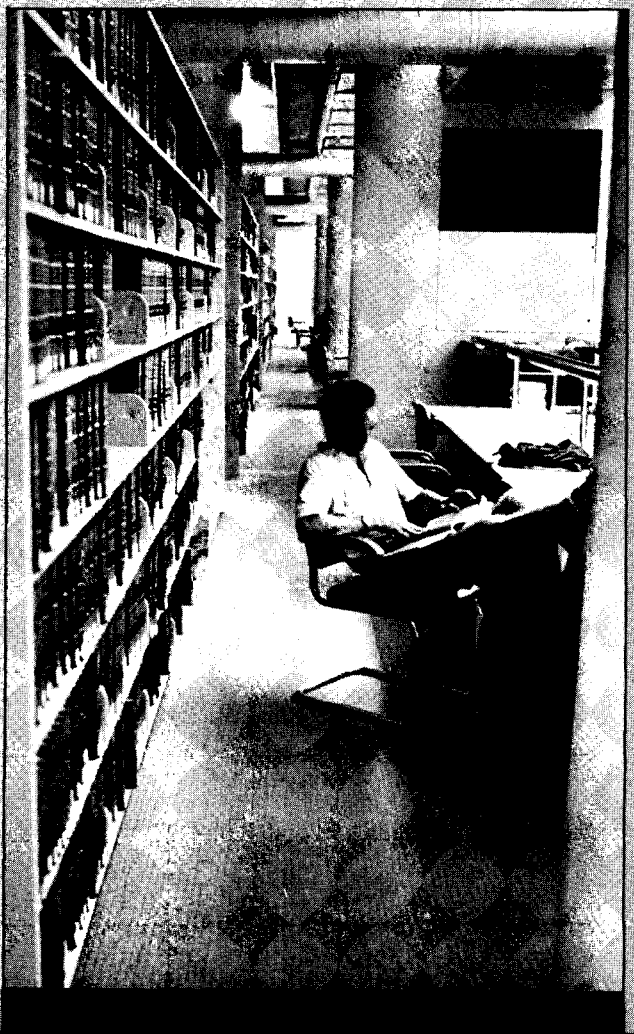
School of Journalism and Mass Communication
Placement Office
15 Murphy Hall
University of Minnesota
206 Church Street S.E.
Minneapolis, MN 55455
612/625-0833

College of Liberal Arts
Career Development Office
345 Fraser Hall
University of Minnesota
106 Pleasant Street S.E.
Minneapolis, MN 55455
612/624-7505

School of Management
Office of Career Planning and Placement
190 Hubert H. Humphrey Center
University of Minnesota
301 19th Avenue South
Minneapolis, MN 55455
612/624-0011

Institute of Technology
Placement Office
Lind Hall
University of Minnesota
207 Church St. S.E.
Minneapolis, MN 55455
612/624-4090

Fields of Instruction



Fields of Instruction

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: James B. Serrin (mechanics)

Professor: Patarasp R. Sethna, *head;* Philip G. Hodge, Jr., *director of graduate studies*; Theodore A. Wilson, *director of admissions;* Roger E. A. Arndt (aerospace engineering); Gordon S. Beavers; Jerald L. Ericksen; Roger L. Fosdick; C.C. Hsiao; Daniel D. Joseph; Thomas S. Lundgren; Mitchell B. Luskin; Robert Plunkett (emeritus); William H. Warner

Associate Professor: William L. Garrard, *associate head*; Richard D. James; John P. Moran; Eugene Stolarik (aerospace engineering); Tayfun E. Tezduyar

Assistant Professor: Hiroshi Higuchi

Adjunct Assistant Professor: Dale F. Enns

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., and Ph.D.; Mechanics: M.S. (Plan A and Plan B) and Ph.D.

Curriculum—In aerospace engineering, emphases include aerodynamics, aerospace structures, astrodynamics, control theory, dynamical systems, fluid mechanics, gas dynamics, and stability theory. In mechanics, emphases include composites, continuum mechanics, control theory, dynamics, dynamical systems, elasticity, fluid mechanics, fracture mechanics, plasticity, stability theory, vibrations, and viscoelasticity.

Prerequisites for Admission—For the M.Aero.E. program, a four-year B.S. degree from an accredited engineering program is required. For the other programs, an engineering degree is not required, although applicants must have adequate preparation in the fundamental engineering sciences (mathematics, physics, mechanics, and chemistry).

Special Application Requirements—Graduate Record Examination scores (for both the General Test and the Subject Test in engineering) are recommended for all students and are required for students whose degrees are not in engineering.

Master of Science Degree Requirements—In aerospace engineering and mechanics, Plan B project requirements may be met in connection with any graduate course or seminar, or with independent work completed under faculty supervision, subject to prior approval from the student's adviser and the faculty member supervising the project. Three quarters of colloquium attendance are required. The M.S. program can normally be completed in one year of full-time study. The final examination is oral.

Master of Aerospace Engineering Degree Requirements—This degree program is primarily for students interested in advanced training with a professional or applied emphasis. The program involves both coursework and a project. Three quarters of colloquium attendance are required. See Professional Master's Degree in Engineering in the General Information section of this bulletin.

Doctoral Degree Requirements—A Ph.D. program must contain a minimum of 64 credits of approved courses and six quarters of colloquium attendance. Programs are designed by the student and the adviser to develop appropriate skills in research and scholarship. In aerospace engineering, students normally concentrate a large portion of their work in one of the emphases. In mechanics, programs include one or more emphases.

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—Contact the director of graduate studies or director of admissions, Department of Aerospace Engineering and Mechanics, 107 Akerman

Hall, University of Minnesota, 110 Union Street S.E., Minneapolis, MN 55455.

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

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5200. KINEMATICS AND DYNAMICS OF FLUID FLOW. (4 cr; prereq mathematics including differential equations and linear algebra)
Kinematics of fluid flow including continuity equation, vorticity, circulation, velocity potential, source and doublet. Application of Gauss and Stokes theorem to fluid flow. Flow about cylinder. Potential flow in two and three dimensions. Dynamics, Euler equation, Bernoulli equation. Aerostatics.

5201. SHOCK WAVES AND COMPRESSIBLE FLUID FLOW. (4 cr; prereq 5200)
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.

5202. INCOMPRESSIBLE BOUNDARY LAYER THEORY. (4 cr; prereq 5200)
Curvilinear coordinate systems, cylindrical and spherical. Viscous incompressible flow. Thin airfoil theory. Stress and strain rate. Navier-Stokes equations. Boundary layer equation and Blasius solution. Von Karman momentum integral. Pohlhausen method. Turbulent boundary layer.

5206. AERODYNAMICS OF LIFTING SURFACES. (4 cr; prereq 5200, knowledge of FORTRAN recommended or #)
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 5201 or #)
Elementary kinetic theory. 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 5206)
Topics in advanced aerodynamics selected from the following: potential flow, hypersonic flow, compressible boundary layer flow, one-dimensional flow with friction and heat addition, real gas effects.

5250. COMPUTATIONAL FLUID MECHANICS. (4 cr; prereq FORTRAN and 5206 or #)
Methods for solving practical problems in aerodynamics that require use of large, high-speed computers. Emphasis on utilization of methods and results rather than on mathematical analysis.

5300. FLIGHT MECHANICS. (4 cr; prereq 5206)
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. Introduction to longitudinal dynamics.

5319. DYNAMIC STABILITY OF AEROSPACE CRAFT. (4 cr; prereq 3401, 5206)
Static stability coefficients and derivatives about the three main axes. Equations of motion for six degrees of freedom. Decoupled equations of motion about the longitudinal axis, specific and generalized. Effect of elevator and rudder powers, stick-fixed and stick-free conditions. Routh discriminant. Aerospace vehicle working equations and solutions. Vehicle response to control actions.

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.

5329. FUNDAMENTALS OF AIRCRAFT DESIGN. (4 cr; prereq 5300 or #, AEM sr)
Aircraft design considerations, mission analysis, estimates of weights and wing loading, airfoil and platform selection, fuselage and tail sizing, propulsion system sizing, material selection, control surface placement and sizing. Students prepare a conceptual design of an aircraft as course project.

5330, 5331. DESIGN OF AEROSPACE ELEMENTS AND SYSTEMS. (4 cr per qtr; prereq 4th-yr engineering major and #)
Interdisciplinary projects with students from other departments.

5359. DECELERATION OF AEROSPACE CRAFT. (4 cr; prereq 3036, 5200)
Aircraft approach and landing run with parachutes, reverse pitch propellers, jet thrust reversers. Terrestrial and reentry trajectories. Systems for aerial delivery and space recovery. Aircraft antispin parachutes. Aerodynamic characteristics of parachutes. Screen drag of porous sheets. Interaction between screen drag and parachute aerodynamic characteristics.

5370, 5371. AERODYNAMICS OF V/STOL FLIGHT. (4 cr per qtr; 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 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, multiple-degree-of-freedom dynamical systems.

5440. INTERMEDIATE DYNAMICAL SYSTEMS. (4 cr; prereq 5438)
Application of Lagrangian methods to multi-degree of freedom systems; vibrations of strings, rods, shafts, and beams; frequency and time domain analysis of multi-degree of freedom mechanical systems.

5515. AEROSPACE STRUCTURES I. (4 cr; prereq 3016)
Elastic analysis of components important to aerospace structures. Plane stress analysis of composites. Torsion and bending of thin-walled structural members. Castigliano method for trusses and beams. Stability and buckling.

5516. AEROSPACE STRUCTURES II. (4 cr; prereq 5515 or #)
Extension of structures considered in 5515 to design problems, inelastic behavior, and computer solution of moderate size examples.

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. INTRODUCTION TO THE MECHANICS OF SOLIDS. (4 cr; prereq 3016 or #)
Linear theory of strain and stress in two dimensions. Stress-strain relations (plane stress) for elastic and perfectly plastic materials. Plane-stress beam solutions; St. Venant principle. Rotationally symmetric solutions in plane stress. Three-dimensional strain, stress, and constitutive relations. Simple exact solutions. Plane stress and plane strain as three-dimensional problems.

5581, 5583. MECHANICS OF SOLIDS II, III. (4 cr per qtr; prereq 5580 or # for each)
Virtual work, minimum potential and complementary energy with applications. Torsion of prismatic bars, thermoelasticity. Waves and vibrations. Plastic limit analysis for plane stress and simple structures; creep and relaxation phenomena, linear viscoelasticity; approximate solution techniques based on energy methods; technical theory of curved bars, plates, and shells.

5642. ELEMENTARY AEROMECHANICS LABORATORY. (2 cr; prereq 5200, 3016, aerospace engineering major)
Basic measurement techniques in aeromechanics. Material properties, manometers, pitot tubes, strain gages. Simple experiments illustrating basic principles of aeromechanics.

5645, 5646, 5647. AEROMECHANICS LABORATORY I-II-III. (2 cr per qtr; prereq 5200, 3016, upper div IT student)
Subsonic and supersonic wind tunnel experiments including lift and drag measurements, flow-visualization methods, pressure measuring techniques, and boundary layer measurements. Viscous flow experiments. Vibrations. Analog methods. Rheological and strength properties of materials and structures.

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. FUNDAMENTALS OF ACOUSTICS. (4 cr; prereq Phys 1291 or equiv, Math 3221 or equiv)
Derivation of the wave equation, plane wave solution, dissipative and nonlinear effects, energy and momentum balance, reflection and transmission at boundaries, resonators, spherical waves, multipole analysis.

5688. INTERMEDIATE ACOUSTICS. (4 cr; prereq 5687)
Wave propagation in inhomogeneous media with application to atmospheric and underwater acoustics, propagation in ducts, Kirchoff solution to the inhomogeneous wave equation, radiation from moving sources including rotating machinery.

5689. SPECIAL TOPICS IN ACOUSTICS. (4 cr; prereq 5688)
Selected topics of current interest to students and staff.

5800, 5801, 5802 PROBLEMS IN MECHANICS AND MATERIALS. (1-4 cr per qtr; prereq △)
Topics of current interest. Individual projects.

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

8207. HYDRODYNAMIC STABILITY AND BIFURCATION I. (4 cr; prereq 8201 or #; offered alt yrs) Joseph
Global stability and uniqueness. Instability and bifurcation into steady and periodic solutions. Floquet theory and stability of time periodic solutions. Bifurcating tori and nonperiodic attractors. Stability and bifurcation of parallel and nearly parallel flow. Stability and bifurcation of spiral flow between rotating cylinders and spheres.

8208. HYDRODYNAMIC STABILITY AND BIFURCATION II. (4 cr; prereq 8207 or #; offered alt yrs) Joseph
Bifurcation of conduction into motion in a container of fluid heated from below. Bifurcation and stability of bifurcation at eigenvalues of higher multiplicity. Variational theory of turbulence. Laminar and turbulent comparison theorems. Global and linear analysis of interfacial stability. Buckling of cylindrical and plane jets.

8209. ROTATING FLUIDS. (3 cr; prereq background in fluid mechanics especially boundary layer theory; offered when feasible) Lundgren
Geostrophic flow. Eckman layer. Stewartson layer. Spin up. Stratified flow. Application to geophysical flows.

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. TURBULENCE LABORATORY. (1-2 cr; prereq 5645 or #, 8217 or #; offered alt yrs)
Experiments in turbulent flows, including homogeneous turbulence, turbulent shear flows, and boundary layer separations. Flow visualization, hot-wire technique, and Laser Doppler Anemometry. Introduction to digital data acquisition system.

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.

8230. ADVANCED GAS DYNAMICS. (3 cr; prereq 8203 or #; offered alt yrs) Joseph
Transonic and hypersonic flow. Transonic similarity rules. Curved shocks. Real gas effects.

8240. PERTURBATION METHODS IN FLUID MECHANICS. (3 cr; prereq 8202 or #; offered alt yrs) 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.

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

8285. SELECTED TOPICS IN RAREFIED GAS DYNAMICS. (3 cr; prereq 5240, 8201 or #; offered when feasible)
Solutions of the Boltzmann equation are sought in the transition regime; i.e., when the mean free path is too small to neglect molecular encounters (free molecule flow). Methods used are extensions of the Chapman-Enskog expansion to lower densities, extensions of free molecular flow to higher densities, and the use of model equations and approximate moment methods. Topics include shockwave structure, high-frequency sound propagation, low density Couette flow, Knudsen layer, and others.

8410. ADVANCED DYNAMICS. (4 cr; prereq 5438 or #; offered alt yrs) Warner
Kinematics and dynamics of particle and rigid body systems, Lagrange equations, Routhian and Hamiltonian mechanics, canonical equations, Hamilton-Jacobi theory. Dissipative, gyroscopic, and circulatory systems. Elements of Liapunov theory.

8411. LINEAR SYSTEMS. (4 cr; prereq 5438 or #) Warner
Analysis of high order linear systems. Applications to motion in the neighborhoods of equilibrium and steady motion. Diagonalization procedures, Jordan forms and normal modes. Vector-matrix formulation and fundamental matrix solutions, linear optimal control theory, Floquet theory.

8412. NONLINEAR SYSTEMS. (4 cr; prereq 8411 or #) Sethna
General properties of nonlinear dynamical systems. Critical points and phase space analysis. Poincaré perturbation theory. Asymptotic methods and the method of averaging. Oscillatory phenomena in autonomous and nonautonomous systems. Bifurcations in nonlinear systems. Introduction to center manifold theory and theory of normal forms.

8413-8414-8415. DYNAMICAL SYSTEMS IV, V, VI (ADVANCED TOPICS). (3 cr per qtr; prereq 8411, 8412 or #; offered when feasible) Garrard, Sethna, Warner
Advanced topics in such areas as nonlinear oscillation theory; calculus of variations and optimum control theory; theory of stability of dynamical systems—Liapunov theory; celestial mechanics and applications; classical mechanics, state observers, advanced frequency response techniques; application of optimal control theory to aerospace systems; theory of integral manifolds; bifurcation theory.

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

8510. CONTINUUM MECHANICS I. (4 cr; prereq #) Fosdick
Concepts that are common to all continuous media. Elements of tensor analysis. Motion, deformation, and the local concepts of strain, rotation, spin, 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
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) Hodge
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) Ericksen
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.

8541. VISCOELASTICITY. (4 cr; prereq 8540 or #; offered when feasible) Hsiao
Statistical behavior of material systems, infinitesimal viscoelasticity, second-order viscoelasticity. Stress analysis in viscoelasticity. Solutions to some viscoelastic problems. Thermal viscoelastic behavior.

8570. FRACTURE MECHANICS. (4 cr; prereq #; offered alt yrs) Hsiao
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, #) Ericksen, 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.

8588. THEORY OF LIQUID CRYSTALS. (3 cr; prereq 8510 or #; offered alt yrs) Ericksen
Static and dynamic continuum theory of liquid crystals. Analyses of typical experiments and devices. Methods for controlling orientation. Theory of defects.

8589. MECHANICS OF CRYSTALLINE SOLIDS. (3 cr; prereq 8510 or #)
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
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
(Continuation of 8594) Contact stress; finite deformations; other special topics.

8596. ELASTODYNAMICS. (4 cr; prereq 5580 or 8510 or #; offered alt yrs) Fosdick, James
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, #)
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)
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 △)
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 △)
Topics of current interest. Individual student projects completed under guidance of faculty sponsor.

8880. PLAN B PROJECT. (1-4 cr [max 4]; prereq grad major in aerospace engineering or mechanics and △)
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)

Professor: Michael D. Boehlje, *head;* Vernon R. Eidman, *director of graduate studies;* Dale C. Dahl; Reynold P. Dahl; K. William Easter; Kenneth E. Egertson; Earl I. Fuller; Hans M. Gregersen; Jerome W. Hammond; James P. Houck; Jean L. Kinsey; Wilbur R. Maki; Glenn L. Nelson; Willis L. Peterson; Philip M. Raup (emeritus); Terry L. Roe; Vernon W. Ruttan; G. E. Schuh; Benjamin H. Senauer; Francis J. Smith, Jr. (emeritus); Thomas Stinson; W. B. Sundquist; Kenneth H. Thomas; John J. Waelti; Arley D. Waldo; Delane E. Welsch

Associate Professor: Jeffrey D. Apland; Buddy G. Crewdson; Jeremiah F. Fruin; Robert P. King; Richard A. Levins; Glenn D. Pederson; C. Ford Runge; Harald von Witzke

Assistant Professor: Karen M. Brooks; Theodore D. Graham-Tomasi; William F. Lazarus; Kent D. Olson; Claudia D. Parliament; Jo Ann Paulson; Stanley C. Stevens; Steven J. Taff

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 are: production economics and farm management, agricultural business management, agricultural finance, agricultural development, agricultural marketing, agricultural prices, agricultural policy, consumption economics, economics of public services, regional economics, and resource economics.

Prerequisites for Admission—An undergraduate grade average of B or better is normally required. Students lacking background work in economics, mathematics, and statistics may be required to complete deficiencies before acceptance in the graduate program or while concurrently working on their graduate programs.

Special Application Requirements—Graduate Record Examination scores are required for domestic students. A minimum TOEFL score of 550 is required for applicants whose native language is not English. Applicants should provide evidence of superior scholarship, professional experience, and general aptitude for graduate study.

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

A minimum grade point average 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 three subfields 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 public services, and consumption economics.

Students must complete work in quantitative techniques (e.g., statistics and mathematical techniques). The written preliminary examinations cover economic theory and subfields of agricultural economics.

Language Requirement—None.

Minor Requirements for Students Majoring in Other Fields—A minor in agricultural and applied economics must include micro and macro theory courses from the Department of Economics at the intermediate level (5151 and 5152) or higher. Other courses are chosen by the student and major and minor advisers and must be approved by the director of graduate studies. Written examinations for both M.S. and Ph.D. students minoring in agricultural and applied economics may be required at the discretion of the major and minor adviser. Ph.D. students majoring in economics who select a minor in agricultural and applied economics are required to pass the written preliminary examination for the Ph.D.

For Further Information—Contact the director of graduate studies, Department of Agricultural and Applied Economics, 231 Classroom Office Building, University of Minnesota, 1994 Buford Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5020. APPLIED LINEAR PROGRAMMING. (3 cr; prereq 1030 and Math 1111 or 1131)
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.

5099. RCD INTERDISCIPLINARY SEMINAR I. (4 cr, 5099-5100†, §RCD 5099, §AgET 5099, §LA 5099, §Soil 5099; prereq RCD sr or #)
Speakers, readings, and discussion topics relating to resource and community development analysis and implications for resource allocation. Students participate as a team to analyze complex resource problems.

5100. RCD INTERDISCIPLINARY SEMINAR II. (4 cr, 5099-5100†, §RCD 5100, §AgET 5100, §LA 5100, §Soil 5100; prereq 5099 or #)
(Continuation of 5099) Papers, presentations, and critiques on selected complex resource problems in 5099.

5104. AGRICULTURAL SYSTEMS ANALYSIS AND MODELING. (4 cr, §Soil 5104, §PlPa 5104, §AnSc 5104; prereq Math 1142 or #)
Introduction to bioeconomic modeling as preparation for interdisciplinary agricultural systems analysis. Basic concepts; deterministic and stochastic models, delays, feedback and clockwork; data acquisition, model verification and validation; role of models for agroecosystems management.

5400. INTERMEDIATE MARKET AND PRICE ANALYSIS. (3 cr; prereq 1400 or 3101 or Econ 3101 or Econ 5151)
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. (3 cr; prereq 1400)
Economic problems and issues facing agricultural cooperatives, including changing market organization, financing, taxation, antitrust regulations, and others.

5480. FUTURES MARKETS AND PRICES. (3 cr; prereq 1400 or #)
Economics of cash and futures trading on organized markets; futures trading theory; hedging and speculation.

5500. ADVANCED AGRICULTURAL FINANCE. (3 cr; prereq 3500)
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 MARKET ECONOMICS. (3-4 cr, §FScN 5474; prereq 3101 or #)
Economics of food marketing in U.S. 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. ECONOMIC ORGANIZATION OF THE HOUSEHOLD. (3 cr; not open to agricultural economics majors; prereq 1030 or Econ 1002)
Economic concepts applied to analysis of household production, market and nonmarket work, family formation and size, and household consumption activity.

5600. LAND ECONOMICS. (3 cr; prereq 3101, 3102 or Econ 3101, 3102 or #)
Land as a factor of production; land use, classification, and value; sale and rental markets for land; domestic and foreign land policies.

5620. REGIONAL ECONOMIC ANALYSIS. (3 cr; prereq 1030 or Econ 1002)
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 1030 or Econ 1002)
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. (3 cr; prereq 3101 or Econ 3101)
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 POLICY. (3 cr; prereq 3101 or Econ 3101 or Econ 5151 or #)
Application of economic analysis, including project evaluation, to current natural resource issues. Emphasis on conservation and resource scarcity, environmental quality, population growth, and resource use issues and their implications for public policy.

5660. ECONOMICS OF PUBLIC SERVICES. (3 cr; prereq 3101 or Econ 3101 or Econ 5151 or #)
Introduction to issues of finance and supply and demand for public services; pricing, producing, and financing public goods; bureaucratic decision making; implementation of policies.

5670. ECONOMICS OF AGRICULTURAL TRANSPORTATION. (3 cr; prereq 3101 or #)
Application of economic analysis to current issues in agricultural and rural transportation policy. Relationship between transportation infrastructure, economic development, and regional and national trade.

5720. ECONOMICS OF WORLD AGRICULTURE. (3 cr; prereq AgEc/Econ 3101, AgEc/Econ 3102, or #)
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 AND EUROPEAN FOOD AND AGRICULTURAL POLICIES. (3-4 cr)
Characteristics of agriculture in Europe; determinants of the development of European agriculture; goals and instruments of European agricultural policy.

5740. AGRICULTURAL POLICY IN PLANNED ECONOMIES. (3-4 cr; prereq 3101 or Econ 3101 or #)
Principles of economics used to analyze agricultural policy and performance in centrally planned economies. Emphasis on Soviet agriculture, but some attention to China and Eastern Europe.

5750. AGRICULTURAL TRADE AND COMMERCIAL POLICY. (3 cr; prereq 3101, 3102 or Econ 3101, 3102)
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 SUPPLY PROBLEMS. (3 cr, §Agro 5200, §Soc 5675, §LACS 5280, §FScN 5643)
A multidisciplinary examination of social, economic, and technical problems of feeding the world's growing population. Principles sought from the economic and social sciences, plant sciences, and animal sciences for their application to food problems.

5840. MANAGEMENT OF THE FARM BUSINESS. (3 cr; prereq 3820 and 3830, 3850 recommended)
Decision-making procedures under conditions of uncertainty; development of an information system to monitor and control the ongoing operation; control of crop and livestock enterprises; labor management; cash flow management.

5860. ECONOMICS OF AGRICULTURAL PRODUCTION. (3 cr; primarily for grad students; prereq 21 cr in economics or agricultural economics)
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 #)
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 #)
Special classes, independent study, and supervised reading and research on subjects and problems not covered in regularly offered courses.

8200. ADVANCED TOPICS IN AGRICULTURAL AND APPLIED ECONOMICS. (1-9 cr [may be repeated for cr])
Special seminars or individual work on subject suited to needs of particular groups of students.

8205. RESEARCH METHODOLOGY IN AGRICULTURAL ECONOMICS. (3 cr)
Examination of various philosophical positions in research; methodological problems in social science generally and in agricultural economics specifically.

8220. APPLIED MATHEMATICAL PROGRAMMING. (3 cr; prereq Math 1142 or equiv, Econ 5151 or #)
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)
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, 5152 or #)
Economic theory and analytical tools used in coordinated, cross-commodity analysis of marketing of farm supplies and products; factor-product relationships under varying conditions of imperfect competition, structure-conduct-performance relationships in agricultural markets, private and public policies to regulate and facilitate marketing processes.

8264. RESOURCE ECONOMICS. (3 cr; prereq Econ 5162 or ¶Econ 5162 or #)
Economic analysis relevant to resource use and management; concepts of joint production and joint costs; external effects of resource decisions; applications of public finance, welfare economics, capital theory, and discount rates; cost-benefit analysis and other decision-making approaches; investment and management problems related to water resources, outdoor recreation, forestry, and fisheries; economic problems of air pollution and environmental quality.

8266. APPLIED REGIONAL ECONOMICS. (3 cr; prereq Econ 5151, 5152 or equiv or #)
Concepts, theories, and models of regional economic growth and development. Application of regional location, income and product, export base and multiplier, business cycle, industrial complex, and community economic analysis in regional policy and planning.

8270. APPLIED WELFARE ECONOMICS AND PUBLIC POLICY. (3 cr; prereq calculus and intermediate economic theory)
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)
Theories of socioeconomic growth; models of economic growth; consumption, production, and supply relations in agricultural development; agricultural development policy.

8287. PRODUCTION FUNCTIONS: THEORY AND ESTIMATIONS. (3 cr; prereq 5860 or equiv, Stat 5302 or equiv)
Functional forms; 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 and Econ 8101)
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)

8346. SEMINAR: LAW AND AGRICULTURAL ECONOMICS. (3 cr; offered to both law and grad students)

8360. SEMINAR: LAND ECONOMICS AND TENURE. (3 cr; offered when demand warrants)

8364. SEMINAR: RESOURCE ECONOMICS AND POLICY. (3 cr; offered when demand warrants)

8366. SEMINAR: APPLIED REGIONAL ECONOMICS. (3 cr; offered when demand warrants)

8370. AGRICULTURAL POLICY IN DEVELOPED COUNTRIES. (3 cr; prereq 8270 or #)
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.

8373. SEMINAR: FOOD AND AGRICULTURAL POLICY IN THE UNITED STATES. (3 cr; offered when demand warrants)

8375. THE ECONOMICS OF EC FOOD AND AGRICULTURAL POLICIES. (3 cr; prereq #)
European Community (EC) food and agricultural policy measures, effects on social welfare, income distribution, international trade, and U.S. agriculture; financial system of the EC; European monetary union, EC enlargement, EC policy decision making.

8378. SEMINAR: AGRICULTURAL DEVELOPMENT. (1 or 3 cr; offered when demand warrants)

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)
Economic analysis of issues and impact of public policies relating to food pricing and distribution, product quality and information, product safety and liability; international comparisons and practice in policy analysis.

8591. CONSUMPTION ECONOMICS. (3 cr; prereq microeconomic theory at the 5xxx level at least and basic regression analysis)
Analytical and empirical treatment of consumer behavior. Modern adaptations of theory to explain household consumption activities.

Agricultural Education

See Vocational and Technical Education.

Agricultural Engineering

Professor: George R. Foster, *head*; Frederick G. Bergsrud; Harold A. Cloud; R. Vance Morey; Cletus E. Schertz

Associate Professor: John L. Nieber, *director of graduate studies*; James J. Boedicker; Philip R. Goodrich; Larry D. Jacobson; Kevin A. Janni; Charles A. Onstad; Robert A. Young

Assistant Professor: Mrinal Bhattacharya; Jonathan Chaplin; Charles J. Clanton; Ian D. Moore

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 specialization offered include agricultural power and machinery; irrigation and drainage; hydrology and erosion control; agricultural waste management; structures and animal environment; food and process engineering; bioprocessing; and electrical and electronic systems. 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 agricultural (or another 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 are recommended, but not required.

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 24 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 8 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—Contact the director of graduate studies, Department of Agricultural Engineering, University of Minnesota, 1390 Eckles Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Agricultural Engineering (AgEn)

Courses That Carry Graduate Credit for Majors or Minors

5060. PROCESSING. (4 cr; prereq 3052, ME 5342, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Morey
Size reduction, cleaning, and conveying of agricultural products. Properties of air, water vapor, and biological materials. Engineering principles of moisture and heat transfer applied to drying of grain crops. Theory and applications of refrigerated and controlled atmosphere storage.

5070. AUTOMATIC CONTROL AND INSTRUMENTATION. (4 cr; prereq 3060, EE 3000 or 3002, upper div IT or grad IT major; 2 lect and 4 lab hrs per wk) Janni
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 and upper div IT or grad student or #; 4 lect hrs per wk) Nieber
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.

5081, 5082, 5083, 5084. DESIGN. (4 cr per qtr; prereq upper div IT student, appropriate AgEn sr-level courses or #; 1 lect and 6 lab hrs per wk) Bhattacharya, Clanton, Janni, Moore, Nieber, Schertz
Engineering design project in student's interest area or multiarea, integrating previous work and covering the whole range of the design process from conceptualization through preparation of project report. 5081: Power and machinery. 5082: Soil and water. 5083: Structures and environment. 5084: Food engineering.

5130. FOOD ENGINEERING. (4 cr; prereq thermodynamics, 3060 or #, upper div IT or grad IT major; 4 lect hrs per wk) Bhattacharya
Fundamental requirements for handling food products. Separation processes in food industry. Storage of foods. Optimization techniques, experimental design, project management methods, and engineering economics for food industry.

5140. THERMAL PROCESSES FOR FOOD. (4 cr; prereq heat transfer, 5060 or #, 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.

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.

5330. AGRICULTURAL MACHINERY. (4 cr; prereq knowledge of actions of agricultural mechanisms as assessed by instructor, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Schertz
Principles of operation and performance characteristics of agricultural machines. Operating forces on selected machine components. Control systems, design for operator convenience and safety. Machinery selection and management. Design of machine elements and assemblies. Motion analysis.

5340. AGRICULTURAL TRACTORS. (4 cr; prereq ME 3301, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Chaplin
Engineering principles governing performance of tractor and implement systems. Transmission design, hydraulic control systems, terramechanics, ergonomics, thermodynamics of diesel engines.

5540. EROSION CONTROL, WATERSHED ENGINEERING. (4 cr; prereq 3052 or CE 3300, CE 5401 or #, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Moore
Measurement and mechanics of watershed runoff and soil erosion. Estimating peak runoff, soil losses, and sediment yields. Environmental effects. Principles of small watershed planning for flood control, water storage and sediment control. Hydraulic design of graded and storage type terraces, grass waterways, diversions, and erosion control structures.

5550. DRAINAGE AND IRRIGATION ENGINEERING. (4 cr; prereq 3052 or CE 3300, CE 5401 or #, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Nieber
Flow of water through agricultural soils. Irrigation and drainage requirements, salinity control, evapotranspiration, water supply development and control. Conveyance of drainage and irrigation waters. Considerations for design, layout, and construction of irrigation and drainage systems. Institutional, environmental, and economic aspects of soil moisture control.

5730. AGRICULTURAL STRUCTURES DESIGN. (4 cr; prereq 3052, AEM 3016, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Clanton
Buildings and materials for agricultural production. Static, live, snow, and wind loads. Codes and standards. Costs. Concrete formulation, quality, testing, footings, columns, beams, and slabs. Wood terminology and characteristics, plywood, fasteners, and protection. Systems, planning, and interaction of buildings with agriculture production.

5740. ENVIRONMENTAL CONTROL FOR AGRICULTURAL PRODUCTION. (4 cr; prereq ME 5603, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Janni
Ventilation, insulation, and condensation control in enclosed plant and animal production structures. Biological constraints upon the system. Temperature, humidity, light, and contaminants; e.g., dust, noxious gases, and pathogens. Simulation of weather phenomena for predicting environmental conditions.

5910. AGRICULTURAL WASTE MANAGEMENT ENGINEERING I. (4 cr; prereq 3052, Chem 1005, 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, processing, and domestic wastes. Physical, biological, chemical, rheological, and microbiological properties. Effects on environment. Collection, storage and treatment (aerobic and anaerobic), and utilization/disposal. Land application.

8100. SEMINAR. (1 cr; prereq #, grad IT major) Schertz
Reports on current topics and departmental research.

8190, 8191, 8192. ADVANCED PROBLEMS AND RESEARCH. (2-6 cr per qtr; prereq 5191, 5192, △) 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) Moore
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 and #, 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

5020. PROGRAM PLANNING AND INSTRUCTIONAL METHODS IN AGRICULTURAL MECHANICS. (3 cr; prereq 10 cr in agricultural engineering technology, AgEd 3031 or ¶AgEd 3031) Bear
Planning and designing high school vocational agriculture facilities; organizing equipment, tools, supplies, and storage as demanded by the instructional program. Administering agricultural mechanics programs. Developing teaching techniques and program planning for student-supervised study programs in agricultural mechanics.

5027. APPROPRIATE TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT. (4 cr; prereq Math 1111, Chem 1001 or 1004, Phys 1041; 3 lect and 3 lab hrs per wk) Goodrich, Nieber
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.

5030, 5031, 5032, 5033, 5034, 5035. PROBLEMS AND FIELD STUDIES IN ADVANCED AGRICULTURAL MECHANICS. (1-3 cr per qtr [max 9 cr]; prereq 5020 or #) Bear
Principles and practices for implementation of instructional programs in agricultural mechanics. Selection, application, operation, service, and maintenance of equipment used for the specific instructional program in agricultural mechanics. 5030: Agricultural tractor and engine power. 5031: Agricultural machinery and mechanization. 5032: Electrical power and processing. 5033: Farm buildings and environmental control. 5034: Natural resources development and management. 5035: Metal fabrication materials and techniques.

5040. ADVANCED METHODS FOR TEACHING AGRICULTURAL MECHANICS. (3 cr; prereq #; off campus fall, spring, on campus 1st summer term) Bear
Trends and the role of agricultural mechanics in the mechanization of agriculture. Organization of instructional areas, selection of tools, supplies, reference materials, and facilities. Preparation of instructional materials and methods of effective teaching. Development of teaching demonstrations and procedures.

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.

5400. DRAINAGE AND IRRIGATION. (4 cr; prereq Soil 3210; 3 lect and 2 lab hrs per wk) Nieber
Soil moisture excesses and deficiencies. Theory and design of tile drainage, surface drainage, and sprinkler irrigation systems. Development of irrigation water supplies. Selection of pumps and power units for drainage and irrigation. Economic feasibility. Legal problems and procedures.

5410. HYDROLOGY AND WATER QUALITY. (5 cr; prereq Math 1111, Phys 1041, Chem 1004, Chem 1005; 3 lect, 3 lab, 1 rec hr per wk) Moore
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)

Professor: Orvin C. Burnside, *head;* Craig C. Sheaffer, *director of graduate studies;* Donald K. Barnes; Robert H. Busch; Vernon B. Cardwell; R. Kent Crookston; Burle G. Gengenbach; John A. Goodding; Leland L. Hardman; Gary H. Heichel; Dale R. Hicks; Robert J. Jones; William E. Lueschen; Gordon C. Marten; Neal P. Martin; Ervin A. Oelke; Ronald L. Phillips; Donald C. Rasmusson; Steve R. Simmons; Lawrence H. Smith; Robert E. Stucker; Deon D. Stuthman; Carroll P. Vance; Donald L. Wyse

Associate Professor: James H. Orf; David A. Somers; John V. Wiersma

Assistant Professor: Charlotte E. Eberlein; Nancy J. Ehlke; Frank Forcella; John W. Gronwald; Stephen Openshaw; Daniel H. Putnam; 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. The program is closely aligned with the interdepartmental programs of plant breeding and plant physiology. 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 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.

Language Requirements—None.

For Further Information—Contact the head, Department of Agronomy and Plant Genetics, 411 Borlaug Hall, University of Minnesota, 1991 Buford Circle, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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. (4 cr; prereq 1010 or #) Sheaffer
Interrelationships between plants and animals as they are involved in the selection, production, and utilization 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 utilization for livestock feeding with emphasis upon ruminant nutrition. Lecture and laboratory.

5020w. INTRODUCTION TO PLANT BREEDING. (4 cr; prereq GCB 3022 or equiv) Orf
Application of genetic principles to improvement of crop plants. Includes self-pollinated, cross-pollinated, and asexually propagated crops.

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.

5040s. CORN AND SOYBEAN MANAGEMENT. (3 cr; prereq 3010, 3020, 3030, Soil 1122 or #) Crookston
Discussion and case-study approach to corn and soybean management in Minnesota based on an integration of agronomic principles.

5055. METHODS IN FARMING SYSTEMS RESEARCH AND EXTENSION. (3 cr, §AgEd 5055, §HeEd 5055)
Introduction to theory and practice of interdisciplinary and holistic approaches to complex farm, rural family, and community problems. Techniques in problem identification and development of desirable and feasible alternatives appropriate for domestic and international situations.

5060s. SMALL GRAINS, SUNFLOWER, AND SUGAR BEET MANAGEMENT. (3 cr; prereq 3010, 3020, 3030, 5030, Soil 1122 or #) Simmons
Discussion and case study of agronomic principles for production of wheat, oats, barley, sunflowers, and sugar beets, including crop and variety selection and rotation, tillage and seedbed preparation, planting, cultural practices, pest control, harvest, and utilization.

5070. ECOLOGY OF FIELD CROPS. (3 cr; prereq 3010, 3 cr in agronomic sciences or #)
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.

5110w. ADAPTATION, DISTRIBUTION, AND PRODUCTION OF FIELD CROPS. (3 cr, §3010; prereq Biol 1011) Simmons
Principles and concepts of origin, adaptation, distribution, and production of world crops as influenced by environmental, ecological, and socioeconomic considerations. Lecture and discussion.

5120s. GROWTH, DEVELOPMENT, AND CULTURE OF FIELD CROPS. (5 cr, §3020; prereq Biol 1011, Chem 1005) Cardwell
Principles of growth and development of field crops and their regulation to achieve maximum crop productivity. Emphasis on seeds and seeding; physiological basis of growth and development, growth regulation, and effects of environment on crop growth, development, and culture. Lecture, laboratory, and discussion.

5130f. MATURATION, HARVEST, AND STORAGE OF FIELD CROPS. (4 cr, §3030; prereq Biol 1011, Chem 1005) Smith
Determination of physiological maturity of grain crops and development of criteria for crop harvest. Principles of grain storage in moist or dry state. Changes in nutritive quality of forages with advancing maturation, time, and frequency of harvest commensurate with maximizing yields and quality of forage. Principles of storage of forage as hay, haylage, and silage.

5200s. WORLD FOOD SUPPLY PROBLEMS. (4 cr, §AgEc 5790, §FScN 5643, §Soc 5675, §LACS 5280; prereq #) Cardwell
Multidisciplinary examination of social, economic, and technical problems of feeding the world's growing population. Principles sought from the social and economic sciences, plant sciences, and animal sciences for their application to food problems.

8000f. SUPERVISED TEACHING EXPERIENCE IN AGRONOMY. (2 cr; for advanced graduate students in agronomy and plant genetics; prereq #) Simmons
Supervised teaching experience in courses offered by the Department of Agronomy and Plant Genetics or experience assisting an agronomy extension specialist. Includes discussion sessions to improve teaching skills and to assist students in developing a 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, PlPh 5182, Biol 5001, or #; offered alt yrs) Eberlein
Classification and structure of herbicides, physiological processes affecting and affected by herbicides, review of selected literature on mode of action of herbicides.

8040f. WEED BIOLOGY. (2 cr; prereq 5030, PlPh 5131, or #; offered alt yrs) Eberlein
Critical review of literature on geographical distribution, habitat, growth and development, reproduction, population dynamics, economic importance of selected weeds.

8050f. PHYSIOLOGY OF FIELD CROPS. (3 cr; prereq 5120, PlPh 5131 or #) 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.

8055w. SOURCE-SINK RELATIONS. (2 cr, §PlPh 8055; prereq PlPh 5182, 5183, 5184 or #; offered alt yrs) Staff
Critical student reviews of selected current literature on mechanism and regulation of assimilate production, partitioning, and transport in higher plants.

8080s. CURRENT TOPICS IN AGRONOMY. (2 cr; prereq 5040, 8050, #; offered odd yrs) Wyse
Current developments in agronomy and crop physiology.

8100w. PASTURE AND FORAGE RESEARCH TECHNIQUES. (3 cr; prereq Stat 5021 or equiv, Agro 5010 or #; offered even yrs) Sheaffer
Potentialities and limitations of grazing trials: in vivo and laboratory methods for estimating forage quality.

8200w. PRINCIPLES OF PLANT BREEDING I. (3 cr; prereq 5020, Stat 5301 or #) Rasmusson
Principles involved in breeding self-pollinated crops. Population concepts, selection schemes, host-pathogen relationships, hybrid breeding, new approaches.

8210s. PRINCIPLES OF PLANT BREEDING II. (3 cr; prereq 8200 or #) Openshaw
Methods and theories useful in genetic improvement of cross-pollinated crops. Population concepts, constructing source populations, recurrent selection techniques, varietal development, and new approaches.

8220w. APPLICATION OF QUANTITATIVE GENETICS TO PLANT BREEDING. (3 cr; prereq 8210, GCB 5042; offered even yrs) Stucker
Use of quantitative genetics in decision making in plant breeding.

8230f. CYTOGENETICS. (4 cr; prereq GCB 5031 or #; 3 lect and 2 lab hrs per wk) Phillips
Genetic principles in relation to the eukaryotic chromosome. Chromosome structure, replication, pairing, crossing over, deficiencies, duplications, inversions, interchanges, Oenothera cytogenetics, aneuploidy, autopolyploidy, allopolyploidy, anomalous meiotic behaviors, and uses of cytogenetic stocks.

8240s. PLANT GENETICS IN RELATION TO PLANT IMPROVEMENT. (3 cr; prereq GCB 5031) Gengenbach, Somers
Genetics of higher plants with emphasis on gene function and action. Genetic control of developmental, physiological, and biochemical economic traits; plant genetic systems, linkage, cell culture, cytoplasmic inheritance, and their applications to plant breeding.

8270f,w. SEMINAR: PLANT BREEDING. (1 cr) Staff

8280s. CURRENT TOPICS IN PLANT BREEDING. (2 cr; prereq 8210 or #) Stucker

8310f,su. ORIENTATION TO FIELD CROP BREEDING. (1 cr; prereq 5020 or #) Stuthman
Field study of plant breeding programs and techniques.

8320f,su. ORIENTATION TO AGRONOMY AND SOILS FIELD RESEARCH TECHNIQUES. (1 cr; offered S-N only; prereq 5040 or #) Goodding
Field survey and discussion of research techniques in crop physiology, crop and soil management, and weed science programs.

8330f,w,s,su. RESEARCH IN PLANT GENETICS. (Cr ar) Staff

American Legal Institutions

Professor: Robert A. Stein, *dean, Law School;* Steve H. Nickles, *director of graduate studies;* Carl A. Auerbach; David Bryden; Laura Cooper; John J. Cound; Daniel A. Farber; Barry C. Feld; Richard S. Frase; Daniel J. Gifford; Robert E. Hudec; William D. Kilbourn, Jr.; K. Bart Koeppen; Victor H. Kramer; Robert J. Levy; Donald G. Marshall; C. Robert Morris; Fred L. Morrison; Roger C. Park; M. Kathleen Price; Leo J. Raskind; Stephen B. Scallen; Ferdinand P. Schoettle, Jr.; Suzanna Sherry; Gerald Torres; Thomas L. Waterbury; David Weissbrodt; Judith T. Younger

Associate Professor: Stephen F. Befort; Karen C. Burke; Ann M. Burkhart; Carol L. Chomsky; Philip P. Frickey; John H. Matheson

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.

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 Fields[1]—A minor for either the master'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.

[1]*The faculty for the minor in law is the same as for American Legal Institutions.*

For Further Information—Contact the director of graduate studies, American Legal Institutions, Law Building, University of Minnesota, 229 19th Avenue South, Minneapolis, MN 55455.

American Studies (AmSt)

FACULTY

Professor: David W. Noble, *chair;* Roland A. Delattre

Associate Professor: Linda Hogan (on leave); George Lipsitz; Elaine T. May; Lary L. May; Gayle Graham Yates

AFFILIATED FACULTY

Professor: Chester G. Anderson (English); Ayers L. Bagley (education policy and administration); Kent R. Bales (English); Terence W. Ball (political science); Hyman Berman (history); David O. Born (health ecology); Kinley J. Brauer (history); Clarke A. Chambers (history); Roger D. Clemence (architecture); Marion L. Dobbert (educational policy and administration); Gary A. Fine (sociology); Philip G. Furia (English); Philip J. Gersmehl (geography); Donald M. Gillmor (journalism); Edward M. Griffin (English); John R. Howe, Jr. (history); Karen A. Hoyle (Children's Literature Research Collections); Edwin T. Layton (mechanical engineering and history of science and technology); Fred E. Lukermann (geography); Karal Ann Marling (art history); Toni A. H. McNaron (English); Russell R. Menard (history); Paul L. Murphy (history); Martin Roth (English); Harvey B. Sarles (anthropology); Mulford Q. Sibley (emeritus: political science); Geneva H. Southall (Afro-American and African studies); Ellen J. Stekert (English); Roger H. Stuewer (physics and history of science and technology); Richard E. Sykes (speech-communication); Rudolph J. Vecoli (history); Jean W. Ward (journalism); George T. Wright (English)

Associate Professor: Riv-Ellen Prell (anthropology), *director of graduate studies;* W. John Archer (humanities); Reginald T. Buckner (music and Afro-American and African studies); Hazel Dicken-Garcia (journalism); John M. Dolan (philosophy); Sara M. Evans (history); Arthur I. Geffen (English); George D. Green (history); Nancy L. Roberts (journalism); Robert B. Silberman (art history); Allan H. Spear (history); John S. Wright (English and Afro-American and African studies)

Other: Judith A. Martin (coordinator, urban studies); Nobuya Tsuchida (director, Asian/Pacific American Learning Resource Center); Stephen M. Wilbers (director, CLA student academic support services)

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 American Studies, in one of the participating departments, 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, three letters of recommendation, scores from the General (Aptitude) Test of the Graduate Record Examination, and transcripts of all college work. TOEFL scores are required from applicants whose native language is not English. Applications must be submitted by January 15; late applications will be considered only if space is available. 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; 2 two-quarter sequences 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 10 other adviser-approved courses. 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. A written examination is required.

For Further Information—Contact the director of graduate studies, Program in American Studies, 104 Scott Hall, University of Minnesota, 72 Pleasant Street S.E., Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1 36 cr per qtr)

5101, 5102. RELIGION IN AMERICAN CULTURE. (4 cr per qtr, §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 *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.

8219, 8220. AMERICAN CULTURAL REGIONS. (4 cr per qtr [max 12 cr for 8220]; prereq # or △ for 8219; 8219 or # or △ for 8220) Staff
Regional, ethno-cultural investigation of U.S., 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]; prereq # or △ for 8229, 8229 or # or △ for 8230) Staff
Relationship between American culture and role of U.S. in world; how U.S. 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]; prereq # or △ for 8239, 8239 or # or △ for 8240) Staff
Social, psychological, historical, artistic modes of self-expression and intellectual analysis of people in the U.S. 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]; prereq # or △ for 8249, 8249 or # or △ for 8250) Staff
Patterns of American building, artifacts, customs; human-made plans and procedures for use of space; 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 △ for 8259, 8259 or # or △ 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 △ for 8269, 8269 or # or △ 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.

8279, 8280. SOCIETY AND SOCIAL PROCESSES. (4 cr per qtr [max 12 cr for 8280]; prereq # or △ for 8279, 8279 or # or △ for 8280) Staff
Integrated study of American society, past and present, with emphasis on issues in social history and sociology; presentations from literature, fine and popular arts, science and technology. 8279: Research strategies. 8280: Topical development.

8289, 8290. RELIGION AND SPIRITUALITY IN AMERICA. (4 cr per qtr [max 12 cr for 8290]; prereq # or △ for 8289, 8289 or # or △ for 8290) Staff
Forms, practices, and history of religious life and institutions in U.S. 8289: Research strategies. 8290: Topical development.

8311, 8312. SEMINAR. (4 cr per qtr; prereq # or △)
Problems and methods in the study of American culture.

8401. PRACTICUM IN AMERICAN STUDIES. (4 cr; prereq PhD candidate in AmSt, #)
Application of American studies expertise, either inside or outside the classroom.

8801-8802. DISSERTATION SEMINAR. (4 cr per qtr; prereq # or △)
Intended for doctoral students beginning work on dissertations in American studies.

8970. READINGS IN AMERICAN CIVILIZATION. (Cr ar; prereq △)
Independent study of interdisciplinary aspects of American civilization under guidance of members of various departments.

Anatomy (CBN)[1]

Professor: David W. Hamilton, *head, director of graduate studies;* G. Eric Bauer; Robert P. Elde; Stanley L. Erlandsen; Orion D. Hegre; Theodore John Leppi[2]; Paul C. Letourneau; Richard W. Linck; Jonathan A. Parsons; Arlen R. Severson[2]; Robert L. Sorenson

Associate Professor: Stephen W. Downing[2]; Glenn J. Giesler; Steven C. McLoon; Lillian A. Repesh; Donald W. Robertson; Virginia S. Seybold

Assistant Professor: Ryoko Kuriyama

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) under special circumstances and Ph.D.

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.

Doctoral Degree Requirements—Students must have completed or must complete two of the four introductory courses in anatomy (embryology, gross anatomy, histology, and human neuroanatomy), in addition to four advanced courses offered by the department.

Language Requirements—None.

Minor Requirements for Students Majoring in Other Fields—Prerequisites for the minor in anatomy are the same as for the major. Required coursework includes two of the four introductory courses in anatomy (5100, 5103, 5104, and 5111) and at least 6 credits of advanced courses.

For Further Information—Contact the Department of Cell Biology and Neuroanatomy, 4-135 Jackson Hall, University of Minnesota, 321 Church Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5100. GROSS HUMAN ANATOMY. (12-13 cr [12 cr for med/dent fr]; prereq regis med/dent fr, Anat grad student, or grad student with #) Parsons and 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 #) Erlandsen and staff
Microscopic structure, cytochemical and functional aspects of cells, tissues, and organs.

5104. PRINCIPLES OF DEVELOPMENT. (1 cr; prereq regis med fr or grad student) Letourneau and staff
Lectures on basic concepts of development at cellular level. Topics range from developmental control of gene expression to interactions between epithelial cells and mesenchyme and cell motility. Relation of basic principles to important clinical problems.

5110. NEUROSCIENCE FOR DENTAL STUDENTS. (2 cr, §Phsl 5100; prereq regis dentistry fr or #) Seybold and staff
Introduction to structure and function of central nervous system. Correlation between morphology and physiology emphasized.

[1]*No new students will be accepted for the anatomy major during 1988-90. See programs in cell and developmental biology and neuroscience.*
[2]*University of Minnesota, Duluth*

5111. HUMAN NEUROSCIENCE A. (3-4 cr [3 cr for med students]; prereq regis med fr or grad or #; 5111-Phsl 5112†) Elde and staff
Structure and function of the nervous system including the organs of special sense.

5127. PROBLEMS IN MODERN DEVELOPMENTAL BIOLOGY. (2 cr; prereq 5104 or #) Hegre and staff
Fundamental principles of vertebrate developmental biology from fertilization through establishment of tissue and organs. Focus on the cellular processes involved. Emphasis varies.

5134. LIGHT MICROSCOPY. (3 cr; prereq #) Staff
Introduction to the theory and application of light microscopic techniques; tissue processing, observation of tissues with different sources of illumination, photomicroscopy, and analysis of histological data.

5190. ADVANCED ANATOMY. (2 cr; prereq regis med, 5103, #) Staff
Teaching methods, supervision of student's original research or combination of both.

5211. BIOLOGY OF NERVE CELLS. (3-4 cr, §NSc 5211; prereq #) Staff
Anatomical basis of nerve cell function with emphasis on excitable membranes, interactions among neurons and other cells, and current topics and technology.

5301. SURGICAL ANATOMY FOR ORAL SURGEONS. (5 cr; prereq participation in oral surgery residency program) Robertson and oral surgery staff
Normal and variant anatomy encountered in various surgical procedures, with step-by-step analysis of procedures and underlying rationale. Performance of selected procedures in the laboratory required.

5304. HEAD AND NECK ANATOMY FOR MEDICAL/DENTAL RESIDENTS. (5 cr; prereq participation in a residency program in the medical or dental schools) Robertson and 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. Laboratory participation required.

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.

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.

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.

8141. NEUROANATOMICAL METHODS. (2 cr; prereq #; offered summer of even yrs) Elde
Introduction to contemporary morphological technics applicable to investigation of nervous system. Theoretical basis of these technics and practical aspects related to their use. Laboratory experience with selected technics.

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 and staff
Structure, development, physiology, and cell biology of pancreatic islets of Langerhans. Primary sources: original publications supplemented by recent reviews.

8201, 8202, 8203, 8204. RESEARCH IN ANATOMY. (1-10 cr per qtr; prereq #) Staff
Cytochemistry, embryology, gross anatomy, histology, hematology, or neuroscience. Special facilities offered to graduate students in clinical departments for work on problems in applied anatomy.

8205, 8206, 8207. SEMINAR: ANATOMY. (1 cr per qtr; prereq #) Hamilton
Reviews of current literature and discussion of research work being carried on in the department.

8210f. DEVELOPMENTAL NEUROBIOLOGY. (3 cr; prereq 5111, Phsl 5112 or #; offered even yrs) McLoon
Nervous system development. General mechanisms and experimental approaches.

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) Seybold, Elde
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.

Ancient Studies (AnSt)

Regents' Professor: Rutherford Aris (chemical engineering and materials science); Robert H. Beck (educational policy and administration); Margaret B.

Davis (ecology and behavioral biology); Tom B. Jones (emeritus: history); William A. McDonald (emeritus: classical studies)

Professor: Peter S. Wells, *director* and *director of graduate studies;* Frederick M. Asher (art history); Arthur C. Aufderheide (laboratory medicine and pathology, anthropology); Bernard Bachrach (history); Frederick A. Cooper (art history); William D. E. Coulson (classical studies); Edward J. Cushing (ecology and behavioral biology); Guy E. Gibbon (anthropology); Stephen Gudeman (anthropology); Jackson P. Hershbell (classical studies); Elden Johnson (anthropology); Fred E. Lukermann (geography); Richard B. Mather (emeritus: East Asian studies); Sheila J. McNally (art history); Thomas S. Noonan (history, Russian and East European studies); Robert J. Poor (art history); George R. Rapp, Jr. (geology); Philip M. Raup (emeritus: agricultural and applied economics); William B. Schwabacher (chemistry); Alan E. Shapiro (physics); Mulford Q. Sibley (emeritus: political science); Robert F. Spencer (emeritus: anthropology); Theofanis G. Stavrou (history); James W. Vaupel (public affairs); Tzvee Zahavy (ancient Near Eastern and Jewish studies)

Associate Professor: Stan E. Aschenbrenner (anthropology); Robert C. Bright (ecology and behavioral biology); Gerald W. Johnson (civil engineering); William W. Malandra (religious studies, South and Southwest Asian studies); Ronald T. Marchese (history, humanities); Jonathan Paradise (ancient Near Eastern and Jewish studies); Daniel D. Reisman (ancient Near Eastern and Jewish studies); Janet D. Spector (anthropology)

Assistant Professor: Joan Fagerlie (University Libraries); Christine A. Hastorf (anthropology); Oliver P. Nicholson (classical studies); Philip Sellew (classical studies)

Other: John Parker (curator, Bell Library)

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 function of the Center for Ancient Studies (CAS) is to organize and encourage interaction between students and faculty members from a broad spectrum of relevant fields. The focus is on interdisciplinary research that probes relationships between people in antiquity and their social and physical environments.

Prerequisites for Admission—Applicants must demonstrate a commitment to a course of interdisciplinary studies not available in traditional department settings.

Special Application Requirements—The program normally begins in fall quarter, but enrollment beginning in winter or spring quarter is possible in special circumstances. The application deadline for financial aid is January 15.

Degree Requirements—A sequence of three core seminars is required for students beginning graduate work with a B.A. degree. In addition, all students are required to take one ancient studies interdisciplinary research seminar sequence at the master's level and one at the Ph.D. level. Additional courses are selected with the adviser's consent. All programs of study are subject to review by the Executive Committee of the Center. The final examination for both master's degrees is oral.

Language Requirements—For the master's degree, reading knowledge of at least one foreign language (ancient or modern) with reasonable facility is required; for the Ph.D. degree, two.

For Further Information—Contact the director of graduate studies, Center for Ancient Studies, 205½ Folwell Hall, University of Minnesota, 9 Pleasant Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5100. TOPICS IN ANCIENT STUDIES. (4 cr; prereq enrollment in ancient studies or #)

5120. ARCHAEOLOGY OF PREHISTORIC EUROPE. (4 cr, §Anth 3371, §Anth 5120)
Survey of early development of non-Mediterranean European society from Old Stone Age through Iron Age to Roman Period, based on archaeological evidence. Principal transformations of European culture with introduction of agriculture, development of metallurgy and trade, and emergence of towns and cities.

5910. TOPICS IN ANCIENT STUDIES. (4 cr)
Topics specified in the *Class Schedule.*

5970. DIRECTED STUDIES. (4 cr)

8001. BASIC SEMINAR: UNDERSTANDING THE PAST: METHOD AND THEORY IN ARCHAEOLOGY. (4 cr; prereq grad major or #) Staff
Survey and evaluation of archaeological approaches to the nonliterary, material evidence for past human activities.

8002. BASIC SEMINAR: UNDERSTANDING THE PAST: APPROACHES TO ANCIENT TEXTS. (4 cr; prereq grad major or #) Staff
Review and evaluation of approaches to textual reconstruction and criticism.

8003. BASIC SEMINAR: UNDERSTANDING THE PAST: NATURAL SCIENTIFIC APPROACHES. (4 cr; prereq grad major or #) Staff

8100-8110-8120. INTERDISCIPLINARY SEMINAR. (4 cr per qtr; prereq grad major or #) Staff, visitors
Themes involve various disciplines in ancient studies; leadership and research shared by staff, visitors, and students.

8200. DIRECTED READINGS. (Cr ar; prereq △) Staff
Independent reading program under supervision of CAS staff members.

8300. DIRECTED RESEARCH. (Cr ar; prereq △) Staff
Independent work under supervision of CAS staff members. Projects include, but are not restricted to, research involved in master's and Ph.D. programs.

Anesthesiology (Anes)

Professor: Joseph J. Buckley, *head*

Associate Professor: James F. Cumming, *director of graduate studies;* Ji-Chia Liao

Assistant Professor: Josephine Lo

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

Degree Offered—M.S. Anes. (Plan A only).

Curriculum—The first three years offer training, both didactic and clinical, in all types of general and regional anesthesia. Extensive operating room and ward experiences and selected investigative opportunities are provided. Work in cooperation with other departments is available. The program satisfies the requirements of the certifying medical specialty board.

Prerequisites for Admission—Candidates must hold an M.D. degree from an approved medical school.

Special Application Requirements—College and medical school transcripts and letters of recommendation are required in support of the application.

Master's Degree Requirements—Selected students spend a fourth year in research with a major in anesthesiology and a minor in one of the basic medical sciences. A final oral examination is required.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Department of Anesthesiology, Box 294 UMHC, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address).

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

5015. DIRECTED STUDY, ANESTHESIA TOPICS/PROJECT: COURSE DEVELOPMENT. (Cr ar; prereq CRNA, regis BS in nurs anes, #)

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, #)

5286. DIRECTED STUDY, ANESTHESIA TOPICS/PROJECT: CLINICAL. (Cr ar; prereq CRNA, regis BS in nurs anes, #)

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, #)

5586. NURSE ANESTHESIA: MANAGEMENT SEMINAR. (3 cr; prereq CRNA, regis BS in nurs anes, 5486, #)

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; Phcl 5109, 8203; PubH 5450, 5451.

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); Edmund F. Graham (animal science); Eugene Grim (physiology); Richard E. Phillips (ecology and behavioral biology); William D. Schmid (ecology and behavioral biology); Jonathan E. Wheaton (animal science)

Associate Professor: Donald E. Gilbertson (Bell Museum); Shirley Johnston (small animal clinical sciences); Benjamin S. Leung (obstetrics and gynecology)

Assistant Professor: Kevin S. Guise (animal science); Hugh Hensleigh (obstetrics and gynecology); Eric A. Wong (animal 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—Emphases are reproductive, behavioral, and gastrointestinal physiology with a species orientation toward domestic and wild mammals and birds. In the reproductive area, research specializations include neuroendocrinology, cryobiology, immunoreproduction, and sperm-oocyte-embryo physiology. In the behavioral area, research specializations include neuroendocrinology and electrophysiology. In the gastrointestinal physiology area, research specializations include cecal function and intestinal motility. 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 5120 (5 cr) and VB 5308 (10 cr), or equivalent courses, and 9 credits of specialized physiology courses (avian, reproductive, etc.) are required.

For Further Information—Contact the director of graduate studies, Animal Physiology, 495 Animal Science/Veterinary Medicine Building, University of Minnesota, 1988 Fitch Avenue, St. Paul, MN 55108.

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.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

AnSc 5322f. PHYSIOLOGY OF REPRODUCTION. (5 cr; prereq 6 cr systemic physiology or #)

AnSc 5327w. GENERAL ENDOCRINE PHYSIOLOGY. (3 cr; prereq 3301 or #)

AnSc 5328w. GENERAL ENDOCRINE PHYSIOLOGY LABORATORY. (2 cr; prereq 5327 or #)

AnSc 8325w. PHYSIOLOGY OF FERTILIZATION AND GESTATION. (4 cr; prereq 5322 or #; offered alt yrs)

AnSc 8326s. IMMUNOREPRODUCTION. (4 cr; prereq 5322 or #; offered odd yrs)

AnSc 8332. PRESERVATION OF SPERMATOZOA AND EMBRYO. (5 cr; prereq 5322, 3 cr upper division biochemistry, #)

EBB 5156. COMPARATIVE ANIMAL PHYSIOLOGY. (5 cr; prereq Biol 1106 or 3011, Chem 3302 or #)

GCB 5114w. GENERAL PHYSIOLOGY. (3 cr; prereq Biol 3011, Biol 5001, Phys 1106 or 1295)

VB 5120f. COMPARATIVE VERTEBRATE MORPHOLOGY. (6 cr; prereq Biol 1106 or #)

VB 5306w,5308s,5310. ANIMAL PHYSIOLOGY. (5 cr per qtr for 5306, 5308 and 3 cr for 5310; prereq regis vet med or #)

VB 5320w. AVIAN PHYSIOLOGY. (5 cr; prereq 3301 or 6 cr systemic physiology or equiv, #)

Animal Science (AnSc)

Professor: Richard D. Goodrich, *head*; Paul B. Addis; C. Eugene Allen; Robert D. Appleman; William J. Boylan; Bo G. Crabo; William R. Dayton; John D. Donker; Mohamed E. El-Halawani; Franklin D. Enfield; Richard J. Epley; Edmund F. Graham; Melvin L. Hamre; Alan G. Hunter; Dennis G. Johnson; Robert M. Jordan; James G. Linn; Jay C. Meiske; Donald E. Otterby; Richard E. Phillips; William E. Rempel; Paul E. Waibel; Jonathan E. Wheaton; Charles W. Young

Associate Professor: Marshall D. Stern, *director of graduate studies;* Craig N. Coon; Steven G. Cornelius; Leslie B. Hansen; Hans-Joachim G. Jung; Ronald L. Moser; James E. Pettigrew

Assistant Professor: Hugh Chester-Jones; Brian A. Crooker; James W. Curtsinger; Kevin S. Guise; Marcia R. Hathaway; Sally L. Noll; Eric A. Wong

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 breeding and genetics, nutrition, and physiology 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.

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.

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—Contact the director of graduate studies, Department of Animal Science, University of Minnesota, 1404 Gortner Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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.

5240s. ANIMAL CYTOGENETICS. (4 cr; prereq GCB 3022 or #) Shoffner
Application of cytogenetics to problems in animal breeding, pathology, and animal biology. Relationship of cytogenetic principles and practices to other fields such as animal breeding, pathology, cellular biology, and systematics.

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.

5328w. 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.

5331w. FERTILITY AND INCUBATION OF AVIAN EGGS. (3 cr; prereq 10 cr biology or #; offered even yrs) Staff
Principles of physiology and management underlying the production of hatching eggs from a variety of avian species, including incubation of eggs and hatchery management.

5401f. SWINE NUTRITION AND FEEDING. (4 cr; prereq 1401 or 3401) Cornelius, Moser, Pettigrew
Nutrient requirements of swine in all phases of life cycle; feed sources and their composition and utilization in formulation of adequate diets. Least cost formulations, nutritional interrelationships and feeding systems. Use of feed additives.

5403s. RUMINANT NUTRITION. (4 cr, §5413; 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 utilization; energy utilization; nutritional disorders, formulation of adequate rations.

5405w. POULTRY NUTRITION. (3 cr; prereq 1401) Waibel
Nutrient requirements of chickens and turkeys; feed supplies, their composition and utilization in formulation of adequate diets. Role of feed additives, their use and limitations. Least cost formulations, nutritional interrelationships and feeding systems.

5512f. MEAT AND PROTEIN TECHNOLOGY. (4 cr; prereq BioC 1302 or #) Addis
(Same as FScN 5512) Meat proteins; effects of pH, salt, and temperature on hydration and emulsification; methods of fractionation. Meat preservation: effects of heat, freezing, curing; and problems of product stability during storage. Sausage manufacture: chemistry, technology, least-cost analysis (graphical and computer methods), chemical methods of quality control (rapid and classical), and methods of proximate analysis.

5601. SWINE PRODUCTION. (4 cr; prereq 1401 or 3401, 3220 recommended) Moser
Application of principles of animal breeding, nutrition, physiology, and economics. Discussions of swine production systems including swine feeding, breeding programs, selection of breeding animals, management of all classes of swine, housing, diseases and parasites.

5602f. SHEEP PRODUCTION. (4 cr; prereq 1401, 3220 and 5403 recommended) Jordan
Status and characteristics of the sheep industry; application of principles of animal breeding, nutrition, physiology, and economics to management of sheep breeding flocks. Ration formulation, management, and marketing of feedlot lambs.

5603s. BEEF CATTLE PRODUCTION. (4 cr, §5613; prereq 1401, 3320 and 5403 recommended) Meiske
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) Staff
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, §5615; prereq 1401, 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.

5609. PRINCIPLES OF FARM ANIMAL ENVIRONMENT. (3 cr; prereq jr, 3301 or #) El-Halawani
Processes involved in the adjustment of animals to ambient environments, with applications to farm animal management.

5703f,w,s. LITERATURE AND SEMINAR. (2-3 cr; prereq jr) Staff
Introduction to library resources concerned with animal science. Techniques of searching, abstracting, and constructing reviews for written and oral reports from library materials. Evaluation of seminar reports.

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.

8081w. NEUROETHOLOGY. (3 cr, §EBB 8081; prereq EBB 5312, Psy 5061 or #; offered odd yrs) Phillips
Current concepts of neurological and neurochemical bases of animal behavior, including reception, coding, transmission, and storage of information; levels of integration; central control of input and output; spontaneity, development, and learning.

8220f.* ADVANCED ANIMAL BREEDING. (3 cr; prereq GCB 3022, Stat 5021) Boylan
Assigned readings and lectures on more recently proposed techniques and their likely application to farm animals.

8221w.* QUANTITATIVE INHERITANCE. (3 cr; prereq GCB 5042) Boylan
Application of principles of quantitative genetics to improvement of economic species. Selection indexes and choice of breeding systems.

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.

8332. PRESERVATION OF SPERMATOZOA AND EMBRYO. (5 cr; prereq 5322, 3 cr upper division biochemistry, #) Graham
Chemical, physical, and physicochemical properties of gametes, reproductive secretions. Preservation of gametes using cryogenic techniques.

8335. MOLECULAR BIOLOGY TECHNIQUES IN ANIMAL SCIENCE. (3 cr; prereq Biol 5001, Biol 5003, or equiv or #) Wong
Basic theory and procedures used in recombinant DNA work. Cloning, sequencing, hybridization, and gene transfer. Primarily for students with limited exposure to molecular biology.

8420f. ANIMAL BIOENERGETICS AND NUTRITIONAL PHYSIOLOGY. (3 cr; prereq #, BioC 5002 recommended; offered even yrs)
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 even yrs) Coon
Role; sources, how determined; measurements of protein quality; fate and use of ingested protein and amino acids and interrelationships with other nutrients.

8423w.* MINERAL NUTRITION. (3 cr; prereq BioC 5002 or #, BioC 5742 recommended; offered even yrs)
Principles of mineral nutrition for domestic and laboratory animals; mineral requirements, interrelationships, utilization, and metabolism.

8440w.* RUMINANT NUTRITION. (4 cr; prereq BioC 5002 or #, MicB 5321 recommended; offered odd 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 even 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.

8741s. CONCEPTS AND DEVELOPMENTS IN AVIAN NUTRITION. (2 cr; prereq #; offered even yrs) Coon, Waibel
Review and evaluation of recent research reports, current concepts, and ongoing research in poultry nutrition.

8742s. CONCEPTS AND DEVELOPMENTS IN SWINE NUTRITION. (2 cr; prereq #; offered even yrs) Cornelius, Pettigrew
Review and evaluation of scientific literature pertinent to swine and small animal nutrition.

8750. CONCEPTS AND DEVELOPMENTS IN MEAT SCIENCE AND TECHNOLOGY. (1 cr [may be repeated once for cr]; prereq #) Staff
Review and evaluation of pertinent 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, 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.

8850.* RESEARCH IN MUSCLE CHEMISTRY AND PHYSIOLOGY. (Cr ar; prereq #)
Individual, original research under staff direction on selected problems involving chemical, biochemical, and physiological aspects of muscle and meat technology. Topic may be a specialized aspect of a thesis problem or an individual problem of mutual interest to graduate student and adviser.

Anthropology (Anth)

Professor: Stephen F. Gudeman, *chair;* Luther P. Gerlach; Elden Johnson; Frank C. Miller; Eugene Ogan; William L. Rowe; Robert F. Spencer (emeritus); Peter S. Wells

Associate Professor: Marion L. Dobbert; Timothy Dunnigan; Nina L. Etkin; Guy E. Gibbon; Glenn L. Hendricks; John M. Ingham; Mischa Penn; Riv-Ellen Prell; Janet D. Spector

Assistant Professor: Christine A. Hastorf; David M. Lipset; Frederick W. Lorey

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, archaeology, biological anthropology, and linguistic anthropology. Strong supporting programs in related fields are available. A special M.A. track, designed principally for professionals in other disciplines, and a public archaeology track are 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 for fall quarter; the deadline for all materials is February 1.

Master's Degree Requirements—For the regular M.A. degree, 8001, 8002, and a course in the method and theory 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, one language (other than English). For the Ph.D. degree, students must demonstrate a basic reading knowledge of two languages other than English; a basic reading knowledge of one language plus one research skill appropriate to the student's interests; or a reading and speaking knowledge of one language adequate for field research.

Minor Requirements for Students Majoring in Other Fields—The minor program is individually designed by each student.

For Further Information—Contact the director of graduate studies, Department of Anthropology, 215 Ford Hall, University of Minnesota, 224 Church Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5102. PRINCIPLES OF CULTURAL ANTHROPOLOGY. (4 cr, §1102; prereq jr or #)
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 3- and 5-level Anth courses)
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. KINSHIP AND MARRIAGE. (4 cr; prereq 1102 or 5102 and 3201 or #) Gudeman, Ogan
Systems of kinship and marriage in cross-cultural perspective; relationship to economic, religious, and political institutions; significance of kinship studies for theory and methods in social anthropology.

5114. STRUCTURAL ANTHROPOLOGY. (4 cr; prereq 1102 or 5102 and 3201 or #) Gudeman
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 and 3201 or #) Gerlach, Gudeman
Analysis and comparison of systems of production and distribution; special reference to nonindustrial societies. Relationship among economic and social, political, religious, psychological, and environmental factors.

5116. CULTURAL ECOLOGY. (4 cr; prereq 1101 and 5102 or 1102, one ethnographic area course or #) Hastorf
Survey of literature on cultural ecology with emphasis on biological approach to ecosystems and population studies.

5117. ANTHROPOLOGY OF RESOURCE MANAGEMENT. (4 cr)
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 U.S., 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 comparative legal systems. Law: cultural background and relation to society. Functions and evolution of law as revealed in analysis of cultures ranging from primitive to complex.

5131. ANTHROPOLOGY OF RELIGION. (4 cr; prereq 1102 or 5102 or #) 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 and 5112 or #) Gudeman, Ingham, Prell
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. CULTURE AND PERSONALITY. (4 cr; prereq 1102 or 5102 or #—waived for majors in public health, nursing, psychology, sociology, and social work) Ingham, Rowe
Role of culture in formation of personality. Problems of individual adjustments to demands of culture. Psychological approach to culture.

5144. THE ANTHROPOLOGY OF AMERICAN EDUCATION. (3 cr, §SPFE 5172; prereq 1102 or 5102 or 5145 or SPFE 5178 or ¶1102, 5102 or ¶5145 or ¶SPFE 5178 or #)
Application of anthropological principles of study of socialization, schooling, and cultural transmission in the United States. Emphasis on utility of anthropological concepts for the study of our own education systems and for analysis of introduced educational change.

5145. ANTHROPOLOGY AND EDUCATION. (4 cr, §SPFE 5171; 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, 5102 or #) Miller, Ogan
Processes of cultural change; invention, diffusion, and acculturation. Effects of colonialism, urbanization, and modernization. Analysis of developing societies. Applied anthropology.

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 #) Prell, 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 #) Ogan, Rowe
Social, structural, symbolic, and psychological aspects of the societies of colonizers and colonized; emphasis on South Asia, Oceania, and Puerto Rico.

5155. CURRENT ISSUES IN CROSS-CULTURAL PERSPECTIVE. (4 cr; prereq 1102 or 5102 or #) Miller
Anthropological, cross-cultural understanding of several interrelated present-day issues: condition of the family, changing male-female relations, population growth, environmental degradation.

5156. CULTURE AND COMPARATIVE POLITICS. (4 cr; prereq 1102 or #)
Theoretical analyses and comparative case studies illustrating how culture influences political behavior.

5161. LANGUAGE, CULTURE, AND COGNITION. (4 cr; prereq 1102 or #) Dunnigan
Language-based approaches to study of cultures as cognitive systems.

5175. ETHNOHISTORIC ARCHAEOLOGY. (4 cr; prereq 1101, 3301 or #) Spector
Archaeological approaches to the study of historically known native American peoples. Uses of historical documents and ethnographic data in archaeological research.

5176. ENVIRONMENTAL ARCHAEOLOGY. (4 cr; prereq 1101, 3301 or #) Hastorf, Johnson, Spector
Archaeological field and laboratory techniques used to reconstruct past environmental conditions. Paleoecological interpretation in archaeology.

5177. ARCHAEOLOGICAL RESOURCE MANAGEMENT. (4 cr; prereq 1101) Johnson
Analysis of public archaeology; impact of federal, state law and regulation on archaeological site survey, mitigation, preservation, and interpretation.

5185. MEDICAL ANTHROPOLOGY. (4 cr; prereq jr or sr or grad) Etkin
Human health and disease from biological and behavioral perspectives. Origins of human disease, relationship to lifestyles. Comparisons of health beliefs and medical care in Western and non-Western societies.

5186. NUTRITIONAL ANTHROPOLOGY. (4 cr; prereq jr or sr or grad) Etkin
Biocultural perspectives on cross-cultural dietary patterns. Biocultural evolution of human diet; sociocultural factors affecting food choice and taboos and their implications for nutritional health; methods and nutritional correlates of dietary change and development.

5187. FOLK MEDICAL SYSTEMS: CROSS-CULTURAL STUDIES. (4 cr; jr or sr or grad) Etkin
Concepts of disease and treatment of the ill in tribal and folk societies around the world.

5258. ANTHROPOLOGICAL ANALYSIS OF AMERICAN CULTURE. (4 cr; prereq 1102 or 5102 or #) Rowe
Anthropological perspectives on contemporary American culture and society with emphasis on values, family organization, socialization and kinship, education, community integration.

5305. STUDIES IN ANTHROPOLOGICAL CLASSICS. (5 cr)
Intensive studies of notable theoretical and ethnographic works in the past and recent history of anthropology. Topics and works selected yearly.

5316. FIELD METHODS IN SOCIAL AND CULTURAL ANTHROPOLOGY. (4 cr; prereq #)
Rationale underlying a variety of methods; field projects to gain experience in their use.

5331. CULTURE THEORY: AN INTRODUCTION. (4 cr; prereq jr, sr, 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?

5335. THE POLITICS OF GENDER IN RITUAL. (4 cr; prereq 1102 or #)
Symbolism of gender in ritual systems of small-scale societies; theoretical models commonly applied.

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.

5411. COMMERCE AND SOCIETY: CONTEXTS, PERCEPTIONS, ACTIONS. (4 cr; prereq 1101 or 1102 or 5102 or #)
Organization of commercial activities in cultural contexts, from ancient times to modern day; interplay between commerce and society; perceptions of commercial opportunities; commercial behavior in different contexts.

5413. FIELD METHODS IN ANTHROPOLOGICAL LINGUISTICS. (4 cr; prereq #) Dunnigan, Spencer
Problems in linguistic structures of one or two languages outside of the Indo-European speech family for students engaging in anthropological field research.

5592. HISTORY OF ARCHAEOLOGY. (4 cr; prereq 12 cr in 3- or 5-level Anth courses)
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 *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 #, △, CLA approval)
Qualified students may register for work on tutorial basis.

8001. HISTORY OF ANTHROPOLOGICAL THEORY. (3 cr; prereq anthropology grad student or #) Staff

8002. CONTEMPORARY ANTHROPOLOGY. (3 cr; prereq 8001 or #) Staff

8121. PROBLEMS IN SOCIAL AND CULTURAL ANTHROPOLOGY. (3 cr) Staff

8122. PROBLEMS IN APPLIED ANTHROPOLOGY AND POLICY ANALYSIS. (3 cr) Staff

8123. PROBLEMS IN BIOLOGICAL ANTHROPOLOGY. (3 cr) Etkin

8124. PROBLEMS IN ARCHAEOLOGY. (3 cr) Gibbon, Hastorf, Johnson, Spector

8125. PROBLEMS IN LINGUISTIC ANTHROPOLOGY. (3 cr) Staff

8201. METHOD AND THEORY IN ARCHAEOLOGY. (3 cr) Gibbon, Hastorf, Johnson, Spector

8202. RESEARCH METHODS IN SOCIAL AND CULTURAL ANTHROPOLOGY. (3 cr) Staff

8211. ADVANCED FIELD TECHNIQUES IN ARCHAEOLOGY. (3 cr) Gibbon, Hastorf, Johnson, Spector

8310. SEMINAR: CULTURAL ANTHROPOLOGY. (3 cr) Staff

8320. SEMINAR: SOCIAL ANTHROPOLOGY. (3 cr) Staff

8330. SEMINAR: ECONOMIC ANTHROPOLOGY. (3 cr) Gudeman, Ogan

8340. SEMINAR: POLITICAL ANTHROPOLOGY. (3 cr) Staff

8350. SEMINAR: CULTURE AND PERSONALITY. (3 cr) Ingham

8360. SEMINAR: RELIGION. (3 cr) Prell

8370. SEMINAR: SYMBOLISM. (3 cr) Ingham, Prell

8381. SEMINAR: STRUCTURALISM. (3 cr) Gudeman

8390. SEMINAR: PHILOSOPHICAL ANTHROPOLOGY. (3 cr) Penn, Spencer

8410. SEMINAR: CULTURAL ECOLOGY. (3 cr) Gerlach, Hastorf

8420. SEMINAR: CULTURAL CHANGE. (3 cr) Gerlach, Miller, Ogan, Dunnigan

8431. SEMINAR: PROTEST AND SOCIAL MOVEMENTS. (3 cr) Gerlach

8440. SEMINAR: URBAN ANTHROPOLOGY. (3 cr) Staff

8450. SEMINAR: DEVELOPMENT THEORIES AND POLICIES. (3 cr) Gudeman, Miller

8460. SEMINAR: ANTHROPOLOGY OF GENDER. (3 cr) Lipset, Prell, Spector

8510. SEMINAR: ARCHAEOLOGY. (3 cr) Gibbon, Hastorf, Johnson, Spector

8520. SEMINAR: PALEOECOLOGY AND ARCHAEOLOGY. (3 cr) Staff

8531. SEMINAR: ETHNOHISTORIC ARCHAEOLOGY. (3 cr) Hastorf, Spector

8610. SEMINAR: BIOLOGICAL ANTHROPOLOGY. (3 cr) Etkin

8710. SEMINAR: LINGUISTIC ANTHROPOLOGY. (3 cr) Dunnigan, Spencer

8810. SEMINAR: SPECIAL TOPICS. (Cr ar) Staff

8950. DIRECTED STUDIES. (Cr ar; prereq #) Staff

Arabic (Arab)

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 cultural traditions of the Arab world.

Master's Degree Requirements—Three years of Arabic or demonstration of an equivalent level of proficiency is required. 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.

Language Requirements—None for admission.

For Further Information—Contact the coordinator of the Arabic Program, Department of Afro-American and African Studies, 808 Social Sciences Building,

University of Minnesota, 267 19th Avenue South, Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

5014. STRUCTURE OF ARABIC. (4 cr; prereq 2 yrs Arabic or #; offered when feasible)
Descriptive analysis of main structure of Arabic, both classical and colloquial.

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.

5121. READINGS IN ISLAMIC THEOLOGICAL AND PHILOSOPHICAL TEXTS. (4 cr per qtr; prereq 5013 or #)

5211, 5212, 5213. READINGS IN CLASSICAL ARABIC LITERATURE. (4 cr per qtr; prereq 5013 or #) AshShareef

5231. ARABIC LITERATURE IN THE 19TH-20TH CENTURIES. (4 cr per qtr; prereq 5013 or #) AshShareef

5900. TOPICS: READINGS IN ARABIC TEXTS. (4 cr per qtr [max 12]; prereq 5113 or #) AshShareef
Reading and discussion of selected classical works in Arabic.

5970. DIRECTED READINGS. (Cr ar; prereq 5013 or #)
Special problems for advanced students. Reading and periodic consultations.

5990. HONORS COURSE: RESEARCH. (Cr ar; prereq 5970 or #)
Individual studies for honors work at advanced level.

See Afro-American and African Studies *and* Jewish Studies (*in the* Related Courses *section*) *and* South and Southwest Asian Studies (*in the* Fields of Instruction *section*).

Architecture (Arch)

Professor: Harrison Fraker, *head*; John G. Rauma, *director of graduate studies;* Roger D. Clemence; Dennis Grebner; Roger B. Martin; Leonard Parker; James Stageberg; Milo Thompson; Duane E. Thorbeck

Associate Professor: Gunter Dittmar; Mary Alice Hinson-Dixon; Edward J. Kodet; Lance LaVine; Kay Lockhart; Richard B. Morrill; Dale Mulfinger; Garth Rockcastle; Julia W. Robinson; Leon G. Satkowski; Robert D. Sykes; Lee Tollefson; J. Stephen Weeks

Assistant Professor: Lee B. Anderson; Joseph A. Burton; Patrick Condon; Foster Dunwiddie; Cynthia Jara; Susan Ubbelohde

Lecturer: Jeff Scherer

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

Degree Offered—M.Arch. (see Degree Requirements for plans offered).

Curriculum—Students seeking the M.Arch. as a first professional degree who have no previous experience with architectural design education normally need four years of architectural design courses as the heart of their professional curriculum. Coursework is also required or recommended in environment/behavior studies, energy topics, architectural history and theory, structural design, urban design/planning, computer-aided design, technology, and practice. Related work is encouraged in such diverse areas as business, American studies, and journalism. Students in the final two years of this program are exposed to design scales ranging from a regional or community level to the details of a site and building. During the final year, students complete their graduate thesis of two quarters duration. Students who hold the B.Arch. normally study for four quarters to earn the M.Arch. as a second professional degree, developing an individualized program in consultation with faculty and the director of graduate studies.

Prerequisites for Admission—Students who hold only a nonarchitectural baccalaureate degree and lack the lower level technical coursework required for the professional degree will be considered as Type I applicants for graduate admission in the four-year M.Arch. program. Students will be classified as Type II candidates and admitted as graduate students with advanced standing if they have completed a four-year preprofessional degree, such as the bachelor of arts with a major in architecture or its equivalent. Type III classification will be assigned to those who hold the professional degree bachelor of architecture, which is a prerequisite for admission to the M.Arch. as a second professional degree.

Special Application Requirements—Applicants for the four-year program must complete a design exercise prepared by the School of Architecture and must submit three letters of recommendation to the director of graduate studies in addition to meeting the Graduate School application requirements. Examples of original design work, in 8½″ × 11″ portfolio format, are encouraged. The Graduate Record Examination is not required, but candidates who wish to submit scores are encouraged to do so. Prospective students are encouraged to contact the director of graduate studies before applying for admission. A statement of intent is helpful.

Students seeking entry with advanced standing (such as those with preprofessional degrees) and students applying to enter the M.Arch. as a second professional degree must submit portfolios. An 8½″ × 11″ format is recommended.

Fall quarter candidates for the four-year program must apply by April 1. All others (including those with preprofessional or professional degrees) are advised to apply by February 1 (although fall admission for advanced level students can take place as late as mid-July). Since fellowship nominations are made in early February, students with outstanding academic records should apply by January 15 for fall quarter admission. Admission to the first graduate design course in each year is normally limited to fall quarter.

Degree Requirements—Students who hold a nonarchitectural baccalaureate degree will normally need four years of study to earn the M.Arch., and will study under Plan A. Those who hold a four-year preprofessional or nonarchitectural baccalaureate degree, coupled with the required prerequisite technical courses, will also follow a Plan A program but for a shorter period (which generally involves six quarters of graduate design, including five studio quarters and a partially overlapping two-quarter thesis). Required support courses and electives complete the sequence. Students who hold the B.Arch. degree (i.e., those seeking a second professional degree) will study for four quarters, and may follow either a Plan A or Plan B program. Plan A requires 44 credits, which includes a thesis; Plan B requires 44 credits and three major papers.

Specific requirements for the master of architecture program will depend on the content of the undergraduate program and may occasionally exceed the Graduate School minimum. The total requirement for a program will be determined in consultation with the adviser and director of graduate studies.

Degree programs in architecture are exempted from the Graduate School minor or related field requirements. Programs often, however, include coursework from one or more departments outside of architecture.

Language Requirements—None.

Minor Requirements for Students Majoring in Other Fields—No minor is offered in architecture.

For Further Information—Contact the director of graduate studies, School of Architecture and Landscape Architecture, 110 Architecture Building, University of Minnesota, 89 Church Street S.E., Minneapolis, MN 55455.

Note—See also the program in Landscape Architecture.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

5051. ANCIENT ARCHITECTURE. (4 cr; prereq 1021 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.

5052. EARLY MEDIEVAL ARCHITECTURE. (4 cr, §ArtH 5052; prereq 1021 or #; 3 lect and 1 seminar hrs per wk)
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.

5053. GOTHIC ARCHITECTURE. (4 cr, §ArtH 5053; prereq 1021 or #; 3 lect and 1 seminar hrs per wk)
History of development of architecture and urban design in Western Europe from 1150 until 1400 A.D.

5054. RENAISSANCE AND BAROQUE ARCHITECTURE. (4 cr, §ArtH 5054; prereq 1021 or #; 3 lect and 1 seminar hrs per wk)
History of development of architecture and urban design in Italy, Spain, France, Germany, and the low countries from 1400 until the French Revolution.

5055. 18TH-CENTURY ARCHITECTURE AND THE ENLIGHTENMENT. (4 cr, §ArtH 5055; prereq 1021 or #; 2 lect hrs per wk)
Architecture, urban planning, and garden design in Europe, 1700-1850.

5056. MODERN ARCHITECTURE. (4 cr, §ArtH 5056; prereq 1021 or #; 3 lect and 1 seminar hrs per wk)
Architecture and urban design from early 19th-century sources in Europe and America to World War II.

5057. ASIAN ARCHITECTURE. (4 cr, §ArtH 5057; prereq 1021 or #; 3 lect and 1 seminar hrs per wk)
Selected topics from history of architecture and urban design in West, South, and East Asia.

5061. CONTEMPORARY ARCHITECTURE. (4 cr; prereq architecture major, 1022, 3083 or #; 3 lect and 1 seminar hrs per wk)
Developments, theories, movements, and trends in architecture and urban design from World War II to the present.

5101-5102-5103. TUTORIAL WORK IN HISTORY OF ARCHITECTURE. (4 cr per qtr; prereq 12 cr upper div history or #, architecture major or adult special; 1 conf and 5 research hrs per wk; offered when feasible)
Reading and written reports on historical problems.

5104. SEMINAR: EUROPEAN ARCHITECTURE. (4 cr; prereq 5056 or 5061 or #; 4 seminar hrs per wk; offered when feasible)
Contemporary architecture from the beginning of the modern movement until the present time, with specific emphasis upon the contributions of August Perret, Peter Behrens, Walter Gropius and the Bauhaus, Le Corbusier, and the early work of Mies van der Rohe.

5105. SEMINAR: SCANDINAVIAN ARCHITECTURE. (4 cr; prereq 5056 or 5061 or #; 4 seminar hrs per wk; offered when feasible)
Survey of Scandinavian architectural history, with emphasis on origin and development of modern architecture in Denmark, Finland, Norway, and Sweden.

5106. SEMINAR: AMERICAN ARCHITECTURE. (4 cr; prereq 5056 or 5061 or #; 4 seminar hrs per wk; offered when feasible)
Contemporary architecture in the United States from the period of Henry Hobson Richardson until the present time and including contributions of Louis H. Sullivan, Frank Lloyd Wright, Eliel and Eero Saarinen, Walter Gropius, Mies van der Rohe, Louis Kahn, Ralph Rapson, Robert Venturi, Frank Gehry, Michael Graves, and others.

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, IT architecture major; 18 lab hrs per wk)
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.

5116. STRUCTURE AND FORM IN ARCHITECTURE. (4 cr per qtr; prereq 3093 and CE 3602 , IT architecture major or adult special)
Form as interface between programmatic requirements for environmental change and physical means available to the architect: social paradigm and physical environment; search for organizational principles of architectural form; geometrical order, properties of materials, distribution of forces, construction techniques, experimental work on models.

5121-5122. ARCHITECTURAL DESIGN. (6 cr per qtr; prereq 5113 and CE 3602, architecture major)
Building design and development in the urban context. Individual and collaborative effort; survey and analysis of urban problems; reporting and preparation of large-scale proposals; design process.

5124. BUILDING DEVELOPMENT PROCESS. (4 cr; prereq 3062 or LA 3075, 3093 or LA 3093, or #)
Architectural design process parallel to building project management and development processes. Control of scope of work, quality, schedule and budget management, organizational settings, system-based estimating, construction and delivery systems, logic networks, analysis by case study methods.

5125. REAL ESTATE DEVELOPMENT. (4 cr; prereq sr or grad student in architecture or #)
Fundamentals of real estate development and investment building. Processes and roles of specialists in the development of investment projects. Three lectures per week plus research assignments.

5126. PROFESSIONAL PRACTICE. (4 cr; prereq 3rd-yr design or ¶, architecture major or adult special)
Relations of architect to clients, contractors, and fellow practitioners; procedures of architectural practice, preparation of contract documents.

5127, 5128. LAW FOR ARCHITECTS. (4 cr per qtr; prereq 3093 or △; 2 lect hrs per wk)
Legal subject matter relevant to work of architects and design professionals.

5129. LAW FOR ARCHITECTS SEMINAR. (4 cr; prereq 3093, 5128 or #; 4 seminar hrs per wk; offered when feasible)
(Continuation of 5127, 5128) Series of case studies dealing with legal subjects relevant to work of architects and design professionals; individual research assignments.

5134, 5135, 5136. PLANNING. (3 cr per qtr; prereq #; offered when feasible)
Individual problems and research in planning.

5137. PLANNING: URBAN FUNCTION AND STRUCTURE. (4 cr; prereq 3093 or #)
Economic, technological, and social factors that underlie the location, distribution, and internal structure of urban settlements. Quantitative and qualitative analysis of social, economic, and physical problems or consequences of contemporary urbanization.

5138. PLANNING: THEORY AND METHODOLOGY. (4 cr; prereq 5137 or #)
Logic of a planning process as a method of decision making. Formulation of goals and evaluation of alternative courses of action, standards, and requirements for specific planning objectives (housing, transportation, and community facilities). Legal, administrative, and fiscal devices for plan implementation. Place of the planning function in government and the role of citizens and private groups.

5141. HISTORIC PRESERVATION PROCESS. (4 cr; prereq 1021 or #; 4 lect hrs per wk)
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.

5142. HISTORIC BUILDING CONSERVATION. (4 cr; prereq 5141 or #; 2 lect and 2 lab hrs per wk)
Historic building systems and materials and methods for their conservation; introduction to use of contemporary systems in historic buildings.

5143. HISTORIC BUILDING RESEARCH AND DOCUMENTATION. (4 cr; prereq 5141 or #; 2 lect and 2 lab hrs per wk)
Philosophy, theory, and methods of historic building research, descriptive analysis of buildings, building documentation, historical archaeology, and architectural taxonomy.

5155. URBAN DEVELOPMENT PROCESS. (3 cr; prereq #; offered when feasible)
History of urban development programs in the United States, including urban renewal, new communities and community development, review of relevant legislation, economics and politics of urban development process.

5156. URBAN DEVELOPMENT PROCESS. (3 cr; prereq 5155 or #; offered when feasible)
(Continuation of 5155) Comparative study of major urban development projects drawing on American and European experience. Process through which development projects are planned and executed.

5170. CITYSCAPE. (3 cr; prereq 3093 or #)
The city and its components as aesthetic elements; factors that have helped to generate urban form.

5850. TOPICS IN THEORY. (Cr ar; prereq architecture major or adult special)
Special topics in architecture in a philosophical and theoretical context.

5852. ARCHITECTURE: THEORY AND PHILOSOPHY. (3 cr; prereq 3093 or #, architecture major or adult special)
Architecture in a general philosophical context: nature, role, purpose, meaning, definition, and mode of operation as a discipline and in relation to other fields.

5853. ARCHITECTURE AS THOUGHT—DESIGN PROCESS. (3 cr; prereq 3093 or #, architecture major or adult special; offered when feasible)
Architecture as a thought, creative, and transformational process; underlying attitudes, paradigms, models, strategies, and tools, and their potential, limitations, implications, formal outcome, and meaning.

5854. THE LANGUAGE OF ARCHITECTURE: SEMIOTICS, SYMBOLISM, AND METAPHOR. (3 cr; prereq 3083 or #, architecture major or adult special)
Communicative dimensions of architecture, especially as they relate to linguistic analogies. Broad historical perspective including current aspects of subject.

5855. TYPOLOGY AND ARCHITECTURE: THEORIES OF ANALYSIS AND SYNTHESIS. (3 cr; prereq 3083 or #, architecture major or adult special)
Theoretical traditions and development of the use of typology in architecture. Works of Laugier, Quatremere De Quincy, Viollet-Le-Duc, Ledoux, Durand, Camillo Sitte, and LeCorbusier. Recent developments and theoretical positions of the "neorationalist" and "contextual" arguments for contemporary applications of typology.

5856. ARCHITECTURE: FORM AND MEANING. (3 cr; prereq 3093 or #, architecture major or adult special)
Architectural form, order, and meaning relative to architecture as an aesthetic, social, environmental, and technical object. Current theories and concepts; their potential and implications.

5950. TOPICS IN ARCHITECTURE. (Cr ar; prereq 3093 or #)
Special topics of concern to the field of architecture.

5951. ARCHITECTURE AND BEHAVIOR. (3 cr; prereq 3083 or #, architecture major or adult special)
Relation between people and built environments. Theoretical basis for exchange between designers and behavioral scientists; impact of knowledge or behavior on design process (design/evaluation/programming cycle); behavioral findings; problems of implementation. Guest lecturers and reading of materials from related disciplines.

5952. PROGRAMMING FOR ARCHITECTURAL DESIGN. (4 cr; prereq 3093 or #, architecture major or adult special)
Principles of programming explored through case study method. Guest lectures on how principles are applied in architectural practice. Students develop program for a specific academic design problem. Examination of procedures, site selection, function analysis and relationship diagrams, assumptions examination, form options, and design directives.

5953. HOUSING AND VALUES. (3 cr; prereq upper division or grad student; 3 lect/discussion hrs per wk)
Meanings and values attached to housing in different cultures, at various stages in the lifecycle, and in differing climatic situations. Impact of housing heritage on housing choice, potential impact of emerging constraints (such as energy availability) on current and future housing decisions.

5954. ARCHITECTURE AND BEHAVIOR RESEARCH METHODS. (3 cr; prereq 3083 or #, architecture major or adult special)
Use of behavior research in architectural practice; evaluation of buildings, architectural programming methods, application of findings in architectural design. Students design and implement a small behavioral research project.

5956. THE MEANINGS AND MESSAGES OF PLACE: CITY, TOWN, AND COUNTRYSIDE. (4 cr; prereq upper div undergrad or grad Arch or Land Arch major or #)
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.

5958. ENERGY AND ARCHITECTURE. (4 cr; prereq 3093 or #, architecture major or adult special)
Relationship of conservation, passive solar, and active solar strategies in design of small buildings. Exercises and case studies provide direct experience with systems, calculating techniques, and evaluative methods as basis for understanding space-heat requirements.

5959. LIGHTING AND ARCHITECTURAL DESIGN. (4 cr; prereq arch major, 3083, 3065 or #)
Lighting in architectural design through analysis of buildings, simulation techniques, and design.

5961. COMPUTER-AIDED ARCHITECTURAL DESIGN. (4 cr; prereq architecture major, 3083 or #)
Introduction to computing and Pascal programming. Methods, hardware, software, problems, and potentials of computer-aided architectural design; weekly projects using Terak microcomputers as design tool.

5962. COMPUTER-AIDED ARCHITECTURAL DESIGN. (4 cr; prereq 5961 or #, architecture major)
Application of principles and practice of computer-aided design and drafting the architecture.

5963. ADVANCED COMPUTER-AIDED ARCHITECTURAL DESIGN. (4 cr; prereq 5962 or #, Arch and LA majors)
Large-scale computer-aided drafting, site modeling, facilities management, solid modeling, and design simulation. Expert systems language and application to design processes.

5970. DIRECTED STUDY. (Cr ar; prereq #)
Areas of study useful to individual program objectives not available in regular course offerings.

8201, 8202, 8203. SPECIAL RESEARCH IN ARCHITECTURAL HISTORY. (Cr ar; prereq 5056 or #; offered when feasible)

8231, 8232, 8233. PLANNING. (Cr ar; offered when feasible)
Individual problems and research in planning.

8251, 8252, 8253, 8254, 8255, 8256.* ARCHITECTURAL DESIGN. (6 cr per qtr; prereq architecture grad; 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; architecture grad)
Advanced architectural design problems; research and development of significant architectural form. Individual and collaborative effort.

8271, 8272, 8273, 8274, 8275, 8276. PROBLEMS IN CITY AND COMMUNITY DESIGN. (1-9 cr per qtr; prereq Arch grad student; offered when feasible)
Studies in the development of city spaces and urban character as they relate to changing socioeconomic needs and advancing technologies.

Art Education

See Curriculum and Instruction.

Art History (ArtH)

Professor: Gabriel Weisberg, *chair;* Frederick Asher; Norman Canedy; Frederick Cooper; Karal Ann Marling; Sheila McNally; Marion Nelson; Robert J. Poor

Associate Professor: Michael Stoughton, *director of graduate studies;* W. John Archer; Charles Haxthausen; Robert Silberman; John Steyaert

Adjunct Faculty: Michael P. Conforti; Robert D. Jacobsen; George S. Keyes; Lyndel I. King

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: American, Baroque, East Asian, film studies, Italian Renaissance, late Gothic/northern Renaissance, popular art, nineteenth- and twentieth-century, Scandinavian, and South Asian.

Prerequisites for Admission—For the M.A. program, a bachelor's degree in any subject and evidence of academic excellence, preferably in art history. For the Ph.D. program, an M.A. degree in art history or in a field or discipline closely related to the chosen area of specialization, and a minimum of four graduate courses in art history.

Special Application Requirements—For the M.A. program: results from the Graduate Record Examination General Test, at least one term paper in art history or a related field, and three letters of recommendation. For the Ph.D. program: an M.A. thesis or extended research paper, and three letters of recommendation. Admission to the Ph.D. program requires written declaration of an area of specialization offered by the department (see Curriculum above).

Applications for the M.A. degree are reviewed once a year. Application forms, official transcripts, and GRE scores must reach the Graduate School by January 15. Photocopies of transcripts, GRE scores, and the statement of purpose, along with other supporting materials, must be sent directly to the department by that date. For the Ph.D. program, application forms and supporting materials must reach the Graduate School and the department at least 8 weeks before the quarter of entry. Applications are not processed during the summer. The deadline for all applications for financial aid is January 15 preceding the academic year for which aid is sought.

Master's Degree Requirements—A minimum of 44 credits is required; 36 must be in art history and 8 outside art history. The student and an academic adviser selected by the student plan a program of study responsive to the special needs and interests of the student. Courses must include: Methods of Research, a concentration, a distribution, and two seminars. One Plan B paper is required. A written examination must be successfully completed, normally during the sixth quarter of full-time work.

Doctoral Degree Requirements—The Ph.D. program is designed by the student in consultation with the faculty adviser and other faculty members in or outside the department in related areas of interest. Coursework, including previous credits accepted from the M.A. degree, should amount to no fewer than 70 credits. In addition, 36 doctoral thesis credits are required.

Language Requirements—For the M.A. degree, students must attain reading proficiency in either French or German no later than the third quarter of residence. For the Ph.D., reading knowledge of two foreign languages, normally French and German, is required. Substitutions may be made with departmental approval.

Minor Requirements for Students Majoring in Other Fields—A minimum of 16 graduate credits in art history, including Methods of Research, is required.

For Further Information—Contact the director of graduate studies, Department of Art History, 107 Jones Hall, University of Minnesota, 27 Pleasant Street S.E., Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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.

5053. GOTHIC ARCHITECTURE. (4 cr, §Arch 5053; prereq Arch 1021 or #)
Architecture and urban design in Western Europe from 1150 to 1400 A.D.

5054. RENAISSANCE AND BAROQUE ARCHITECTURE. (4 cr, §Arch 5054; prereq 1021 or #)
Architecture and urban design in Italy, Spain, France, Germany, and the low countries from 1400 A.D. to the French Revolution.

5055. 18TH-CENTURY ARCHITECTURE AND THE ENLIGHTENMENT. (4 cr, §Arch 5055; prereq Arch 1021 or #)
Architecture, urban planning, and garden design in Europe, 1770-1850.

5056. MODERN ARCHITECTURE. (4 cr; §Arch 5056; prereq Arch 1021 or #)
Architecture and urban design from early 19th-century sources in Europe and America to World War II.

5057. ASIAN ARCHITECTURE. (4 cr, §Arch 5057; prereq Arch 1021 or #)
Selected topics from history of architecture and urban design in West, South, and East Asia.

5103. HELLENISTIC ART AND ARCHAEOLOGY. (4 cr, §Clas 5103; prereq jr or #) Coulson, McNally
Survey of sculpture, architecture, painting, and topography in developing centers of Hellenistic culture in eastern Mediterranean areas from beginning of 4th century B.C. to end of Hellenistic period.

5104. ROMAN ARCHITECTURE. (5 cr, §Clas 5104; prereq jr or #) Cooper, McNally
Types and techniques of buildings in the city of Rome and throughout 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 #) McNally
General introduction to Roman painting and mosaics; specific problems and sites such as Pompeii and Antioch.

5106. GREEK PAINTING. (5 cr, §Clas 5106; prereq jr or #; offered every 3rd yr) McNally
Methods of research and analysis in classical art as applied to study of vases; investigation of original objects and of sources.

5107. ROMAN SCULPTURE. (4 cr, §Clas 5107; prereq jr 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 #) 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.

5113. ARCHAIC AND CLASSICAL GREEK ART AND ARCHAEOLOGY. (4 cr, §Clas 5113; prereq jr or #) Coulson, McNally
Architecture, sculpture, and painting in Greek lands 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.

5122. INTRODUCTION TO HISTORICAL ARCHAEOLOGY OF THE U.S.A. (4 or 5 cr; prereq #) McNally
Theories and methods of studying advanced societies (e.g., Williamsburg, Fort Snelling, Winchester) through written records and material remains.

5123. ADVANCED STUDIES IN THE HISTORICAL ARCHAEOLOGY OF THE U.S.A.. (5 cr; prereq 5122 or #) McNally
Design and completion of projects testing theory and methodology of historical archaeology.

5203. EARLY MEDIEVAL ART. (5 cr; prereq one art history course or grad student or #)
Architecture, sculpture, painting, and selected minor arts of the Mediterranean world and of Western Europe from early Christian to Romanesque period.

5210. TOPICS IN MEDIEVAL ART. (5 cr; prereq 4 cr in medieval art history or medieval history or #) Steyaert

5214. GOTHIC ARCHITECTURE. (5 cr; prereq 4 cr medieval art history or #; offered alt yrs) Steyaert
Gothic architecture from the mid-12th to the early 16th centuries in France, Germany, England, Italy, and Spain; later regional variants produced.

5215. ROMANESQUE AND GOTHIC PAINTING. (5 cr; prereq 4 cr medieval art history or #; offered alt yrs) Steyaert
Wall and panel painting, mosaics, and manuscript illumination in France, Germany, England, Italy, and Spain from the 11th to the 14th centuries.

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.

5306. ITALIAN ART OF THE 14TH CENTURY. (4 cr; prereq one art history course or #; offered alt yrs) Canedy
Emergence of Italian painting and the proto-Renaissance; subsequent counterdirections during the periods of the black death and international style.

5307. 15TH-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 utilized.

5324. 15TH-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.

5326. 16TH-CENTURY PAINTING IN NORTHERN EUROPE. (4 cr; prereq 3011 or grad student or #) Steyaert
Northern Renaissance painting in Germany, the Netherlands, and France.

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 ENGLAND, FRANCE, AND LOWLANDS. (5 cr; prereq 3011 or grad student or #; offered alt yrs) Stoughton
French architecture, painting, and sculpture, Flemish and Dutch painting, and English painting and architecture of the 17th century. Emphasis on major artists: Rembrandt, Rubens, Poussin, Jones.

5357. 18TH-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. 18TH-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 19-CENTURY GRAPHIC ARTS. (5 cr; 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, Gaverni), 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.

5431. AGE OF REVOLUTION: FRENCH PAINTING FROM 1789 TO 1848. (5 cr, §5441; 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.

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, §5442; prereq one 3xxx art history course or grad student or #) Weisberg
Major styles and movements: post-impressionism, symbolism, fin de siècle, jungendstil.

5443. 19TH-CENTURY GERMAN PAINTING. (5 cr; prereq one 3xxx or 5xxx art history course or grad student or #) Haxthausen
Major movements, groups, and artists in the Germanic lands: Runge, Friedrich, the Nazarenes, Biedermeier, the Leibl circle, Menzel, Marées, Böcklin.

5444. LANDSCAPE PAINTING. (5 cr; prereq one 3xxx or 5xxx art history course or grad student or #) Staff
Landscape painting and theory in Europe from 1600 to 1900 with emphasis on developments in England and France from mid-18th century.

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 U.S. 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 American or modern art course or #) Haxthausen
Modern painting mainly before the mid-1920s.

5464. LATER 20TH-CENTURY PAINTING. (5 cr; prereq one American or modern art course or #) Haxthausen
Modern painting after the mid-1920s.

5466. THE AVANT-GARDE. (5 cr; prereq 3012 or 5463 or #; offered alt yrs) Haxthausen
History and theory of the avant-garde as applied to problems of contemporary art: anti-art tendencies and movements, John Cage, Buckminster Fuller, Marshall McLuhan, rock music and the counterculture, structuralism, pop art, and conceptual art.

5468. MODERN ART CRITICISM I. (5 cr; prereq 3012 or 3467 or 5463 or 5465 or #) Haxthausen
Major critics of visual art from late 18th century to World War II, from Diderot to Herbert Read.

5469. MODERN ART CRITICISM II. (5 cr; prereq 3012 or 3467 or 5463 or 5465 or #) Haxthausen
Major critical approaches to modern art from World War II to the present; analysis of works of influential contemporary working critics. Criticism workshop.

5471. ART IN CENTRAL EUROPE, 1893-1918. (5 cr; prereq 3012, grad or #) Haxthausen
Painting, sculpture, and graphic art in German-speaking Europe from founding of Secessions to end of WWI. Impressionism, jugendstil, expressionism. Style, criticism, theory, and art institutions. Corinth, Munch, Kirchner, Nolde, Klimt, Kokoschka, Kandinsky, Marc.

5472. ART IN CENTRAL EUROPE BETWEEN THE WORLD WARS. (5 cr; prereq 3012 or grad student or #) Haxthausen
Major artistic tendencies in German-speaking Europe from 1919 to 1938: Dada, the Bauhaus, realism. Style, theory, contemporary criticism, art institutions, relations between art and politics. Artists include Beckmann, Dix, Grosz, Kandinsky, Klee, Schwitters.

5521. 20TH-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 #) 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.

5641. SCANDINAVIAN ART OF THE 19TH AND 20TH CENTURIES. (5 cr, §Scan 5641; prereq one art history course or #) Nelson
Painting, sculpture, architecture, and decorative arts; rise of expressionism in the fine arts and "Scandinavian modern" in design.

5643. PREHISTORIC ART OF NORTHERN EUROPE. (4 cr; prereq one art history course or #) Nelson
Art north of the Alps from the Ice Age through the Celtic period. Includes cave painting, sculpture, funerary architecture, ceramics, and metalwork.

5644. MEDIEVAL ART OF SCANDINAVIA. (4 cr, §Scan 5644; prereq one art history course or #) Nelson
Migration, Viking, and Christian art in Scandinavia from the 5th through the 15th centuries. Architecture, sculpture, painting, with emphasis on minor arts.

5645. FOLK ARTS OF SCANDINAVIA. (4 cr, §Scan 5645; prereq one art history course or #) Nelson
Wood carving, metalwork, decorative painting, weaving, stitchery, and domestic architecture of rural Scandinavia; origins in pagan and medieval art.

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 #; offered alt yrs) Poor
Direct examination of Oriental art objects in local collections.

5774. THE ART OF ASIA: PERSPECTIVE AND PROBLEMS. (5 cr; prerq grad or #; A-F only) Asher, Poor
Overview of art in India, China, and Japan, selected problems. Lectures and journal articles representing various approaches to history of art.

5775. EARLY INDIAN ART. (5 cr; prereq 4 cr art history or #) 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 #) 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 #) 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.

5895. METHODS OF RESEARCH IN ART HISTORY. (4 cr, §8801; prereq sr art history major or #) For highly qualified undergraduate majors intending to pursue professional training and for incoming master's majors.

5911. MESOAMERICA: ART AND ARCHITECTURE OF MEXICO AND GUATEMALA. (5 cr; prereq sr or grad student or #; offered alt yrs) Staff
Primarily pre-Hispanic monuments in Mexico and Guatemala, with emphasis on Olmec, Teotihuacan, and Mayan cultures.

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.

5923. ART OF THE FILM. (4 cr; prereq #; offered when feasible) Silberman
Aesthetics of the film. Editing, montage, sound, use of camera.

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 #)
Topics specified in *Class Schedule*.

5970. DIRECTED READINGS. (1-5 cr; prereq sr, #, △, CLA approval) Staff

5990. DIRECTED RESEARCH. (1-5 cr; prereq sr, #, △, 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

8320. SEMINAR: PROBLEMS IN NORTHERN RENAISSANCE ART. (4 cr; prereq 9 cr art history or #) Steyaert

8330. SEMINAR: PROBLEMS IN ITALIAN RENAISSANCE ART. (4 cr; prereq one Renaissance art history course, #) Canedy

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 #) Haxthausen

8520. SEMINAR: AMERICAN ART. (4 cr; prereq #) Marling

8650. SEMINAR: STUDIES IN SCANDINAVIAN ART. (4 cr; prereq #) Nelson

8660. SEMINAR: PREHISTORIC EUROPE. (4 cr; prereq 5643 or 5655 or #) Nelson
Selected topics or problems in art of prehistoric Europe.

8720. SEMINAR: ORIENTAL ART. (4 cr; prereq #) Poor

8770. SEMINAR: ART OF INDIA. (4 cr; prereq #) Asher

8801. HISTORIOGRAPHY. (4 cr; prereq #) Staff
History of art history and study of contemporary philosophies of art history and criticism.

8810. BIBLIOGRAPHY. (4 cr; prereq #) Staff

8910. SEMINAR: PROBLEMS IN CLASSICAL ARCHAEOLOGY. (4 cr [may be repeated for cr], §Clas 8910; prereq #) Cooper, McNally

8970. DIRECTED STUDIES. (1-5 cr; prereq #) Staff

8975. DIRECTED MUSEUM STUDIES. (1-3 cr; prereq art history major or 8992-8993, △) Staff
Projects in museum studies based on the literature, practice, or internship.

Arts, Studio

See Studio Arts.

Astronomy and Astrophysics (Ast)

Regents' Professor: Edward P. Ney

Professor: Thomas W. Jones, *chair*; Lawrence Rudnick, *director of graduate studies*; Kris D. Davidson; Phyllis S. Freier; Robert D. Gehrz; Roberta M. Humphreys; Paul J. Kellogg; Robert O. Pepin; Wayne A. Stein; C. J. Waddington; Paul R. Woodward

Associate Professor: John M. Dickey; Terry J. Jones; Robert C. Kennicutt, Jr.; Robert L. Lysak; Keith A. Olive

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

Degrees Offered—Astronomy: M.S. (Plan A and Plan B); Astrophysics: 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, and the cosmic distance scale. 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 jointly operates a 60-inch telescope on Mt. Lemmon, near Tucson, Arizona, with the University of California, San Diego. It is well

equipped for both optical and infrared observations. A 30-inch telescope is maintained at the O'Brien Observatory about 40 miles from the Twin Cities campus. Plans are under development for a major (3.5 meter) observatory in the Southwest. Excellent shop facilities support our instrument development for the telescopes at O'Brien and Mt. Lemmon and for major national observatories such as the NASA Infrared Telescope Facility (IRTF) in Hawaii.

The unique Automated Plate Scanner (APS) is available for measuring the positions and magnitudes of stars and galaxies. This machine simultaneously scans two photographic plates of the same field and can analyze 100,000 images per hour. Plates of different colors or epochs can be compared for very rapid surveys. The APS also performs densitometry studies of extended objects and measurement and reduction of spectra. A color image-processing system is used for interactive analysis of images.

Another image-processing system is coupled to a departmental VAX/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 a 1.5 Mbyte/sec network to Cray 2 and Cyber 205 supercomputers at the University's Supercomputer Institute. 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; and the IRTF in Hawaii.

Prerequisites for Admission—For major work, Ast 3051 or the equivalent, differential and integral calculus, and two years of college physics are required. Advanced undergraduate work in physics is strongly recommended.

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 for fall quarter are due February 1.

Master's Degree Requirements—Two quarters of the classical physics sequence Phys 5051-5052-5053 and three 5xxx astronomy courses are required. 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 placement test in physics is taken during spring of the first year, with the comprehensive examination in astrophysics taken during spring of the second year. After a thesis topic and adviser are selected, by the end of the third year, an oral examination is taken that focuses on the thesis area.

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—Contact the director of graduate studies, Department of Astronomy, University of Minnesota, 116 Church Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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.

5063. COMPUTATIONAL METHODS IN THE PHYSICAL SCIENCES III. (4 cr, §Phys 5063; prereq CLA jr or sr or IT upper div student or grad student, Phys/Ast 5062, or #; 2 lect, 6 lab hrs per wk)
Simulation of complex physical systems by advanced computational techniques using the Supercomputer Institute Cray-2 and/or Cyber 205. Major project selected by student in areas such as plasmas, stellar systems and evolution, magnetohydrodynamics, fluid or aerodynamic flow, molecular dynamics, statistical mechanics.

5161.* ASTROPHYSICS OF DIFFUSE MATTER. (4 cr; prereq 3051, Phys 5024 or #)
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 #)
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 #)
Structure and evolution of external galaxies. Classification, stellar and gaesous contents, kinematics and dynamics, extragalactic distance scale, clusters, galactic nuclei and associated activity.

5165.* COSMOLOGY. (4 cr; prereq Phys 3513 or #)
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.

5321.* RADIATION PROCESSES IN ASTROPHYSICS. (4 cr; prereq Phys 5024, 5102 or #)
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 #)
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 #)
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 #, △)
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)
For students who are prepared for advanced work along specific lines.

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

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: COSMIC RAY AND SPACE PHYSICS

Phys 8411-8412.* COSMIC RAY AND SPACE PHYSICS

Phys 8421-8422.* SOLAR AND MAGNETOSPHERIC PHYSICS

Biochemistry

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.[1]

Curriculum—A joint graduate program in biochemistry is offered by the two departments of biochemistry in the College of Biological Sciences and the Medical School. Four designated areas of biochemistry are: general biochemistry/enzymology, physical biochemistry, biochemical aspects of molecular biology, and physiological chemistry. Students may select a major in one area and take courses from other areas to fulfill a minor or supporting program.

Prerequisites for Admission—Prospective students generally should have completed courses in analytical, organic, and physical chemistry as well as undergraduate biochemistry. In addition, students are required to have upper division biology courses on their record. The latter are sometimes taken as part of the graduate program. Applicants may be admitted without some of these prerequisites, but usually will be expected to satisfy them before enrollment.

Special Application Requirements—Three letters of recommendation, a complete set of official transcripts, and official scores from the General (Aptitude) Test of the Graduate Record Examination (GRE) are required; the biology or chemistry Subject (Advanced) Test of the GRE is strongly recommended.

Master's Degree Requirements—Students must satisfactorily complete one year of graduate biochemistry (5751-5752-5753), laboratory courses, 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 (5751-5752-5753), laboratory courses, and two special topics biochemistry courses and must participate in seminars. For more information, contact the director of graduate studies.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Department of Biochemistry, 4-225 Millard Hall, University of Minnesota, 435 Delaware Street S.E., Minneapolis, MN 55455, or 140 Gortner Lab, 1479 Gortner Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Biochemistry (BioC)

(College of Biological Sciences)

Professor: Victor A. Bloomfield, *head;* Gary L. Nelsestuen, *director of graduate studies;* John S. Anderson; Bianca M. Conti-Tronconi; James A Fuchs; Gary R. Gray[6]; Alan B. Hooper[8]; Charles F. Louis[7]; Rex E. Lovrien; Eckard Muenck[2]; Palmer Rogers[3]; Ulysses S. Seal[5]; Kamil Ugurbil[2]; John M. Wood[2]; Clare K. Woodward

Associate Professor: Michael C. Flickinger[4]; Janet L. Schottel

Assistant Professor: David A. Bernlohr; Anath Das; William J. Sharrock; Terry P. Lybrand[9]; Lawrence P. Wackett[2]

[1]*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.*

[2]*Member of Gray Freshwater Biological Institute staff*

[3]*Primary appointment in Department of Microbiology*

[4]*Member and head, Bioprocess Technology Institute*

[5]*Member of Veterans Administration staff*

[6]*Primary appointment in Department of Chemistry*

[7]*Primary appointment in Department of Veterinary Biology*

[8]*Primary appointment in Department of Genetics and Cell Biology*

[9]*Primary appointment in Department of Medicinal Chemistry and Pharmacognosy*

5002w,s. TOPICS IN BIOCHEMISTRY. (3 cr; prereq Biol 5001)
Biol 5001, BioC 5002 constitute a two-quarter sequence for undergraduate and graduate students lacking physical chemistry and serve as a prerequisite for certain advanced courses.

5025f,w,s. LABORATORY IN BIOCHEMISTRY. (2 cr; prereq Biol 5001 or ¶Biol 5001)
Discussions of techniques and problem-solving approaches illustrated with laboratory experiments and demonstrations.

5525 (formerly 5522). PHYSICAL BIOCHEMISTRY: SOLUTION STRUCTURE AND INTERACTIONS OF BIOLOGICAL MACROMOLECULES. (4 cr, §MdBc 5525, §Chem 5525; prereq 2 qtrs physical chemistry; Biol 5001 or equiv)
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.

5526 (formerly 5523, 8260). PHYSICAL BIOCHEMISTRY: SPECTROSCOPIC METHODS I. (4 cr, §MdBc 5526, §Chem 5526; prereq 2 qtrs physical chemistry)
Lecture on fundamental spectroscopic principles emphasizing development of magnetic resonance theory used in study of biological macromolecules.

5527 (formerly 5523). PHYSICAL BIOCHEMISTRY: SPECTROSCOPIC METHODS II. (4 cr, §MdBc 5527, §Chem 5527; prereq 2 qtrs physical chemistry, BioC/MdBc 5526)
Applications of optical and magnetic resonance techniques to study of structure and dynamics in proteins, lipids, nucleic acids, and synthetic analogs.

5528 (formerly 5524). PHYSICAL BIOCHEMISTRY: ENZYME KINETICS. (4 cr, §MdBc 5528, §Chem 5528; prereq 2 qtrs physical chemistry, BioC/MdBc 5751 or Biol 5002 or equiv desirable)
Theory and application of steady-state and transient kinetics for study of enzymes, enzyme systems, and cellular regulation.

5744. ANALYTICAL BIOCHEMISTRY. (4 cr; prereq lab work in analytical and organic chemistry, #)
Principal techniques of biochemistry experimental work; instrumentation and methods for isolation and characterization of proteins, lipids, and carbohydrates. Chromatography, electrophoresis, spectrophotometry, potentiomentry, and fluorimetry.

5751f-5752w-5753s. GENERAL BIOCHEMISTRY. (4 cr per qtr, §MdBc 5751-5752-5753; prereq 3 qtrs organic chemistry, 2 qtrs physical chemistry, 1 qtr biochemistry or #)
Comprehensive discussion of structure, function, metabolism, and metabolic regulation of components in biological systems.

5950f,w,s. SPECIAL TOPICS. (1-5 cr; prereq #, △)

5970. DIRECTED STUDIES. (Cr ar; prereq #, △) Staff
Individual study of selected topics; selected readings and use of scientific literature.

5990. DIRECTED RESEARCH. (Cr ar; prereq #, △)
Laboratory or field investigation of selected areas of research.

8094. RESEARCH AND LITERATURE REPORTS. (1 cr) Staff
Current developments in biochemistry.

8194. GRADUATE SEMINAR. (1 cr) Staff
Reports on recent developments in biochemistry and on research projects in department.

8206. CELL SIGNALLING AND METABOLIC REGULATION I. (3 cr, §MdBc 8206; prereq BioC/MdBc 5751-5752-5753 or equiv)
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.

8207. CELL SIGNALLING AND METABOLIC REGULATION II. (3 cr, §MdBc 8207; prereq BioC/MdBc 5751-5752-5753 or equiv)
Qualitative and quantitative aspects of metabolic control theory; covalent modification and allosteric regulation of mechanisms of enzyme activity changes in regulatory processes; control of metabolism by transcription and translation, including catabolite repression, steroid and thyroid hormones; examples of coordinate metabolic regulation from current literature.

8213f. ADVANCED MOLECULAR BIOLOGY I. (4 cr, §GCB 8213, §MdBc 8213; prereq BioC/MdBc 5753 or GCB 5032 or #) Staff
Lectures, readings, and discussions. Topics include DNA replication, recombination and gene conversion, regulation of gene expression in procaryotes, regulation of gene expression in eucaryotes, chromatin structure and transcription, organellar gene expression.

8214. ADVANCED MOLECULAR BIOLOGY II. (4 cr, §GCB 8214, §MdBc 8214; prereq BioC/MdBc 5753 or GCB 5032 or #) Staff
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.

8225s. TRACER TECHNIQUES. (1-3 cr; prereq 5002 or 5751 or 5745 or MdBc 5750, #)
Laboratory work on application of radioisotopes to study of metabolic processes.

8230. ADVANCED TOPICS IN MEMBRANE BIOCHEMISTRY. (3 cr, §MdBc 8230; prereq 5753 or #; A-N only, offered alt yrs)
Lectures and readings on current topics in membrane structure, biosynthesis and function with emphasis on structural models, hormone receptors, neurotransmitters and excitable membranes.

8232w. ADVANCED TOPICS IN PROTEINS AND ENZYMES I. (3 cr, §MdBc 8232, 8233; prereq BioC 5751 or 5002 or MdBc 5100; A-N only)
In-depth analysis of the recent literature, with lectures, seminars, and assigned readings.

8233s (formerly 8221). ADVANCED TOPICS IN PROTEINS AND ENZYMES II. (3 cr, §MdBc 8233; prereq MdBc/BioC 5751 or #, MdBc/BioC 5526 desirable; A-F only)
Lectures and assigned readings on the nature and function of enzymes and proteins with emphasis on metalloenzymes and metalloproteins.

8250. SPECIAL TOPICS IN BIOCHEMISTRY. (1-3 cr; prereq 5002) Staff
Lectures and discussions on topics varying from quarter to quarter according to staff availability and needs of department.

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.

8990. GRADUATE RESEARCH. (2-5 cr; prereq #) Staff
Research problems in various fields in biochemistry represented by staff interests.

Biochemistry (MdBc)

(Medical School)

Professor: Harry P.C. Hogenkamp, *head;* John D. Lipscomb, *director of graduate studies;* Paul M. Anderson[7]; James W. Bodley; Mary E. Dempsey; Lester R. Drewes[7]; Nelson D. Goldberg; James B. Howard; James F. Koerner; Theodore R. Oegema[5]; Michael A. Raftery[1]; Andreas Rosenberg[2]; David D. Thomas; Howard C. Towle; Frank Ungar; John F. Van Pilsum

Adjunct Professor: Quenton T. Smith[3]

Associate Professor: Kenneth W. Adolph; Ronald D. Edstrom; Ernest D. Gray[4]; Thomas E. Huntley[7]; David C. LaPorte; Dennis M. Livingston; Joseph R. Prohaska[7]; Robert J. Roon; Wilmar L. Salo[7]

Assistant Professor: Michel M. Sanders[6]

5053f,w,s,su. PROBLEMS IN BIOCHEMISTRY. (Cr and hrs ar [may be repeated 1 or more qtrs for cr]; prereq 5753 or 5100)

5100f.[8] MEDICAL BIOCHEMISTRY. (6 cr; prereq registered medical freshman or grad) Livingston and staff

5101w. MEDICAL BIOCHEMISTRY. (4 cr; prereq 5100; primarily for med students) Livingston and staff

5201. BIOCHEMISTRY FOR DENTAL STUDENTS. (4 cr; prereq regis dental fr or grad)

5202. BIOCHEMISTRY FOR DENTAL STUDENTS. (3 cr; prereq 5201) Roon
A core biochemistry course.

5203f. TOPICS: DENTAL BIOCHEMISTRY. (Cr ar; prereq 5202) Smith
Biochemical topics related to dentistry.

5444s. MUSCLE CONTRACTION. (3 cr; prereq undergrad courses in biochemistry or physiology or #) Thomas, Louis, Poppele
Introduction to physiology, biochemical regulation, and physical chemistry of muscle contraction.

5460f. NEUROCHEMICAL COMMUNICATIONS. (4 cr, §NSc 5460, §VBio 5460; prereq biochemistry) Koerner, Wilcox, 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.

5525f. PHYSICAL BIOCHEMISTRY: SOLUTION STRUCTURE AND INTERACTIONS OF BIOLOGICAL MACROMOLECULES. (4 cr, §BioC 5525, §Chem 5525; prereq 2 qtrs physical chemistry, Biol 5001 or equiv) Bloomfield, Woodward
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 of determining biopolymer size and shape, including sedimentation, diffusion, viscosity, electrophoresis, and scattering.

5526w. PHYSICAL BIOCHEMISTRY: SPECTROSCOPIC METHODS I. (4 cr, §BioC 5526, §Chem 5526; prereq 2 qtrs physical chemistry) Muenck, Que
Lectures on fundamental spectroscopic principles with emphasis on development of magnetic resonance theory used in study of biological macromolecules.

[1]*Primary appointment in Department of Chemistry*

[2]*Primary appointment in Department of Laboratory Medicine and Pathology*

[3]*Primary appointment in School of Dentistry*

[4]*Primary appointment in Department of Pediatrics*

[5]*Primary appointment in Department of Orthopedic Surgery*

[6]*Primary appointment in Department of Medicine*

[7]*University of Minnesota, Duluth*

[8]*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.*

5527s. PHYSICAL BIOCHEMISTRY: SPECTROSCOPIC METHODS II. (4 cr, §BioC 5527, §Chem 5527; prereq 2 qtrs physical chemistry; BioC/MdBc 5526 or #) Thomas, Ugurbil
Applications of optical and magnetic resonance techniques to study of structure and dynamics in proteins, lipids, nucleic acids, and synthetic analogs.

5528f. PHYSICAL BIOCHEMISTRY: ENZYME KINETICS. (4 cr, §BioC 5528; prereq 2 qtrs physical chemistry, BioC/MdBc 5751 or BioC 5002 or equiv desirable) LaPorte, Lipscomb
Theory and application of steady-state and transient kinetics to study of enzymes, enzyme systems, and cellular regulation.

5750f. BIOCHEMISTRY LABORATORY. (4 cr; prereq 5751 or ¶5751; offered when feasible) Staff
General experimental techniques and biochemical instrumentation; individual projects.

5751f-5752w-5753s. GENERAL BIOCHEMISTRY. (4 cr per qtr, §BioC 5751-5752-5753; prereq Biol 5001 or equiv, 2 qtrs physical chemistry) Staff
For description, see BioC 5751.

8150f,w,s. SEMINAR: BIOCHEMISTRY. (1 cr) Staff

8206f. CELL SIGNALLING AND METABOLIC REGULATION I. (3 cr; prereq BioC/MdBc 5751-5752-5753 or equiv) Edstrom and 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.

8207w. CELL SIGNALLING AND METABOLIC REGULATION II. (3 cr; prereq BioC/MdBc 5751-5752-5753 or equiv) Edstrom and staff
Qualitative and quantitative aspects of metabolic control theory. Covalent modification and allosteric regulation of mechanisms of enzyme activity changes in regulatory processes. Control of metabolism by transcription and translation, including catabolite repression, steroid and thyroid hormones. Examples of coordinate metabolic regulation.

8213f. ADVANCED MOLECULAR BIOLOGY I. (4 cr, §BioC 8213, §GCB 8213; prereq BioC/MdBc 5753 or GCB 5032 or #) Towle, staff
Lectures, readings, and discussions. Topics include DNA replication, recombination and gene conversion, regulation of gene expression in procaryotes, regulation of gene expression in eucaryotes, chromatin structure and transcription, organellar gene expression.

8214w. ADVANCED MOLECULAR BIOLOGY II. (4 cr, §BioC 8214, §GCB 8214; prereq BioC/MdBc 5753 or GCB 5032 or #) Towle, staff
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.

8219s. BIOCHEMISTRY OF SPECIALIZED TISSUES. (3 cr; prereq 5753 or 5100; offered alt yrs) Van Pilsum
Biochemical and physiological functions and metabolism of adipose, nervous, muscle, liver, kidney, and other tissues in mammals.

8230w. ADVANCED TOPICS IN MEMBRANE BIOCHEMISTRY. (3 cr, §BioC 8230; prereq 5753 or #, offered alt yrs) Roon, Thomas, staff
Lectures and readings on membrane structure, biosynthesis, and function. Structural models, hormone receptors, neurotransmitters, and excitable membranes.

8232w. ADVANCED TOPICS IN PROTEINS AND ENZYMES. (3 cr per qtr, §BioC 8232; prereq BioC 5002, BioC/MdBc 5751 or MdBc 5100) Nelsestuen, staff
In-depth analysis of the recent literature with lectures, seminars, and readings.

8233s. ADVANCED TOPICS IN PROTEINS AND ENZYMES. (3 cr, §BioC 8233; prereq MdBc/BioC 5751 or #, MdBc/BioC 5526 desirable) Hogenkamp, Howard
Lectures and assigned readings on nature and function of enzymes and proteins, with emphasis on metalloenzymes and metalloproteins.

8290f,w,s,su. CURRENT RESEARCH TECHNIQUES. (1-3 cr; prereq grad major in biochemistry or #) Staff

8300f,w,s,su. RESEARCH. (Cr ar) Staff

8460f. NEUROCHEMICAL COMMUNICATION. (1 cr, §GCB 8460, §NSc 8460, §Phcl 8460, §VBio 8460; prereq 5460 or ¶5460) Koerner, Wilcox, staff
Biochemistry of neuronal signaling and its manipulation by pharmacological agents, in context of current research papers. Information about most systems (e.g., autonomic and central nervous systems) in context of specific transmitter systems wherever practical. Research-oriented paper or grant application in area discussed in 5460.

Biomedical Engineering

Professor: Perry L. Blackshear, Jr. (mechanical engineering), *director of graduate studies;* Eugene Ackerman (biometry and health information systems); Robert J. Bache (medicine); Victor A. Bloomfield (biochemistry); Henry Buchwald (surgery); Frank B. Cerra (surgery); Jay N. Cohn (medicine); Edward L. Cussler (chemical engineering and materials science); John W. Eaton (laboratory medicine and pathology); Arthur G. Erdman (mechanical engineering); Darrell A. Frohrib (mechanical engineering); Franz Halberg (laboratory medicine and pathology); Russell K. Hobbie (physics); Michael P. Kaye (surgery); Kenneth H. Keller (chemical engineering and materials science); Maurice M. Kreevoy (chemistry); Tarald O. Kvalseth (mechanical engineering); David G. Levitt (physiology); Jack L. Lewis (orthopedic surgery); Rex E.

Lovrien (biochemistry); Rufus W. Lumry (chemistry); Larry L. Miller (chemistry); Wilmer G. Miller (chemistry); Richard E. Poppele (neurophysiology); Otto H. Schmitt (emeritus: biophysics, electrical engineering); Matthew V. Tirrell (chemical engineering and materials science); Naip Tuna (surgery); Yang Wang (medicine); Theodore A. Wilson (aerospace engineering and mechanics)

Associate Professor: David G. Benditt (medicine); Dennis D. Caywood (small animal clinical sciences); Max Donath (mechanical engineering); Stanley M. Finkelstein (biometry and health information systems); James E. Holte (electrical engineering); William J. M. Hrushesky (medicine); Robert P. Patterson (physical medicine and rehabilitation); Harry M. Wechsler (electrical engineering)

Assistant Professor: Wei-Shou Hu (chemical engineering and materials science); Clark M. Smith, II (pediatrics); Kim A. Stelson (mechanical engineering)

Other: Prakash Keshaviah (senior research assistant, Hennepin County Medical Center)

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—Biomedical engineering is an interdisciplinary program designed to provide broad familiarity with the interactions among the engineering, biological, and medical sciences plus in-depth training in at least one of these disciplines. Thesis research topics, which provide the focus for a student's training, may be chosen from among the following areas of biomedical engineering research: blood fluid mechanics and its application to cardiovascular problems and design of artificial internal organs; 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; intestinal 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 is preferred. Applicants with a baccalaureate degree in physical or biological science may be accepted into the program, but are required to complete the coursework through the junior year of an undergraduate engineering curriculum before being admitted as a candidate for the degree. In most cases, this coursework is not considered part of the graduate 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.

Degree Requirements—Programs are planned with the aid of an adviser and a three-member subcommittee selected jointly by the candidate and the director of graduate studies from the above list of department faculty members 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 biomedical aspects of at least one area of biomedical engineering. Students normally complete a broad but cohesive program consisting of at least 9 credits in each of three departments. Two of these departments should be in a college other than that offering the minor. In addition, students normally register in one of the ongoing biomedical engineering seminar series for at least six quarters. The minor program must be the equivalent of major field coursework for a Plan B M.S. program in an 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—Contact the director of graduate studies, Biomedical Engineering, Department of Mechanical Engineering, 455 Mechanical Engineering, University of Minnesota, 111 Church Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Biometry (PubH)[1]

Professor: Thomas A. Louis, *head,* biometry; Marcus O. Kjelsberg, *director of graduate studies;* James R. Boen; Anne I. Goldman; Vernon E. Weckwerth

Associate Professor: Glenn E. Bartsch; David R. Jacobs; Kathleen M. Keenan; Chap T. Le; Ruth B. Loewenson; Stephen S. Rich; Philip J. Smith

Assistant Professor: John E. Connett; James D. Neaton

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—Biometry is the statistical and other quantitative analysis of data from biology, medicine, and public health. Emphases include biostatistics, experimental design and analysis, health statistics, clinical trials, and computerized data management. Students may elect to complement biometry course offerings with courses from such fields as epidemiology, mathematics, management information, computer science, or health sciences. Advanced work in statistics is usually taken as part of the program.

Prerequisites for Admission—General biology, linear algebra, four quarters of calculus, introductory statistics, and an undergradaute major in one of the social, biological, mathematical, or physical sciences. A student may be allowed to take one or two of these courses after admission.

Special Application Requirements—Fall quarter entry is recommended.

Master's Degree Requirements—Most students are enrolled in the Plan B program, usually completed in two academic years. During the first year, students take basic sequences. The remainder of the program is designed for further specialization and advanced courses. Students with an undergraduate degree in biometry may be able to finish in one year. Candidates must pass a final oral examination.

Doctoral Degree Requirements—Consult the director of graduate studies for requirements.

Language Requirements—None.

For Further Information—Contact Biometry, School of Public Health, A460 Mayo, Box 197, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455.

Note—Biometry courses are listed and described in the Public Health section of this bulletin. See PubH 5400 to 5471 and 8400 to 8450.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Biophysical Sciences (BPhy)

Professor: Dean E. Abrahamson (public affairs); Eugene Ackerman (laboratory medicine and pathology); Victor A. Bloomfield (biochemistry/biological sciences); William H. Douglas (operative dentistry); Russell K. Hobbie (physics); Faiz M. Khan (therapeutic

[1]*A master of public health degree (M.P.H.) with an emphasis in biometry is offered by the School of Public Health. Consult the School of Public Health Bulletin for further information.*

radiology); Merle K. Loken (emeritus: radiology); Rex E. Lovrien (biochemistry/biological sciences); Rufus W. Lumry (chemistry); Richard Poppele (physiology); Andreas Rosenberg (laboratory medicine and pathology); Murray D. Rosenberg (genetics and cell biology); Otto H. Schmitt (emeritus: electrical engineering); Chang W. Song (therapeutic radiology); David D. Thomas (biochemistry/medicine); Warren J. Warwick (pediatrics)

Associate Professor: Stanley M. Finkelstein (laboratory medicine and pathology)

Assistant Professor: James J. O'Leary (laboratory medicine and pathology), *director of graduate studies;* F. Christopher Deibel, Jr. (therapeutic radiology); Ralph DeLong (operative dentistry); Bruce J. Gerbi (therapeutic radiology); Barry L. Werner (therapeutic radiology)

Research Associate: Piotr G. Fajer (biochemistry/medical school)

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.

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 of study 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, as well as another course sequence yet to be determined (formerly Path 5415, 5416, and 5417). 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. Foreign 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—Contact the director of graduate studies, Biophysical Sciences, Laboratory Medicine and

Pathology, Box 198 UMHC, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455.

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.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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
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 #) Geise
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.

8204. RESEARCH IN BIOPHYSICS AND RADIATION BIOLOGY. (Cr ar) Staff

8218. SEMINAR: RADIOBIOLOGY. (1 cr; prereq #) Song
Biological effects of ionizing radiations. Discussion of research problems and current literature.

8221, 8222, 8223. RESEARCH IN BIOPHYSICS. (Cr ar) Staff

8296, 8297, 8298. SEMINAR: BIOPHYSICS. (Cr ar) Schmitt

See also Phys 5551, 5552, 5553.

Botany (Bot)

Regents' Professor: Margaret B. Davis; Eville Gorham

Professor: William P. Cunningham; Edward J. Cushing; Albert W. Frenkel; Willard L. Koukkari; David J. McLaughlin; Patrice A. Morrow; Douglas C. Pratt; Eduard J. Stadelmann; Clifford M. Wetmore

Associate Professor: Thomas K. Soulen, *head;* David D. Biesboer, *director of graduate studies;* Iris D. Charvat; Florence K. Gleason; James A. Perry; Carolyn D. Silflow

Assistant Professor: Judith G. Berman; John F. Doebley; J. Stephen Gantt; Neil E. Olszewski; Susan M. Wick

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—Botany encompasses all aspects of the basic biology of plants, including algae, fungi, and bacterial-plant interactions. Major emphases include molecular and physiological approaches to

development, structural and functional studies at the cellular and organismal level, and systematic and evolutionary biology. Opportunities exist for laboratory and field research in Minnesota and at the national and international levels. Each student's program is planned to meet individual requirements. Seminars are an integral part of the program.

Prerequisites for Admission—For major work, general biology, at least 15 credits in botany or related subjects, one year of college physics, and two quarters of organic chemistry are required. One quarter of calculus or statistics is a prerequisite for the master's degree, and two quarters of calculus or statistics for the Ph.D. degree. Deficiencies can be made up during the course of study. Special programs can also be arranged for students with unusual backgrounds—for example, in the physical sciences.

Special Application Requirements—Applicants must submit scores from the Graduate Record Examination. To be considered for financial aid, applicants are required to submit three letters of recommendation evaluating their scholarship and research potential. While applications for admission may be considered at any time, deadlines for certain fellowships are January 15; the deadline for teaching assistantships is April 1.

Master's Degree Requirements—Programs are designed by the student in consultation with an advisory committee. The final examination is either oral or written, at the discretion of the graduate faculty.

Doctoral Degree Requirements—Doctoral programs are designed by students in consultation with their advisory committee. Two options are available for the preliminary written examination: a written, subject area examination or the writing and defense of two research proposals.

Language Requirements—None. However, a language requirement may be specified by the faculty adviser after consultation with the student.

For Further Information—Contact the director of graduate studies, Department of Botany, 220 Biological Sciences Center, University of Minnesota, 1445 Gortner Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5001. BASIC BOTANY. (Cr ar; prereq Biol 1008 or Biol 1009, #, △)
Individual work in fundamental aspect of discipline.

5103f.* ALGAE, FUNGI, AND BRYOPHYTES. (5 cr; 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.

5105.* MORPHOLOGY OF VASCULAR PLANTS. (5 cr; prereq Biol 1103 or Biol 3012 or #; offered alt yrs) Staff
Ferns and their allies, gymnosperms (cycads, Ginkgo, conifers) and angiosperms (flowering plants). Comparative morphology of vegetative and reproductive structures; life cycles; evolutionary relationships.

5111w.* PLANT CELL, TISSUE, AND ORGAN DEVELOPMENT. (5 cr; 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, §PlPh 3131, §PlPh 5131; prereq Biol 1103 or 3012, BioC 1302 or ¶BioC 1302 or Biol 5001) Frenkel, Gleason, Olszewski, Soulen
Physiological principles underlying processes that occur in living plants with emphasis on higher plants. Growth and development, mineral nutrition, water relations, metabolism including respiration and photosynthesis. Includes a weekly discussion section.

5132f. PLANT PHYSIOLOGY LABORATORY. (2 cr; prereq 3131 or 5131 or ¶3131 or ¶5131)
Laboratory course to accompany 3131 or 5131.

5141. PLANT CELL BIOLOGY. (4 cr; prereq Biol 5004 or equiv; offered alt yrs) Wick
Structural, functional, developmental, and biochemical aspects of cellular components and processes specific to algae, fungi, and higher 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, §PlPh 5182; 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, §PlPh 5183; prereq 5131 or equiv) 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, §PlPh 5184; prereq 5131 or equiv) Hackett, Olszewski
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.

5205s.* FLORA OF MINNESOTA. (4 cr; prereq 3201 or #; offered when feasible) Staff
Vascular plants of Minnesota; taxonomic and floristic relationships; geographical distribution and variation; collecting and identifying; field trips.

5231f. INTRODUCTION TO THE ALGAE. (5 cr; prereq 10 cr in botany or biology or #; offered alt yrs) McLaughlin
Structure, reproduction, and life histories of major algal divisions.

5235. ALGAL PHYSIOLOGY. (3 cr; prereq BioC 1302 or Biol 5001; offered when feasible) Gleason
Photosynthesis, carbon metabolism, nitrogen fixation and assimilation, and secondary metabolism in algae. Algal genetics and use of mutants in physiological studies. Algal interactions with environmental parameters and other organisms.

5801su. PLAINS AND BOREAL FLORA. (5 cr; prereq course in taxonomy, △; offered in Lake Itasca Biology Session)
Survey of summer flowering plants and ferns of the state, with particular reference to local flora. Identification by technical keys; important plant families; field recognition of common species; habitat preferences; natural history and population biology of selected important species.

5805su. AQUATIC FLOWERING PLANTS. (5 cr; prereq course in taxonomy; offered when feasible in Lake Itasca Biology Session)
Higher plants of aquatic and marsh habitats. Identification and collection; association of species; relation to habitat; adaptive morphology and food value to wildlife.

5811su. FRESHWATER ALGAE. (5 cr; prereq 10 cr in botany or biology or zoology or equiv, △; offered in Lake Itasca Biology Session)
Morphology, systematics, and distribution of local algal flora. Collection, preservation, numeration, and culture techniques; identification of field collections using appropriate technical literature. Ecological implications of species interactions, algal associations, and indicator taxa.

5890su. RESEARCH PROBLEMS. (1-5 cr; prereq △; offered in Lake Itasca Biology Session)
Individual research for undergraduates and graduates.

5960f,w,s.* SPECIAL TOPICS. (Cr ar; prereq #) Staff
Treatment in depth of a specialized botanical topic.

5970f,w,s,su. DIRECTED STUDIES. (Cr ar; prereq #, △) 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; prereq #, △)
Laboratory or field investigation of selected areas of research.

8287. PLANT MOLECULAR BIOLOGY. (3 cr; prereq BioC 5753, GCB 5031, GCB 5032) Gantt, Olszewski
Gene expression and regulation, gene structure, gene transfer in higher plants.

8301w.* POLLEN MORPHOLOGY AND QUATERNARY PALYNOLOGY. (3-5 cr; prereq plant taxonomy or #; offered alt yrs) Cushing
Morphology and nomenclature of pollen grains and pteridophyte spores, survey of pollen and spores of major plant families, laboratory techniques. Research topics in pollen analysis of Quaternary sediments and pollen morphology.

8950f,w,s. SEMINAR. (1 cr; prereq #) Staff

8990f,w,s,su.* RESEARCH PROBLEMS. (Cr ar; prereq #) Staff

Other Acceptable Courses

All courses carrying the course designator PlPh (plant physiology) that are listed in this bulletin are acceptable as part of a major in botany, as are certain courses from other departments and colleges of the University. The following are examples of acceptable courses:

Agro 8230. CYTOGENETICS

Biol 5125. RECOMBINANT DNA LABORATORY

EBB 5014. ECOLOGY OF PLANT COMMUNITIES

GCB 5048, 5049. ADVANCED CELL BIOLOGY I AND II

Hort 5041. ENVIRONMENTAL PHYSIOLOGY OF HORTICULTURAL PLANTS

PlPa 5105. INTRODUCTION TO THE STUDY OF FUNGI

Business Administration

Professor: Timothy J. Nantell, *associate dean;* Paul E. Johnson, *director of graduate studies, Ph.D. program;* Norman L. Chervany, *director of graduate studies, M.B.A. program;* Carl R. Adams; Gordon J. Alexander; Richard Arvey; Frederick J. Beier; R. Glen Berryman; Mario Bognanno; John H. Boyd; Richard N. Cardozo; Gordon B. Davis; John W. Dickhaut; Gary W. Dickson; David A. Dittman; Michael U. Dothan; Richard A. Edwards; W. Bruce Erickson; John Flagler; John Fossum; Jack C. Gray; Donald V. Harper; Thomas R. Hoffmann; Michael J. Houston; James S. Jordan; John H. Kareken; Kenneth J. Roering; Ivan Ross; William Rudelius; Roger G. Schroeder; James Scoville; Shyam Sunder; Andrew H. Van de Ven; Orville C. Walker; James C. Wetherbe; Andrew F. Whitman; C. Arthur Williams, Jr.; Raymond E. Willis; Mahmood Zaidi

Associate Professor: Dennis A. Ahlburg; Stuart Albert; Amin H. Amershi; John C. Anderson; Harold L. Angle; Ross Azevedo; P. George Benson; John M. Bryson; Balaji S. Chakravarthy; Terry L. Childers; Grover A. Cleveland; Lane Daley; George P. D'Elia; Gerardine DeSanctis; Gordon L. Duke; Gordon C. Everest; James M. Gahlon; Robert A. Hansen; Patrick J. Hess; Arthur V. Hill; Laurent L. Jacque; Deborah Roedder John; George John; Edward J. Joyce; Chandra Kanodia; W. David Kelton; Barbara Loken; Ian H. Maitland; Salvatore T. March; John J. Mauriel; Christopher Nachtsheim; J. David Naumann; Mary Nichols; Peter S. Ring; Peter Rosko; Robert Ruekert; Gary Scudder; Robert L. Vigeland

Assistant Professor: Cynthia M. Beath; Philip Bromiley; Evelyn F. Carroll; Gary W. Carter; Chun Chang; Dongsae Cho; Shawn P. Curley; Bruce Feiring; Dale L. Goodhue; Doris L. Holt; Stefanie A. Lenway; Alfred A. Marcus; Rema Padman; Gordon S. Potter; Akshay R. Rao; Judy D. Rayburn; Haim Reisman; Paul A. Richardson; Richard Saavedra; Gerald F. Smith; Detmar W. Straub; Scott Ulman

Lecturer: Frederick R. Jacobs, *director of graduate studies, business taxation;* Alan V. Abramson; Mary C. Fenelon; Howard Strauss

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 prepares its graduates for responsible positions in all types of organizations in our economy: large and small, service and manufacturing, profit and non-profit. Throughout the program emphasis is placed on the knowledge and skills necessary to carry out these responsibilities, particularly on analysis—recognizing a problem exists and defining and selecting the appropriate course of action—and implementation—developing, organizing, and motivating people.

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 78 credits is designed for students without prior education in business administration. An accelerated program of 54 credits is designed for students with an undergraduate degree in business administration. These two programs are offered through full-time day and part-time evening study. A Managers M.B.A. program (74 credits) for managers with ten or more years of full-time experience is also available.

For Further Information—A complete brochure is available from the M.B.A. program, Carlson School of Management, University of Minnesota, 271-19th Avenue South, Minneapolis, MN 55455.

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 prac-

tical 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 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 will be considered for admission during fall, winter, spring, or summer terms.

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 will not be granted in most cases.

Students must complete 46 credits, including 16 credits in business, economics, and accounting, 14 credits in the fundamentals of tax, tax research, tax procedure, and corporate tax, and 16 credits of elective tax courses. At least 4 credits of the coursework will serve as a basis for the Plan B project(s). Students must maintain a 3.00 grade point average. The final examination is oral.

For Further Information—Contact the director of graduate studies, Business Taxation, 645 Management and Economics Building, University of Minnesota, 271 19th Avenue South, Minneapolis, MN 55455.

Doctor of Philosophy

Curriculum—The goal of the Ph.D. program is to educate scholars who have the ability to contribute to their field through theoretical and applied research, excellence in teaching, and leadership in the profession. The following areas of specialization are offered: accounting; finance; management information systems; marketing, operations management; decision sciences; risk management and insurance; strategic management and organization; logistics management.

Special Application Requirements—Scores from the Graduate Management Admission Test (GMAT) 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, a supporting field of study, 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 the 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—A complete brochure is available from the director of the Ph.D. program, Carlson School of Management, University of Minnesota, 271-19th Avenue South, Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Accounting (Acct)

5125. AUDITING PRINCIPLES AND PROCEDURES. (4 cr; prereq 3102)
The auditor's role and function. Includes audit standards, ethics, procedures, legal responsibilities.

5126. INTERNAL AUDITING. (4 cr; prereq 3102, 3201)
Preparatory course for accounting students desiring to enter the internal auditing profession directly and for taking the certified internal auditor examination.

5127. EDP AUDITING. (4 cr; prereq 5125, MIS 3300 or MSci 3030)
Role of data processing in the auditing function. Auditing electronic data processing information systems.

5135. INCOME TAX ACCOUNTING. (4 cr; prereq 1025)
Basic concepts of federal income taxation as applied to corporations, individuals, and fiduciaries, emphasizing income tax planning.

5180. ADVANCED ACCOUNTING. (4 cr; prereq 3102)
Consolidated statements, partnerships, fiduciary, international and fund accounting. Issues in reporting to the Securities and Exchange Commission.

5230. CORPORATE TAXATION. (4 cr; prereq 5135, #)
Tax consequences of formation, operation, and liquidation of a business corporation.

5236. TAXATION II. (4 cr; prereq 5135)
Income taxation of corporations. Partnerships. Tax research.

5270. REPORTING FOR MANAGEMENT CONTROL. (4 cr; prereq 3201)
Management control systems, responsibility accounting, transfer pricing problems, capital budgeting.

5271. ACCOUNTING SYSTEMS. (4 cr; prereq 3102, 3201)
Applications of electronic data processing systems in accounting, including modeling, financial planning, auditing, and data security. Analysis and design of accounting information systems.

5281. ACCOUNTING FOR GOVERNMENTAL AND NONPROFIT SEEKING ENTITIES. (3 cr; prereq 3102)
Accounting concepts and practices appropriate for managing and reporting activities and positions of governmental units and not-for-profit organizations.

5290. PERSPECTIVES OF TOP FINANCIAL EXECUTIVES. (4 cr; prereq 3201 or MBA 8035)
In-depth study of problems faced by top financial executives to better understand the work of a financial executive. Interaction with executives in analysis of a problem. Designed to sharpen skills in library research, written and oral expression, and ability to raise relevant questions.

5300. CURRENT TOPICS IN MANAGERIAL ACCOUNTING. (4 cr [may be repeated for cr]; prereq 3201)
Topics vary from quarter to quarter.

5310. CURRENT TOPICS IN FINANCIAL ACCOUNTING. (4 cr [may be repeated for cr]; prereq 3102)
Topics vary from quarter to quarter.

5340. PARTNERSHIP TAXATION. (4 cr; prereq 5135)
Tax consequences of formation, operation, and dissolution of a partnership.

5390. CURRENT TOPICS IN TAXATION. (1-5 cr; prereq 5135 or equiv, #)
Current tax legislation problems. Topics vary from quarter to quarter.

8050. PRINCIPLES OF ACCOUNTING I. (4 cr, §1050; not open to MBA and PhD students in BA)
Basic financial accounting concepts, application to recording and reporting business events.

8051. PRINCIPLES OF ACCOUNTING II. (4 cr, §1051; prereq 8050 or Grad Sch Mgmt approval; not open to MBA or PhD students in BA)
Accounting analysis for management and investor decision making.

8101. CORPORATE FINANCIAL REPORTING. (4 cr, prereq MBA 8030)
Problems in preparation and interpretation of corporate financial reports. Analysis of managerial decisions with respect to income measurement, revenue recognition, income tax allocation, accounting for inventories, fixed assets, long-term debt, and leases.

8102. CORPORATE FINANCIAL REPORTING: ADVANCED TOPICS. (4 cr; prereq 8101)
Pension plans, earnings per share, intercompany investments, business combinations, consolidated financial statements, foreign currency transactions, and translation of foreign currency statements.

8125. SECURITY, CONTROL, AND AUDIT OF FINANCIAL INFORMATION SYSTEMS. (4 cr; prereq 8101)
Insuring quality and reliability of financial information systems through security measures, design and implementation of internal controls, and timely and appropriate audit procedures.

8128. ANALYTIC REVIEW AND AUDIT SAMPLING. (4 cr; prereq #, Grad Sch Mgmt approval)
Effects of audit-specific population characteristics and objectives on the use of standard statistical techniques; theory of and methods for audit-oriented sampling approaches; nature of the auditor's sampling decision problems.

8135. MANAGERIAL ISSUES IN TAXATION. (4 cr; prereq 8051, grad mgmt/IR student or Grad Sch Mgmt approval)
Taxation of individuals, partnerships, and corporations, with emphasis upon the effect of income taxation on business planning.

8150. FINANCIAL ACCOUNTING ISSUES. (4 cr; prereq 1050, 1051, grad mgmt/IR student or Grad Sch Mgmt approval)
Accounting principles and practices underlying preparation of financial statements and additional disclosures. Includes recent pronouncements on financial accounting.

8160. FINANCIAL STATEMENT ANALYSIS. (4 cr, §3160; prereq 1051, grad mgmt/IR Student or Grad Sch Mgmt approval; not for accounting majors)
Interpretation and analysis of financial statements for investment and credit purposes.

8201. ACCOUNTING FOR MANAGERIAL DECISIONS AND CONTROL. (4 cr; prereq MBA 8035 or Grad Sch Mgmt approval)
Relevant accounting data for managerial planning and control. Includes behavioral aspects.

8220. TAX RESEARCH. (2 cr; prereq 5135, grad mgmt/IR student or Grad Sch Mgmt 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, grad mgmt/IR student or Grad Sch Mgmt 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 8135, grad mgmt/IR student or Grad Sch Mgmt 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.

8255. MANAGERIAL COST ACCOUNTING. (4 cr, §3255, §5270; prereq 8051, grad mgmt/IR student or Grad Sch Mgmt approval; not for accounting majors)
Use of cost accounting and analysis by management in setting policies, making decisions, and maintaining controls.

8330. TAXATION OF CORPORATIONS II. (4 cr; prereq 8230, grad mgmt/IR student or Grad Sch Mgmt approval)
Corporate readjustments related to multiple corporations and consolidated returns.

8335. TAX EFFECTS ON BUSINESS DECISION MAKING. (4 cr; prereq 5135 or 8135, grad mgmt/IR student or Grad Sch Mgmt approval)
Business decisions heavily influenced by income tax considerations; approaches used to improve economic effectiveness of decisions made.

8340. TAXATION OF PARTNERS AND PARTNERSHIPS. (4 cr; prereq 5135 or 8135, grad mgmt/IR student or Grad Sch Mgmt approval)
Reviews tax consequences associated with formation, operation, and dissolution of a partnership.

8350. TAXATION OF ESTATES, GIFTS, AND TRUSTS. (4 cr; prereq 5135 or 8135, grad mgmt/IR student or Grad Sch Mgmt 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.

8354. TAX PLANNING FOR FAMILIES AND ORGANIZATIONS. (4 cr; prereq 8230, 8350, grad mgmt/IR student or Grad Sch Mgmt approval)
Interrelationships between federal taxes such as gift, estate, and income taxes. Use of trusts, partnerships, corporations, and other entities as means of reducing the total tax impact on income and accumulation and distribution of wealth.

8356. TAXATION OF DEFERRED COMPENSATION AND FRINGE BENEFITS. (4 cr; prereq 8230, grad mgmt/IR student or Grad Sch Mgmt 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 8135, grad mgmt/IR student or Grad Sch Mgmt approval)
Minnesota individual and corporate income, property, sales, and excise taxes. Tax problems of businesses with multistate operations.

8370. TAXATION OF PROPERTY TRANSACTIONS. (4 cr; prereq 5135 or 8135, grad mgmt/IR student or Grad Sch Mgmt approval)
Determining realized gain or loss and recognized gain or loss, and tax treatment of that gain or loss on property dispositions. Consequences of property transactions including depreciation, depletion, basis, and capital gains problems.

8380. TAX ASPECTS OF INTERNATIONAL BUSINESS. (4 cr; prereq 8230, grad mgmt/IR student or Grad Sch Mgmt 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, grad mgmt/IR student, #, Grad Sch Mgmt approval)
Current tax legislation and problems. Topics may vary from quarter to quareter.

8805. SEMINAR I. (4 cr; prereq #, PhD student, Grad Sch Mgmt approval)
Economics modeling applied to accounting issues.

8810. SEMINAR II. (4 cr; prereq #, PhD student, Grad Sch Mgmt approval)
Empirical financial accounting research.

8820. SEMINAR III. (4 cr; prereq #, PhD student, Grad Sch Mgmt approval)
Behavioral accounting research.

8825. SEMINAR: AUDITING. (4 cr; prereq grad mgmt/IR student, #, Grad Sch Mgmt approval)

8890. READINGS IN ACCOUNTING. (Cr ar; prereq #, Grad Sch Mgmt approval)
Readings useful to individual students but not available in regular courses.

8995. RESEARCH IN ACCOUNTING. (Cr ar; prereq #, PhD student, Grad Sch Mgmt approval)

Business, Government, and Society (BGS)

8009. BUSINESS AND GOVERNMENT I: GOVERNMENT ECONOMIC REGULATION OF BUSINESS. (4 cr; prereq MBA 8055, grad mgmt/IR student or # and Grad Sch Mgmt approval)
American industrial structure, conduct, and performance. Problems of business and labor concentration and their implications. Antitrust laws and their applications to individual business enterprise. Alternatives to antitrust. Antitrust laws as a form of business-government interaction and implications of this experience for other areas of interaction.

8010. BUSINESS AND GOVERNMENT II: GOVERNMENT SOCIAL REGULATION OF BUSINESS. (4 cr; prereq MBA 8055, grad mgmt/IR student or # and Grad Sch Mgmt approval)
The public policy process as a regulator of business behavior. Regulation to achieve key social objectives—environmental protection, product and job safety, equal employment opportunity, ERISA, and other regulation. Role of social responsibility and business ethics. Monitoring economic and social trends. Organizing for social responsiveness.

8017. ORGANIZATIONAL POLITICS AND MANAGEMENT. (4 cr; prereq grad mgmt/IR 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 3002 or #)
Selected topics and problems of current interest and of a varied nature considered in depth. Class discussion and course projects. Content varies from quarter to quarter 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/IR 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/IR student or Grad Sch Mgmt approval; offered when feasible)
Law affecting the relationship between principal and agent, master and servant, and employer and employee. Partnership and corporate forms of business entities including methods of creating these relationships, law developed to regulate and control these organizations and their members, and contracts referred to as commercial papers (negotiable instruments), with emphasis on effect of Uniform Commercial Code.

8288. LAW OF PERSONAL PROPERTY, REAL PROPERTY, WILLS AND ESTATES. (4 cr, §3088; prereq 8158, grad mgmt/IR student or Grad Sch Mgmt approval; offered when feasible)
Basic concepts of personal property including rights of possessors, bailee, finders and holders of security interests. Basic concepts and principles of real property law; transfers of ownership, control of and encumbering such interests. Law of wills and estates in passing rights to property in event of death.

Decision Sciences (DSci)

The Decision Sciences curriculum is currently under review. More information is available from the Management Sciences Department, 395 Humphrey Center, University of Minnesota, 301-19th Avenue South, Minneapolis, MN 55455.

5040. EXPERT SYSTEMS. (4 cr; prereq jr or sr or grad student)
Discussion of expert systems, computer programs that solve a class of problems in narrowly defined domain based on understanding of how humans solve these problems. Concepts from artificial intelligence, cognitive science, and management used to develop understanding of expert systems and how they can benefit the firm. Methods for developing and evaluating expert systems; techniques for managing expert system development project; strategies for choosing applications to enhance organization's competitive advantage.

5050. MANAGERIAL STATISTICS. (4 cr; prereq MSci 1020 or MBA 8020 or □)
Simple linear and multiple regression analysis; residual analysis, model building, and use of transformations; time series forecasting, exponential smoothing, and autoregressive models; use of factorial and response surface designs in product development and testing; decision analysis.

5055. STATISTICAL METHODS FOR QUALITY AND PRODUCTIVITY IMPROVEMENT. (4 cr; prereq 1050 or MSci 1020 or MBA 8020 or equiv or #)
Statisical 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.

5060. DETERMINISTIC MODELING AND OPTIMIZATION. (4 cr, §3055; prereq 1050 or MSci 1020 or MBA 8020 or equiv or #)
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 solution of optimization problems.

5070. STOCHASTIC MODELING AND SIMULATION. (4 cr, §8550; prereq 1050 or MSci 1020 or MBA 8020 or equiv or #)
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.

8600. MODELING AND SCIENTIFIC METHODOLOGY. (4 cr)
Introduction to philosophy of science and research methodology for applied scientists in behavioral and social domains. Modeling practice and applications for both scientific and applied problem solving.

8610. BAYESIAN INFERENCE AND DECISION THEORY. (4 cr, §8633; prereq Stat 5122 or equiv or #, PhD student or #; offered alt yrs)
Probability assessment; utility theory; Bayesian inference and its relationship to classical inference; decision analysis; statistical decision theory, primarily from Bayesian perspective; management applications.

8611. BEHAVIORAL DECISION THEORY. (4 cr; prereq 8610 or #, PhD student or #; offered alt yrs)
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; learning of judgments and effectiveness of training; metachoice: selecting among choice strategies.

8620. HEURISTIC DECISION MAKING. (4 cr; prereq grad student, #; offered alt yrs)
Concepts and methodology for understanding decision behavior of individuals in natural settings. Information processing models of thinking; methods for conducting field studies, use of individual subject designs and case studies; collection and analysis of decision process data; applications in decision support.

8630. MANAGERIAL PROBLEM SOLVING. (4 cr; prereq PhD student or #; offered alt yrs)
Nature of managerial thinking in complex problem situations. Problem types; identification, definition, and structuring of problems; practical inference, including causal and analogical reasoning; systems approaches; alternative generation and design; prescriptive techniques for group and individual problem solving.

8640. KNOWLEDGE ENGINEERING. (4 cr; prereq PhD student or #; offered alt yrs)
Understanding and representing expertise of agents in problem-solving and decision-making tasks. Concepts and methodology for collecting and interpreting data; representation techniques from cognitive science and artificial intelligence; principles and techniques for conducting field studies of behavior; studies from literature.

8650. REGRESSION ANALYSIS. (4 cr, §8530; prereq MBA 8020 or equiv or #)
Regression and correlation models, inferences in simple and multiple regression, multicolinearity, indicator variables, variable selection techniques, treatment of assumption violations, applications to management problems, basic concepts of experimental design.

8651. EXPERIMENTAL DESIGN. (4 cr, §8632; prereq 8650 or equiv or #)
Analysis of variance for one-way, two-way, and multiway data. Basic concepts of statistical design and analysis of results. Randomized block, latin square, cross-over, factorial designs, confounding; estimation and comparison of effects; response surfaces; applications to management.

8660. LINEAR PROGRAMMING. (4 cr, §8641; prereq 5060 or equiv or #)
Advanced methods in linear programming; revised simplex, primal-dual, and large-scale methods, including decomposition and partitioning and methods for bounded variables.

8661. INTEGER PROGRAMMING. (4 cr; prereq 8660 or #; offered alt yrs)
Integer programming models and methods; problem formulation; cutting plane methods; group theoretic approach; branch and bound methods; relaxations; bender's decomposition; specialized problems.

8662. NETWORK FLOW MODELS. (4 cr; prereq 8660 or equiv or #; offered alt yrs)
Network optimization models and methods; network formulations; minimal cost network flows; specialized algorithms for pure networks; dual network simplex method; generalized networks; maximal flow, shortest path, and multicommodity flow problems; out-of-kilter methods.

8670. STOCHASTIC MODELING, ANALYSIS, AND APPLICATIONS. (4 cr; prereq Stat 5122 or equiv)
Probabilistic modeling of dynamic processes, including Markov chains; Poisson, renewal, and continuous-time Markov processes; and queuing models.
Statistical estimation of selected models; applications to managerial problems, such as brand shift, industrial migration, manufacturing, and computer/communications networks.

8671. SIMULATION METHODOLOGY. (4 cr; prereq 5070 or equiv or #; offered alt yrs)
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.

8799. SEMINAR: DECISION SCIENCES. (4 cr; prereq PhD student in DSci or #)
Examination of current literature and research methods in decision sciences. Topics vary according to faculty and student interests.

8850. TOPICS IN DECISION SCIENCES. (1-6 cr; prereq 3055)
Seminar to provide a forum for broad range of state-of-the-art topics in the area of management sciences.

8990. READINGS IN DECISION SCIENCES. (Cr ar; prereq #, Grad Sch Mgmt approval)

8995. GRADUATE RESEARCH IN DECISION SCIENCES. (Cr ar; prereq #, Grad Sch Mgmt approval)

Finance (BFin)

8100. CASES IN FINANCIAL MANAGEMENT. (4 cr; prereq MBA 8040 or #, grad mgmt/IR 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/IR 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, 8200 or #, grad mgmt/IR 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/IR 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.

8700. SEMINAR: WORKING CAPITAL MANAGEMENT. (4 cr; prereq 8150 or #, grad mgmt/IR student or Grad Sch Mgmt approval)
Introduction to how working capital should be managed in theory, with applications of theory. Extended discussion of use of risk, return, and valuation in management of working capital.

8701. SEMINAR: CORPORATE INVESTMENT AND FINANCIAL STRATEGY. (4 cr; prereq 8150 or #, grad mgmt/IR student or Grad Sch Mgmt approval)
In-depth theoretical analysis of long-term financial decisions. Discussion of, *inter alia,* Modigliani-Miller results for capital structure and dividend policy, and use of capital asset pricing models in capital budgeting decision making.

8702. SEMINAR: FINANCIAL MANAGEMENT OF FINANCIAL INSTITUTIONS. (4 cr; prereq 8150, 8200 or #, grad mgmt/IR 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.

8703. FUTURES AND OPTIONS MARKETS. (4 cr; prereq 8300 or #, grad mgmt/IR student or Grad Sch Mgmt approval)
Hedging and speculative trading in commodity, currency, interest rate, and stock index futures and options.

8704. SEMINAR: INTERNATIONAL FINANCIAL MANAGEMENT. (4 cr; prereq 8400 or #, grad mgmt/IR student or Grad Sch Mgmt approval)
Alternative theories of exchange rate determination; how well they predict exchange rate movements. Spot and future foreign exchange markets and management of foreign exchange and exchange control risk.

8705. SEMINAR: THE FEDERAL RESERVE SYSTEM, ITS HISTORY AND CONTROVERSIES. (4 cr; prereq 8200 or #, grad mgmt/IR student or Grad Sch Mgmt approval, Econ 3102 and Econ 3701 recommended)
Ways in which the Federal Reserve System has sought to realize its central bank objectives; response of critics. Its responsibility as lender of last resort considered at length. How observations on interest rates and monetary aggregates should be interpreted, given way system is conducting monetary policy.

8706. SEMINAR: REGULATION OF FINANCIAL INSTITUTIONS AND MARKETS. (4 cr; prereq 8150 or #, grad mgmt/IR student or Grad Sch Mgmt approval, Econ 3101 or Econ 3105 recommended)
Why banks and other depository institutions have been regulated and how regulation has changed, particularly since the end of World War II. Meaning of deposit insurance stressed. Possibility of laissez-faire regulatory policy considered at length. Discussion and appraisal of regulation of financial markets.

8801. INTRODUCTION TO THE THEORY OF CAPITAL MARKETS. (4 cr; prereq ¶Math 3211 or equiv, ¶Math 3221 or equiv, ¶Econ 8101, or #)
Expected utility theory, measures of risk, portfolio choice, aggregation and separation, linear pricing models.

8802. MATHEMATICAL METHODS IN THE THEORY OF CAPITAL MARKETS. (4 cr; prereq 8801, Econ 8101 or equiv, Math 3211 or equiv, Math 3221 or equiv, Stat 5121 or equiv, or #)
Discrete theory: information structures, Radner equilibria, spanning. Continuous theory: information structures, Ito calculus, integral representation of martingales, Radner equilibria, arbitrage pricing.

8803. ADVANCED THEORY OF CAPITAL MARKETS. (4 cr; prereq 8802, Econ 8102 or equiv, or #)
Intertemporal portfolio choice, intertemporal general equilibrium models, options, futures, theory of the term structure, rational expectations.

8811. THEORY OF FINANCIAL CONTRACTS. (4 cr; prereq Math 3211 or equiv, Econ 8101 or equiv, or #)
Risk sharing contracts, incentive contracts, agency, signalling, self-selection, incentive compatibility, financial intermediation.

8821. CORPORATE FINANCE. (4 cr; prereq 8802, 8811, or #)
Separation and unanimity, investment strategies, valuation of corporate liabilities, financing strategies, dividend policy.

8831. ECONOMETRIC METHODS IN FINANCE. (4 cr; prereq 8801, 8821, Stat 5121-5122 or Stat 5131-5132, or #)
Econometric tests of linear pricing models, tests of market efficiency, event studies.

8900. RESEARCH WORKSHOP. (Cr ar [may be repeated for credit, max 12 cr])
Guest speakers, faculty, and Ph.D. students present current research.

8850. INDEPENDENT STUDY IN FINANCE. (Cr ar [may be repeated for cr]; prereq #, grad mgmt/IR student or Grad Sch Mgmt approval)
Problems or developments of special interest in finance.

Logistics Management (LM)

5010. TOPICS IN LOGISTICS MANAGEMENT. (4 cr; prereq 3000 or 3010 or 8010 or 8020 and #)
Specialized topics in field of business logistics; topics change from quarter to quarter.

8010. PRINCIPLES OF TRANSPORTATION. (4 cr, §3010, §Tran 3054, §Tran 8154; prereq Econ 1002 or equiv)
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.

8020. ADVANCED LOGISTICS MANAGEMENT. (4 cr, §3020, §Tran 3064, §Tran 8264; prereq Econ 1002 or equiv)
Management of flow of physical products (supply and distribution) of organization. Transportation alternatives, customer service, inventory management, location decisions, warehousing, logistics information systems, international logistics, and logistics system design. Primarily case problems. Usually includes simulation exercise.

8030. SEMINAR IN LOGISTICS MANAGEMENT. (4 cr; prereq 3000 or 3010)

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 and #)
Specialized topics; content varies from quarter to quarter.

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.

8001. FUNDAMENTALS OF MANAGEMENT. (4 cr, §3001; not open to MBA and PhD students in business administration)
Evolving study of concepts, theory, research, and operational problems of management. Factors and relationships necessary to establish and achieve organizational objectives: goals, policies, procedures; the planning process; control systems; organizational structure and behavior; leadership. Case studies to develop analytic skills and to provide insight into management problems.

8004. ADVANCED TOPICS IN MANAGEMENT. (4 cr [may be repeated for cr]; prereq 3001 or 8001 or MBA 8010, grad mgmt/IR student or Grad Sch Mgmt approval)
Topics of special interest; content varies from quarter to quarter.

8006. PSYCHOLOGY IN MANAGEMENT. (4 cr, §3002; prereq grad mgmt/IR 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 utilization of human resources. Various laboratory procedures used to study these concepts, methods, and skills and furnish practice in applying them to management problems.

8008. ENTREPRENEURSHIP AND THE SMALLER ENTERPRISE. (4 cr; prereq completion business core courses, grad mgmt/IR student or # and Grad Sch Mgmt approval)
Assessment of opportunities and constraints in establishing and managing one's own firm; topics include structuring a new venture, buying into an existing enterprise, owning an enterprise versus becoming a principal employee in a new venture. Case method.

8009. PLANNING AND CONTROL FOR LINE MANAGEMENT. (4 cr; prereq grad mgmt/IR student or Grad Sch Mgmt approval)
Planning at the unit and divisional level for the short and intermediate term. Integration of unit and divisional plans with plans of other units and with organization-wide plans. Control systems—physical, financial, and human—and their application at the unit, divisional, and organizational levels. Planning and control of individual projects and programs; tactics for their justification to top management.

8012. ORGANIZATIONAL BEHAVIOR AND MANAGEMENT ANALYSIS. (4 cr; prereq grad mgmt/IR 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/IR 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 development of skills in management of change and conflict.

8022. CAREER MANAGEMENT. (4 cr; prereq grad mgmt/IR student or Grad Sch Mgmt approval)
Maximizing effectiveness of immediate subordinates. Determining one's own best career path. Topics include coaching, team building, self-assessment, and path analysis.

8101. SEMINAR IN STRATEGIC MANAGEMENT. (4 cr; prereq PhD student or # and Grad School 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, §8011; prereq PhD student or # and Grad School 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 # and Grad School 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 # and Grad School 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 # and Grad School Mgmt approval; at least two courses in statistics and/or research methodology desirable)
Designed to help students understand current research area, identify research topics, formulate researchable problems, and choose appropriate methods. Critique of methods used in outstanding current research required.

8251. BUSINESS RESEARCH METHODS AND TECHNIQUES. (4 cr; prereq DSci 1050, grad mgmt/IR student or Grad Sch Mgmt approval)
Examination and evaluation of research techniques; scientific method and philosophy; project design; data sources and analysis. Place of research in business administration. Student projects.

8301. SEMINAR IN ORGANIZATION BEHAVIOR. (4 cr; prereq PhD student or # and Grad School 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 # and Grad School 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 [may be repeated for cr]; prereq PhD student or # and Grad School Mgmt approval)
Special advanced topics and research problems on specific organizational issues. Development of focused research problems, theory building, hypotheses formulation, research design, and observations.

8401. SEMINAR IN STRATEGY FORMULATION. (4 cr; prereq PhD student or # and Grad School 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 # and Grad School Mgmt approval)
Theories and current research on organizational and procedural aspects of using and integrating physical, financial, and human resources in implementation of strategic plans and programs.

8403. STRATEGIC MANAGEMENT RESEARCH SEMINAR. (4 cr [may be repeated for cr]; prereq PhD student or # and Grad School Mgmt approval)
Special, advanced theories and research in strategic management. Designed to help 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 introductory courses, consent of adviser, # and 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 introductory courses, consent of adviser, # and Grad Sch Mgmt approval)
Special research projects on a specific problem completed in cooperation with a business firm.

Management Information Systems (MIS)

5102. INTRODUCTION TO INFORMATION SYSTEMS ANALYSIS. (4 cr [cr cannot be applied to MBA programs begun after December 15, 1979]; prereq 3098, 3100, 3101)
Phases within the life cycle for development of an information system application. Emphasis on standards, tools, and techniques required in analysis of information requirements and in logical design. Processing alternatives and alternative approaches to systems design.

5103. DATA STRUCTURES AND FILE PROCESSING. (4 cr [cr cannot be applied to MBA programs begun after December 15, 1979]; prereq 5098, 3100, 3101)
Principles and techniques of data organization, physical representation of data in a computer system, and file processing strategy to meet user information requirements and system performance objectives. Topics include theory of files; data storage devices; record design; sequential and random processing; linked structures; indexing; hashing; balanced search trees; multiattribute search; inverted and multilist file organizations; hierarchic, network, and relational structures; sorting; data compression; and data integrity. Students establish and manipulate data structures at the University computer facility.

5199. SOFTWARE ENGINEERING: TESTING SOFTWARE QUALITY. (4 cr, §CSci 5199; prereq advanced undergrad standing or grad status, extensive programming experience and #)
For those concerned with technical and managerial dimensions of software reliability. Survey of major issues in software reliability and testing with emphasis on use of practical techniques. Includes management issues, program testing, design considerations for testing and reliability, test documentation, documentation and procedure testing, data testing, and testing tools.

5300. SURVEY OF COMPUTERS AND MANAGEMENT INFORMATION SYSTEMS. (4 cr [cr cannot be applied to MBA programs begun after December 15, 1979], §3100, §5100, §8300; prereq 3098 or 3099 or ¶3098 or ¶3099)
Computer appreciation course providing technical background for understanding and raising issues treated in later MIS courses. Structure and operation of computer systems. Hardware technology and software development. Tools and methods for developing computer applications. Structure and components of MIS. Using a computer in organizations to support operations and management—in planning and control, and decision making. MIS development, organization, management, and evaluation. Acquiring computer resources. The computer industry and profession. Intended for non-M.B.A. graduate students desiring one course in MIS.

8100. INTRODUCTION TO MANAGMENT INFORMATION SYSTEMS. (4 cr, §8300; prereq grad mgmt/IR student or Grad Sch Mgmt approval)
Organizational information systems and business managers' roles in their implementation and effective use. Planning, development, structure, and management of data bases, information systems, and decision support systems to support operations and decision making in all functional areas and at all levels of the organization. Overview of computer hardware, software, and communications technology, the industry, and future technologicalndevelopments.

8279. LEGAL ASPECTS OF COMPUTING. (4 cr; prereq 8313 or 8304, grad mgmt/IR student or 2nd- or 3rd-yr law student, #, Grad Sch Mgmt approval)
Seminar exploring legal dimensions of computers; liability in their use; problems of evidence and record keeping; contracting for computer use; protection of computer programs; privacy; antitrust and competitive practices in computer industry; implications of computer use in selected application areas; and use of computers in legislative and judicial processes.

8300. COMPUTERS AND MANAGEMENT INFORMATION SYSTEMS. (4 cr, §5100, §5300; prereq MBA 8005, grad mgmt/IR student or Grad Sch Mgmt approval)
Computer appreciation course providing technical background for understanding and raising issues treated in later MIS courses. Structure and operation of computer systems. Hardware technology and software development. Tools and methods for developing computer applications. Structure and components of MIS. Using a computer to support operations and management—in planning and control, and decision making. MIS development, organization, management, and evaluation. Acquiring computer resources. The computer industry and profession.

8301. PROGRAM DESIGN AND PROGRAMMING. (4 cr; prereq grad mgmt/IR student, MBA 8005, MIS 8300 or ¶MIS 8300, Grad Sch Mgmt approval)
Theory and practice of program design; factoring, decomposition, coupling, cohesion, top-down development. Elementary data and control structures and input/output operations. Coding in COBOL and one other language. The programming environment for information systems: operating systems, job control language, compilers, specifications, programming technologies. Survey of programming tools and programming literature.

8302. SYSTEMS ANALYSIS AND DESIGN. (4 cr; prereq 8301, grad mgmt/IR student or Grad Sch Mgmt approval)
Develops skills needed to discover information requirements, construct logical model of information system's processes, prepare specifications for program development, prepare procedures and documentation, and plan and test conversion, installation, and evaluation operation. Study and practice with tools, techniques, and concepts necessary to systems analyst/designer in either MIS or User organization.

8303. DATA STRUCTURES, FILE PROCESSING, AND RETRIEVAL LANGUAGES. (4 cr, §5103; prereq 8301, grad mgmt/IR student or Grad Sch Mgmt approval)
Designed for users of data bases and data base management systems. Nature of data and computer storage devices. Principles of storing, processing, and retrieving data. Record design. Sequential and random processing including indexing, hashing, and multiattribute search mechanisms. Hierarchic and multifile data structures. High-level data languages for retrieval and report generation. Introduction to data base management systems and role of the data base administrator. Students establish and manipulate data structures using data base management systems on the University computer.

8304. MIS ADMINISTRATION. (4 cr, §8269; prereq 8302, grad mgmt/IR student or Grad Sch Mgmt approval)
Administration of management information systems. Topics include project selection and control, staffing and organizing the MIS activity, performance measurement and evaluation, and use of outside services.

8312. ADVANCED SYSTEMS DEVELOPMENT AND ADMINISTRATION. (4 cr; prereq 8302, grad mgmt/IR student or Grad Sch Mgmt approval)
Development of specialized skills and understanding necessary to select systems development projects and direct and control the systems development process including analysis, design, and programming; and apply advanced techniques and resources including software tools and analysis, design, and programming methodologies. Includes study of data communications networks and distributed data processing.

8313. ADVANCED DATA BASE DESIGN, MANAGEMENT SYSTEMS, AND ADMINISTRATION. (4 cr, §8249; prereq 8303, grad mgmt/IR student or Grad Sch Mgmt approval)
Managing organizational data resources. History, motivation, and objectives of data base management. Data base design, definition, creation, and documentation. Data base update, maintenance, and revision. Selection, acquisition, and use of data base management systems. Role of data base administrator. Data base integrity, security, and privacy. Data base machines and distributed data bases.

8315. TELECOMMUNICATIONS. (4 cr; prereq 8302, grad mgmt/IR student or Grad Sch Mgmt approval)
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 regulation, 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 business.

8850. TOPICS IN MANAGEMENT INFORMATION SYSTEMS. (Cr ar [may be repeated for cr]; prereq #, Grad Sch Mgmt approval)
Discussion and analysis of current topics and developments in management information systems: e.g., computers and the law, software systems, data management, social implications of computer use, artificial intelligence, automated systems design.

8985. MIS RESEARCH SEMINAR. (4 cr [may be repeated for cr]; prereq PhD candidate in MIS or # and Grad School Mgmt approval)
Underlying concepts and fundamental problems of management information systems. Exploration of literature and research. Evaluation of current research and preparation of research topic analyses.

8990. READINGS IN MANAGEMENT INFORMATION SYSTEMS. (Cr ar; prereq consent of adviser, #, 2nd-yr grad student, requisite introductory courses, Grad Sch Mgmt approval)

8995. GRADUATE RESEARCH IN MANAGEMENT INFORMATION SYSTEMS. (Cr ar; prereq consent of adviser, #, 2nd-yr grad student, requisite introductory courses, Grad Sch Mgmt approval)

Marketing (Mktg)

8051. MARKETING RESEARCH. (4 cr, §8095; prereq MBA core courses or MBA 8045 and △, grad mgmt/IR student or Grad Sch Mgmt approval) Childers, D John, Loken
Survey, observational, and experimental techniques used in marketing research. Application of these techniques to selected marketing problems. Class project involves utilizing one or more of these techniques to study an actual marketing problem.

8053. MARKETING RESEARCH: ADVANCED ANALYSIS AND FIELDWORK. (4 cr, §8096; prereq 8051, grad mgmt/IR student or Grad Sch Mgmt approval)
Application of multivariate statistical and scaling techniques to marketing data. Class project involves use of one or more of these techniques to study an actual marketing problem.

8055. INTRODUCTION TO CONSUMER BEHAVIOR. (4 cr, §8098; prereq MBA core courses or MBA 8045, grad mgmt/IR student or Grad Sch Mgmt approval) Loken, Ross
Applications of the behavioral sciences to understanding human behavior in the marketplace. Topics include perception, learning, attitude theory and measurement, persuasion, motivation, personality, social and cultural influences, family decision making, the social influence process, consumer decision-making strategies, managerial implications of consumer research and consumerism.

8060. MARKETING SYSTEMS. (4 cr; prereq MBA core courses or MBA 8045 and △, grad mgmt/IR student or Grad Sch Mgmt approval) Walker
Systems approach to marketing institutions and their interrelationships in marketing channels. Institutional, functional, and social aspects of distribution channels. Emphasis on problems of channel management such as design, conflict, power, and control. Social issues and deviant systems.

8072. INTERNATIONAL MARKETING. (4 cr; prereq MBA core courses, or MBA 8045 and △, grad mgmt/IR student or Grad Sch Mgmt approval)
Managing international marketing function. Identifying marketing-based international business opportunities; constructing and evaluating culturally adjusted marketing strategies.

8074. PRODUCT AND PRICE POLICY. (4 cr, §8084, §8086; prereq MBA core courses or MBA 8045 and △, grad mgmt/IR student or Grad Sch Mgmt approval)
Modification of existing product lines, planning and evaluation of new ventures. Pricing new products, modifying prices and margins. Extensive use of cases.

8076. SALES MANAGEMENT. (4 cr; prereq MBA core courses or MBA 8045 and △, grad mgmt/IR student or Grad Sch Mgmt approval)
Management of personal selling function of promotional mix. Emphasis on problems of performance evaluation, sales force selection, compensation, and territorial design. Case materials used.

8078. MARKETING COMMUNICATIONS. (4 cr; prereq MBA core courses or MBA 8045, grad mgmt/IR student or Grad Sch Mgmt approval) Ross, Ruekert
Communication function as facet of marketing strategy; integrating advertising, public relations, sales promotion, and other elements into communications mix; design and evaluation of marketing communications; selection of media; advertiser-agency relationships.

8080. INDUSTRIAL MARKETING. (4 cr, §8090; prereq MBA core courses or MBA 8045 and △, grad mgmt/IR student or Grad Sch Mgmt approval; offered when feasible)
Analysis of industrial markets. Formulation of marketing programs in variety of industrial marketing situations. Industrial product, price, communication, and distribution policies. Implementation of industrial marketing strategy.

8088. STRATEGIC MARKETING. (4 cr, §8086; prereq MBA core courses or MBA 8045 and △, grad mgmt/IR student or Grad Sch Mgmt approval) G John, Roering, 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. Extensive use of cases.

8090. MARKETING TOPICS. (4 cr [may be repeated for cr]; prereq MBA core courses or MBA 8045 and △, grad mgmt/IR 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 from quarter to quarter.

8800. SEMINAR: MARKETING THEORY. (4 cr; prereq MBA core courses or MBA 8045 and △, grad mgmt/IR student or Grad Sch Mgmt approval)

8810. SEMINAR: CONSUMER BEHAVIOR. (4 cr; prereq 8098, grad mgmt/IR student or Grad Sch Mgmt approval)

8820. SEMINAR: SOCIAL AND ECONOMIC ASPECTS OF MARKETING. (4 cr; prereq MBA core courses or MBA 8045 and △, grad mgmt/IR student or Grad Sch Mgmt approval; offered when feasible)

8990. READINGS IN MARKETING. (Cr ar; prereq MBA core courses or MBA 8045 and △ and consent of adviser, #, 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; prereq MBA core courses or MBA 8045 and △ and consent of adviser, #, Grad Sch Mgmt approval)
Individual research on an approved topic appropriate to the student's program and objectives.

Master of Business Administration (MBA)

8005. COMPUTER ACCESS AND PROGRAMMING FOR BUSINESS ANALYSIS. (1 cr)
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)
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)
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)
Availability and content of basic secondary business data, principles of primary data collection. Descriptive and inferential statistics; use of statistical packages.

8025. DECISION SCIENCES AND INFORMATION SYSTEMS. (4 cr)
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)
Understanding, interpreting, and analyzing financial statements of business enterprises.

8035. MANAGERIAL ACCOUNTING. (4 cr)
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)
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)
Hansen, Rao, Roering
Managing the marketing function; marketing planning, strategy, and management concepts. Identification of marketing problems and opportunities; construction, evaluation, and management of a marketing plan.

8050. OPERATIONS MANAGEMENT. (4 cr)
The operations management function in different types of organizations; relation of operations to other business decisions. Concepts of operations planning and control; process management; and relationship to logistics.

8055. BUSINESS, GOVERNMENT, AND MACROECONOMICS. (4 cr)
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)
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.

8065. FIELD PROJECT. (5 cr; 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.

8070. PROBLEM FORMULATION AND DECISION MAKING. (5 cr; offered in evening MBA program only)
Formulation and analysis of managerial problems in unstructured situations.

Operations Management (OM)

8041. PROJECT MANAGEMENT. (4 cr, §5050; prereq 3000 or MBA 8050, grad mgmt/IR student or Grad Sch Mgmt approval)
Principles and methods useful for planning and controlling a project. Topics include developing a project plan, resource planning and scheduling, and project monitoring and evaluation. Various computerized packages studied including PERT and CPM. Examples of different types of projects from manufacturing and service industries used.

8056. PRODUCTION AND INVENTORY MANAGEMENT. (4 cr; prereq MBA 8050 or #, grad mgmt student)
Functions of forecasting, inventory control, materials requirements planning, capacity planning, and scheduling. Taught from planning and control point of view with applications in manufacturing and service industries. Computer packages used and evaluated.

8057. PROCESSES, TECHNOLOGY, AND INNOVATION IN THE OPERATIONS FUNCTION. (4 cr; prereq 3000 or MBA 8050 or #, grad mgmt student)
Comparison of different operations process types; fundamental management problems in each type, including quality planning and control and productivity. Importance of process technology choice, innovation, and future technological advances. Case studies used in conjunction with lectures.

8058. OPERATIONS STRATEGY. (4 cr, §5058; prereq 8056, 8057, grad mgmt/IR student or Grad Sch Mgmt approval)
Integrated view of the operations function and integration of operations within the organization. Focuses on decision making and policy from point of view of chief operations manager. Case studies, lectures, and simulated decision environments used.

8059. QUALITY MANAGEMENT. (4 cr; prereq 3000 or MBA 8050 or #, grad mgmt student)
Quality function within manufacturing and service organizations. Quality planning, vendor relations, process control, acceptance sampling, and quality improvement. Taught from managerial point of view.

8215. OPERATIONAL FORECASTING. (4 cr; prereq 8056 or #, grad mgmt/IR student or Grad Sch Mgmt approval)
Forecasting models for operational problems of inventory, aggregate planning, and scheduling. Various methods of time series analysis. Applications of computer packages to forecasting problems.

8220. INVENTORY MANAGEMENT. (4 cr; prereq 8056 or #, grad mgmt/IR student or Grad Sch Mgmt approval)
Inventory models for independent demand items. Advanced readings from operations management technical journals.

8221. RESOURCE PLANNING AND SCHEDULING. (4 cr; prereq 8056 or #, grad mgmt/IR student or Grad Sch Mgmt approval)
Problems of aggregate planning, scheduling, routing, sequencing, and dispatching. Various models and information systems approaches to solving these problems. Applications to service industries stressed. Advanced computer packages and readings assigned.

8850. TOPICS IN OPERATIONS MANAGEMENT. (Cr ar [may be repeated for cr]; prereq MBA 8050 or #, grad mgmt student)
Discussion and analysis of current topics and developments in operations analysis and management. Topics vary with each course offering.

8900. FOUNDATIONS FOR RESEARCH IN OPERATIONS MANAGEMENT I. (4 cr; prereq 8056, MBA 8050, PhD student or #)
Literature and research methods in operations management. Forecasting, aggregate planning, inventory replenishment systems, scheduling, material requirements planning, project planning and scheduling, workforce scheduling, and quality planning and control.

8901. FOUNDATIONS FOR RESEARCH IN OPERATIONS MANAGEMENT II. (4 cr; prereq 8057, MBA 8050, PhD student or #)
Literature and research methods in operations management. Process design, facility location, facility layout, capacity planning, and operations strategy.

8990. READINGS IN OPERATIONS MANAGEMENT. (Cr ar; prereq consent of adviser and #, 2nd-yr grad student, requisite introductory courses, Grad Sch Mgmt approval)

8995. GRADUATE RESEARCH IN OPERATIONS MANAGEMENT. (Cr ar; prereq consent of adviser and #, 2nd-yr grad student, requisite introductory courses, Grad Sch Mgmt approval)

Risk Management and Insurance (Ins)

5230. LIFE CONTINGENCIES I. (4 cr, §Math 5057; prereq Math 1211 and 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.

8100. RISK MANAGEMENT AND INSURANCE I. (4 cr, §3100; prereq grad mgmt/IR 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.

8101. RISK MANAGEMENT AND INSURANCE II. (4 cr; prereq 8100, grad mgmt/IR student or Grad Sch Mgmt approval; offered when feasible)
Evaluation of various models for determining whether to buy insurance, what policy limits to purchase, and what size deductible to include. Cases illustrating various risk management principles and practices. Development of a risk management game.

8200. PERSONAL FINANCIAL MANAGEMENT. (4 cr, §3200; prereq 8100 or equiv, grad mgmt/IR student or Grad Sch Mgmt approval)
Personal financial planning process, financial statements and cash flow analysis, time value of money and financial functions. Insurance and risk management of liability, disability, life, medical and property exposures. Investment principles and vehicles, investment companies, portfolio construction and management. Taxes and tax management. Retirement planning, employee benefits, funding vehicles, estate planning principles and instruments. Professional ethics and government regulation of financial planners.

8210. ECONOMIC AND SOCIAL SECURITY. (4 cr, §3210, §Econ 5534; prereq grad mgmt/IR student or Grad Sch Mgmt approval)
Nature and causes of economic insecurity and poverty. Details and economic and social implications of private and public approaches to these problems, with emphasis on public programs such as Old Age, Survivors, Disability, and Health Insurance (Social Security), workers' compensation insurance, and public assistance.

8220. PROPERTY AND LIABILITY INSURANCE. (4 cr, §3220; prereq 3100 or 8100, grad mgmt/IR student or Grad Sch Mgmt approval)
Types of property losses and their measurement. Legal doctrines and statutes creating liability risks for business firms, families, and other units. Analysis of major property and liability insurance contracts. How property and liability insurance is priced and marketed. Selection of an insurer. Social issues such as availability of insurance, malpractice, no-fault automobile insurance, and workers compensation.

8800. SEMINAR: RISK MANAGEMENT AND INSURANCE. (4 cr; prereq 3100 or 8100, #, grad mgmt/IR student, Grad Sch Mgmt approval; offered when feasible)
Selected advanced topics in risk management and insurance.

8990. READINGS IN RISK MANAGEMENT AND INSURANCE. (Cr ar; prereq consent of adviser, #, Grad Sch Mgmt approval)
Readings tailored to student's individual program and objectives that are not available in regular course offerings.

8995. GRADUATE RESEARCH IN RISK MANAGEMENT AND INSURANCE. (Cr ar; prereq Grad Sch Mgmt approval)
Research topics tailored to student needs.

Business Education

See Vocational and Technical Education.

Business Taxation

See Business Administration.

Cell and Developmental Biology (GCB)

Professor: Paul C. Letourneau (cell biology and neuroanatomy), *director of graduate studies;* John S. Anderson (biochemistry); G. Eric Bauer (cell biology and neuroanatomy); Robert M. Brambl (plant pathology); Bianca M. Conti-Tronconi (biochemistry); William P. Cunningham (genetics and cell biology); William R. Dayton (animal science); Robert P. Elde (cell biology and neuroanatomy); Stanley L. Erlandsen (cell biology and neuroanatomy); Richard D. Estensen (laboratory medicine and pathology); David P. Fan (genetics and cell biology); Albert W. Frenkel (botany); Leo T. Furcht (laboratory medicine and pathology); David W. Hamilton (cell biology and neuroanatomy); Orion D. Hegre (cell biology and neuroanatomy); Robert K. Herman (genetics and cell biology); William S. Herman (genetics and cell biology); Alan B. Hooper (genetics and cell biology); Ross G. Johnson (genetics and cell biology); Norman S. Kerr (genetics and cell biology); Richard W. Linck (cell biology and neuroanatomy); Charles F. Louis (veterinary biology); Robert G. McKinnell (genetics and cell biology); David J. McLaughlin (botany); John A. Parsons (cell biology and neuroanatomy); Peter G. W. Plagemann (microbiology); Palmer Rogers (microbiology); Murray D. Rosenberg (genetics and cell biology); Irwin Rubenstein (genetics and cell biology); Walter Sauerbier (microbiology); John R. Sheppard (genetics and cell biology); W. Thomas Shier (medicinal chemistry and pharmacognosy); Akhouri Sinha (genetics and cell biology); Leon A. Snyder (genetics and cell biology); Robert L. Sorenson (cell biology and neuroanatomy); Clare K. Woodward (biochemistry); Val W. Woodward (genetics and cell biology)

Associate Professor: Martin Blumenfeld (genetics and cell biology); Stuart F. Goldstein (genetics and cell biology); Perry B. Hackett (genetics and cell biology); Mark C. Herzberg (periodontics and oral biology); Victoria Iwanij (genetics and cell biology); Hon Cheung Lee (physiology); Paul A. Lefebvre (genetics and cell biology); Steven C. McLoon (cell biology and neuroanatomy); Virginia S. Seybold (cell biology and neuroanatomy); Carolyn D. Silflow (genetics and cell biology); Howard C. Towle (biochemistry)

Assistant Professor: Robert J. Brooker (biological process technology); Connie Clark (laboratory medicine and pathology); Donna R. Fontana (microbiology); Ryoko Kuriyama (cell biology and neuroanatomy); William J. Sharrock (biochemistry); Jocelyn E. Shaw (genetics and cell biology); Susan M. Wick (botany)

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—Cell and developmental biologists seek to understand a variety of important biological processes by using an interdisciplinary approach to cell study. The curriculum, therefore, includes components of a biochemical, genetic, physiological, and molecular biological nature. Research addresses basic questions regarding the organization, composition, function, and assembly of cells and cellular components, and their regulation during the processes of cellular growth and differentiation. Graduate experience in cell and developmental biology is offered in such areas as cellular structure, cellular regulation, the biology of cellular organelles, the biology of cell surfaces, and developmental biology.

Prerequisites for Admission—The program is sufficiently flexible to accommodate students with a wide range of backgrounds. Those 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. 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) and Subject (Advanced) Tests of the Graduate Record Examination; and a statement of interests and goals.
Recommended date for receipt of completed applications is February 1. Completed files are reviewed between February and June. 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. Advanced courses in cell biology and biochemistry are typically required, in addition to specialty courses designed to meet the individual student's needs. An oral final examination is required for both plans.

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 cell biology (including the core sequence 8148 and 8149), along with competence in biochemistry and genetics, are required. Special courses, topical seminar courses, laboratory research rotations, thesis research, department seminars, and journal clubs are elected.

Language Requirements—None. Applicants to the cell and developmental biology program 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 should be approved by the director of graduate studies and typically include the cell biology core sequence (8148 and 8149), supplemented by advanced cell and developmental biology courses appropriate to the student's field of specialization.

For Further Information—Inquiries about admission, graduate program activities, courses, and research opportunities should be sent to the director of graduate studies, Department of Cell Biology and Neuroanatomy, 4-135 Jackson Hall, University of Minnesota, 321 Church Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5001f. SCANNING ELECTRON MICROSCOPY LAB. (4 cr; prereq #; S-N only) Kuehn
Practical laboratory experience in operation of scanning electron microscope (SEM) and preparation of biological samples for SEM analysis. Use of SEM for research work. Charges assessed for supplies and microscope time.

5002s. TRANSMISSION ELECTRON MICROSCOPY LAB. (4 cr; prereq #; S-N only) Kuehn
Practical laboratory experience in operation of transmission electron microscope (TEM) and preparation of biological samples for TEM analysis. Thin sectioning of tissues selected by student. Charges assessed for supplies and microscope time.

5013s. MAMMALIAN REPRODUCTION. (4 cr; prereq Biol 3011 and Biol 5001 or #; offered odd yrs) Sinha
Introduction to biological aspects of mammalian reproduction with emphasis on eutherians. Selected topics and examples used to discuss basic problems, current concepts, and patterns of reproduction at molecular, cellular, and organismal levels.

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 genetic basis of morphogenesis and metazoan development. Emphasis on organisms that are amenable to genetic analysis, including certain procaryotes and single-cell eucaryotes, a nematode and Drosophila.

5035f. INTERMEDIATE CELL BIOLOGY. (4 cr; prereq Biol 5004 or #)
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.

5052s. QUANTITATIVE TECHNIQUES, CELL BIOLOGY. (4 cr; calculus, introductory cellular or molecular biology, biochemistry recommended) Mahoney, Rubenstein
Use and detection of radioisotopes; theory and practice of analytical and preparative ultracentrifugation, chromatography, spectroscopy, and electron microscopy; tissue culture and subcellular particle fractionation.

5114f. GENERAL PHYSIOLOGY. (3 cr; prereq Biol 3011, Biol 5001, Phys 1109 or 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, Biol 5001 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, Lefebvre
Experimental approaches to cell structure, function, and replication, including microscopy, autoradiography, cell fractionation, and molecular and chemical analyses.

5970. DIRECTED STUDIES. (Cr ar; prereq #, △)
Individual study of selected topics or problems with emphasis on selected readings and use of scientific literature.

5990. DIRECTED RESEARCH. (Cr ar; prereq #, △)
Laboratory or field investigation of selected areas of research.

8060f,w,s. CURRENT TOPICS. (2 cr [may be repeated for cr])
Several sections offered each quarter, each devoted to a different topic.

8131f. ADVANCED GENETICS I. (4 cr, §5031; prereq 3022 or Biol 5003, Biol 5001 or BioC 5751 or #) Lefebvre
Comparative organization of genetic material in procaryotic and eucaryotic organisms. Mutation, complementation, and recombination as operational criteria for genetic analysis.

8132w. ADVANCED GENETICS II. (4 cr, §5032; prereq 8131) 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, §5048; prereq Biol 5004 or #) Iwanij, Johnson
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, §5049; prereq Biol 5003, Biol 5004) Johnson, 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.

8900f,w,s. SEMINAR. (1 cr [may be repeated for cr]; offered S-N only)

8910f,w,s. JOURNAL CLUBS. (1 cr; prereq △; offered S-N only)
Critical evaluation of selected current literature.

8920f,w,s. SPECIAL TOPICS. (1-5 cr; prereq △; offered S-N only)
Participation in organized symposia and short courses.

8950. PRACTICUM: TEACHING IN GENETICS. (1 cr; prereq △; offered 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 △; offered 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.

8970f,w,s,su. DIRECTED STUDIES. (Cr ar; prereq #, △) Staff
Content determined by interests of individual in consultation with instructor; independent, nonlaboratory study.

8990f,w,s,su. RESEARCH. (Cr ar; prereq #) Staff

Other Courses of Interest

Agro 8230. CYTOGENETICS

BioC 5025. LABORATORY IN BIOCHEMISTRY

BioC 8225. TRACER TECHNIQUES

Biol 5004. CELL BIOLOGY

Biol 5125. RECOMBINANT DNA LABORATORY

Biol 5951. SOCIAL USES OF BIOLOGY

CBN 8166. SEMINAR: PANCREATIC ISLET BIOLOGY

CBN 8210. DEVELOPMENTAL NEUROBIOLOGY

CBN 8223. NEUROBIOLOGY OF ENDOCRINE REGULATION

GCB 5061. DEVELOPMENTAL BIOLOGY

GCB 8213. ADVANCED MOLECULAR BIOLOGY I

GCB 8214. ADVANCED MOLECULAR BIOLOGY II

MicB 5216. IMMUNOLOGY

MicB 5321. PHYSIOLOGY OF BACTERIA

MicB 5424. BIOLOGY OF VIRUSES

MicB 8125. MICROBIAL DEVELOPMENT

MicB 8421. VIROLOGY AND TUMOR BIOLOGY

NSc 5460. NEUROCHEMICAL COMMUNICATION

Path 8108. PATHOBIOLOGY I

Path 8109. PATHOBIOLOGY II

Path 8110. PATHOBIOLOGY III

Path 8130. CELL BIOLOGY OF THE EXTRACELLULAR MATRIX

Chemical Engineering and Materials Science and Engineering

CHEMICAL ENGINEERING

Regents' Professor: Rutherford Aris

Professor: H. Ted Davis, *head;* Robert W. Carr, Jr., *director of graduate studies*; Edward I. Cussler; John S. Dahler; D. Fennell Evans; Arnold G. Fredrickson; Christie J. Geankoplis; Klavs Jensen, Kenneth H. Keller; Christopher W. Macosko; Wilmer G. Miller (chemistry); Stephen Prager (chemistry); William E. Ranz; Lanny D. Schmidt; L. Edward Scriven II; William H. Smyrl; Matthew V. Tirrell

Associate Professor: Michael C. Flickinger (biochemistry): John M. Sivertsen

Assistant Professor: Wei-Shou Hu; Timothy P. Lodge (chemistry); Mitchell B. Luskin (mathematics); José L. Martins; Friedrich Srienc; Robert T. Tranquillo; Henry S. White

MATERIALS SCIENCE AND ENGINEERING

Professor: William W. Gerberich, *associate head;* John H. Weaver, *director of graduate studies;* James R. Chelikowsky; Allen M. Goldman (physics); Klavs Jensen; Christopher W. Macosko; Richard A. Oriani; Emil Pfender; Lanny D. Schmidt; William H. Smyrl; Matthew V. Tirrell

Associate Professor: Earl D. Dahlberg (physics); Alfonso Franciosi; David A. Shores; John M. Sivertsen

Assistant Professor: José L. Martins; Martha L. Mecartney; Henry S. White

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 and Plan B), M.S.Mat.S.E., M.Mat.S.E., and Ph.D.

Curriculum—Emphases are available in applied fracture mechanics, bioengineering, catalysis, chemical kinetics, surface chemistry, chemical reactor analysis, control and optimization, corrosion, fluid and interfacial mechanics, electron micros--

copy, physical and chemical metallurgy, electronic properties of materials, metal physics, interface reactions, microelectronics and microelectronic materials, ceramics, superconductivity, electrochemistry, molecular theory of rate processes, polymers, rheology, structure-property relationships, and thermodynamics.

Prerequisites for Admission—A bachelor's degree in chemical engineering, metallurgy, materials science, polymer engineering, chemistry, or physics is required. Applicants may be accepted without this prerequisite, but may be required to complete additional preparatory studies 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 suggested for all applicants. Deadline for application is February 1; late applications will be 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 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, electrical engineering, or mechanics.

Language Requirements—None.

For Further Information—Write to the director of graduate studies, Chemical Engineering and Materials Science, 151 Amundson Hall, University of Minnesota, 421 Washington Avenue S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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, 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.

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.

5403. CHEMICAL ENGINEERING LABORATORY. (2 cr; prereq 5103, upper div ChEn or MatS major; 4 lab 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 designed to 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 grad students 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.

5755. BIOCHEMICAL ENGINEERING. (4 cr; prereq 5103, 5754 or #; 3 lect hrs per wk)
Application of chemical engineering principles to solution of processing problems of industrially important biological materials. Statistical experimental design of industrial systems.

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 chemistry; 3 lect hrs per wk)
Preparation, stability, and coagulation kinetics of colloidal solutions. DLVO theory, electrokinetic phenomena, and properties of micelles and other microstructures.

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).

5901. CHEMICAL PROCESS LABORATORY. (2 cr; prereq 5301)
Applications of kinetics, heat, and mass transfer to batch and continuous flow reactors.

5902, 5903, 5904, 5905. SPECIAL PROBLEMS. (Cr ar)
Investigations in chemical engineering. Library or laboratory 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.

8106. ADVANCED TOPICS IN FLUID MECHANICS AND TRANSPORT PROCESSES. (3 cr; prereq 8101, 8103)
Topics in ideal, viscous, and turbulent flow and transport, interphase transfer.

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.

8501-8502-8503. CHEMICAL RATE PROCESSES AND REACTOR DESIGN PRINCIPLES. (3 cr per qtr; prereq #)
Theory of chemical engineering reaction kinetics based on chemical rate processes and thermochemical, fluid mechanical, and heat and mass transfer consideration. Applications to industrial reactor design problems. Batch processes and continuous tubular and staged reactor systems. Typical problems for homogeneous, multiphase, catalytic, and radiation-induced reactions.

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.

8640. POLYMERIZATION REACTOR ENGINEERING. (3 cr)
Same as 5640, with advanced problems.

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.

8750. ADVANCED CHEMICAL PROCESS DESIGN. (3 cr; prereq #)
Synthesis of optimum process flowsheets. Analysis of flowsheets using the modular approach. Methods for solution of large sets of algebraic equations. Theory of optimization for constrained and unconstrained problems with applications to process design. Analysis of safety and reliability of chemical plants.

8801, 8802, 8803. SEMINAR. (1 cr per qtr)
Presentation and discussion of papers concerning the newer developments in chemical engineering.

8810. PROCESSING OF ELECTRONIC MATERIALS. (3 cr; prereq MatS 5011 or #; 3 lect hrs per week)
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, or #; 4 lect hrs per wk)
Introduction to fundamentals of electrochemical engineering. Topics include electrokinetics, thermodynamics of cells, practical and advance 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 laboratory 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.

5620. PROCESSING OF POLYMERS AND THEIR COMPOSITES. (4 cr [3 cr w/o lab by dept permission]; prereq heat transfer and 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 5011 or 3400 and 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. THERMODYNAMICS, DEFECT STRUCTURES, PHASE TRANSFORMATIONS, DIFFUSION. (3 cr; prereq #)
Classical equilibrium thermodynamics for systems of constant and variable composition. Techniques for measurement of thermodynamic properties. Theory of imperfections, effects on properties of metals.

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.

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 laboratory exercises associated with compliance, strain-energy release rate, and J-integral techniques.

8320. HIGH TEMPERATURE PROPERTIES OF MATERIALS. (3 cr)
Fundamental studies of refractory metals and ceramics. Phase diagrams, crystal chemistry, thermodynamics, mechanical and electrical properties.

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)

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 laboratory 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.

8610. POLYMER CHEMISTRY. (3 cr)
See 5610 for description.

Chemical Physics

Professor: C. Alden Mead (chemistry), *director of graduate studies;* Jan Almlöf (chemistry); Charles E. Campbell (physics); John S. Dahler (chemistry); H. Ted Davis (chemical engineering and materials science); W. Ronald Gentry (chemistry); Clayton F. Giese (physics); Allen M. Goldman (physics); J. Woods Halley (physics); Robert M. Hexter (chemistry); Sanford Lipsky (chemistry); Rufus W. Lumry (chemistry); Wilmer G. Miller (chemistry); Albert J. Moscowitz (chemistry); Eckard Muenck (Gray Freshwater Biological Institute); Stephen Prager (chemistry); Lanny D. Schmidt (chemical engineering and materials science); Donald G. Truhlar (chemistry); John H. Weaver (chemical engineering and materials science); Walter Weyhmann (physics)

Associate Professor: Paul F. Barbara (chemistry)

Assistant Professor: Doreen G. Leopold (chemistry); Kenneth R. Leopold (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, and biochemical and heterogeneous catalysis.

Prerequisites for Admission—Applicants should have adequate preparation in mathematics, physics, and chemistry. For financial support, applicants must apply either to the Department of Chemistry or to the Department of Physics. Applicants not requiring financial support will 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 phenomenological or statistical 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 the Physics Department.

Doctoral Degree Requirements—Proficiency examinations in physical chemistry and one other subfield (e.g., inorganic chemistry, solid-state physics, optics) are required. Students choose a program of study in consultation with their faculty advisory committee. Programs include thermodynamics, quantum mechanics, and at least one three-quarter sequence in chemistry and in physics. Other aspects of the program are flexible. There is no minor or supporting field requirement.

Language Requirement—None.

For Further Information—Contact the director of graduate studies, Chemical Physics Program, 139 Smith Hall, University of Minnesota, 207 Pleasant Street S.E., Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Chemistry (Chem)

Regents' Professor: Paul G. Gassman

Professor: Louis H. Pignolet, *head;* Donald G. Truhlar, *director of graduate studies;* Jan Almlöf; Victor A. Bloomfield; J. Doyle Britton; Peter W. Carr; John S. Dahler; H. Ted Davis; John E. Ellis; W. Ronald Gentry; Wayne L. Gladfelter; Gary R. Gray; Robert M. Hexter; Essie Kariv-Miller; Maurice M. Kreevoy; Edward Leete; Sanford Lipsky; Rufus W. Lumry; C. Alden Mead; Larry L. Miller; Wilmer G. Miller; Albert J. Moscowitz; Eckard Muenck; Wayland E. Noland; Stephen Prager; Lawrence Que; Michael A. Raftery; Warren L. Reynolds; Harold S. Swofford, Jr.;

Associate Professor: George Barany; Paul F. Barbara; Margaret C. Etter; John F. Evans; Thomas R. Hoye; Timothy P. Lodge; Kent R. Mann; Marian Stankovich

Assistant Professor: Steven R. Kass; Doreen G. Leopold; Kenneth R. Leopold; Hung-wen Liu; Scott D. Rychnovsky

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 five specialty areas: analytical chemistry, biological chemistry, inorganic 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 TOEFL scores of at least 580, as well as GRE scores. One academic year (or more) in residence as a full-time student at a recognized institution of higher learning in the United States will be accepted in lieu of the TOEFL examination.

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.

[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.*

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—Three 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). A minimum of 6 credits must be in the minor or supporting program. Written preliminary examinations are given in the areas of organic chemistry and biological chemistry. The analytical and inorganic areas use the cumulative system of written preliminary examinations. For students specializing in physical chemistry, this examination consists 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—Contact the director of graduate studies, Department of Chemistry, 147b Smith Hall, University of Minnesota, 207 Pleasant Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5001-5002. CHEMISTRY CONCEPTS FOR JUNIOR HIGH SCHOOL TEACHERS. (4 cr per qtr; prereq college-level general chem, secondary school teaching experience or #)
Chemistry fundamentals to expand resources for teaching junior high school chemistry concepts. Demonstration of concepts through experimentation, selection of appropriate topics.

5122. ADVANCED ANALYTICAL CHEMISTRY. (4 cr; prereq 1 yr organic chemistry and one course in thermodynamics)
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 1291, Math 1231 or equiv or #, Chem major or grad)
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 laboratory computer to control of chemical instrumentation and acquisition of data. Hardware (interfacing) and software (assembly language programming) aspects of automating the chemical experiment.

5133. CHEMICAL INSTRUMENTATION AND ANALYSIS LECTURE. (3 cr; prereq 1133, 5534, 5535, or #)
Methodology and practices for solving analytical problems. Application of modern instrumental techniques to analysis.

5139. CHROMATOGRAPHY AND SEPARATION SCIENCE. (3 cr without lab, 4 cr with lab; prereq 5133 and 5134 or equiv or #, Chem major or grad; 3 cr: 3 lect hrs per wk, 4 cr: 3 lect and one 4-hr lab per wk)
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 and #)
Reactions of typical functional groups and introduction to modern laboratory methods of organic synthesis.

5305. INTERMEDIATE ORGANIC CHEMISTRY. (4 cr; prereq 3303 or 3333 or equiv; 3 lect and 1 rec hrs per wk)
Introduction to various aspects of physical organic chemistry with application to typical chemical problems. Reactions of typical functional groups and introduction to modern laboratory methods of organic synthesis.

5309. APPLICATIONS OF MOLECULAR ORBITAL THEORY IN ORGANIC CHEMISTRY. (4 cr; prereq 5536 or Phys 3501 or #)
Application of quantum mechanics to organic reactions and photochemistry.

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.

5365. ORGANIC QUALITATIVE ANALYSIS. (4 cr; prereq 3303 or 3333 or equiv; 8 lab and 2 conf hrs per wk)
Reactions of typical functional groups and introduction to methods of organic structure determination.

5520-5521. ELEMENTARY PHYSICAL CHEMISTRY. (3 cr per qtr; prereq 1 yr college chemistry, Phys 1291 or ¶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 chemistry, 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 chemistry)
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 chemistry, 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.

5533. QUANTUM CHEMISTRY. (4 cr; prereq 1 yr college chemistry, 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.

5580. PHYSICAL CHEMISTRY OF POLYMERS. (3 cr; prereq 5534 or 5535 or #; offered alt yrs)
Molecular weight distribution, statistical mechanics of polymer solutions, network polymers, viscosity, light scattering, viscoelastic behavior.

5610. POLYMER SCIENCE. (4 cr, §MatS 5610; prereq physical chemistry 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 ChemEng 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 ChemEng 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.

5751. PHYSICAL INORGANIC CHEMISTRY I. (4 cr; prereq 5732 or equiv 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.

5752. PHYSICAL INORGANIC CHEMISTRY II. (4 cr; prereq 5751 or equiv or #)
Solution thermodynamics and kinetics applied to inorganic and organometallic systems; determination of reaction mechanisms; symmetry and ligand field concepts.

5756. X-RAY CRYSTALLOGRAPHY. (4 cr; prereq grad student or #)
Determination of crystal structures by x-ray diffraction of single crystals. Data collection, structure solving, and refinement of structures of inorganic and organic molecules of 100 atoms or less.

5761. ORGANOMETALLIC CHEMISTRY. (4 cr; prereq 5732 or equiv 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.

5762. SURVEY OF THE CHEMISTRY OF THE TRANSITION METALS. (4 cr; prereq 5732 or equiv or #)
Reactions and properties of transition metals and their compounds. Modern coordination chemistry including magnetic and spectroscopic properties and qualitative ligand field theory.

5763. SURVEY OF THE CHEMISTRY OF THE NON-TRANSITION ELEMENTS. (4 cr; prereq 5732 or equiv or #)
Reactions and properties of the non-transition elements, including the rare gases and their compounds.

5765. BIOINORGANIC CHEMISTRY. (4 cr; prereq 5732 or equiv, chem major or #; 4 lect hrs per wk)
Survey of role of metal ions in biology with emphasis on structure, function, and spectroscopy of metalloproteins and their synthetic analysis.

5803. THE CHEMISTRY OF INDUSTRY. (4 cr; prereq chemistry 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, △)
Topics of current interest in chemistry. Consult department for details of offerings for any particular quarter.

8104. SPECTROSCOPIC METHODS OF ANALYSIS. (3 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 OTTLE 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 #)

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 chemistry or #)
Practical application of nuclear magnetic resonance, mass, ultraviolet, and infrared spectral analyses to the solution of organic structural problems.

8303. DETERMINATION OF MECHANISMS OF ORGANIC REACTIONS. (4 cr; prereq 1 yr organic chem or #)
Organic reaction mechanisms, transition state theory, linear free energy correlations, isotope effects, solvent effects, and kinetic analysis of data.

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.

8390. SEMINAR: ORGANIC CHEMISTRY. (1 cr per qtr [may be repeated for cr]; required of all grad students majoring in organic chemistry)

8401. BIOORGANIC CHEMISTRY I. (4 cr; prereq 3303 or 3333 or equiv)
Chemistry of biologically important functional groups and compounds including amino acids, lipids, carbohydrates, organophosphates. Techniques for radiolabeling and for synthesis of analogs of biologically active molecules.

8402. BIOORGANIC CHEMISTRY II. (4 cr; prereq 3303 or 3333 or equiv)
Results from mechanistic studies of organic model reactions used to outline current perspectives on fundamental driving forces responsible for enzymatic catalysis and specificity.

8403. BIOORGANIC CHEMISTRY III. (4 cr; prereq 3303 or 3333 or equiv)
Biochemical phenomena as problems in mechanistic organic chemistry: elimination, isomerization, rearrangement, aldol condensation group transfer reactions.

8512. CHEMICAL THERMODYNAMICS. (4 cr; prereq undergrad physical chemistry)
Fundamentals of classical thermodynamics and application to chemical phenomena including chemical equilibrium, phase transitions, surface and solution thermodynamics.

8514. CHEMICAL APPLICATIONS OF GROUP THEORY. (4 cr; prereq undergrad physical chemistry)
Introduction to role of symmetry and group theory in chemistry, with emphasis on applications to molecular and electronic structure and vibrational and electronic spectroscopy.

8521. METHODS OF THEORETICAL CHEMISTRY. (4 cr; prereq undergrad physical chemistry)
Basic theoretical techniques of physical chemistry, application to selected chemical problems.

8531-8532. 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 chemistry)
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 chemistry)
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 nonideal gases and solutions, distribution functions, and nonequilibrium statistical mechanics.

8560. SEMINAR: PHYSICAL CHEMISTRY OF BIOLOGICAL SYSTEMS. (Cr ar)

8590. PHYSICAL CHEMISTRY SEMINAR. (1 cr [may be repeated for cr]; prereq #; S/N only; required of all grad students majoring in physical chemistry)

8593. SPECIAL TOPICS IN PHYSICAL CHEMISTRY. (4 cr; prereq #)

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.

8790. SEMINAR: MODERN PROBLEMS IN INORGANIC CHEMISTRY. (1 cr [may be repeated for cr]; prereq △)

8990. RESEARCH IN CHEMISTRY. (Cr ar; prereq △)

8991. SPECIAL TOPICS IN CHEMISTRY. (Cr ar; prereq 1 yr undergrad organic chemistry)

8992. SPECIAL TOPICS IN CHEMISTRY. (Cr ar; prereq #)

8993. SPECIAL TOPICS IN CHEMISTRY. (Cr ar; prereq 1 yr organic chemistry)

8994, 8995, 8996. SPECIAL TOPICS IN CHEMISTRY. (Cr ar; prereq △)

Child Psychology (CPsy)[1]

Professor: W. Andrew Collins, *director;* Herbert L. Pick, Jr., *director of graduate studies;* Irving Biederman; William R. Charlesworth; Byron R. Egeland; Norman Garmezy (emeritus); Willard W. Hartup;

[1]*See the College of Education Bulletin for information on the Master of Education (M.Ed.) program in early childhood education.*

Michael P. Maratsos; Shirley G. Moore (emeritus); Anne D. Pick; L. Alan Sroufe; June L. Tapp; James E. Turnure; Richard A. Weinberg; Albert Yonas

Associate Professor: Megan R. Gunnar; Charles A. Nelson

Assistant Professor: Ann S. Masten; James L. Morgan; Elsa G. Shapiro; Carolyn L. Williams

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, 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 February 1 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.

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, independent study, and research problems 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.

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—Contact the director of graduate studies, 156 Child Development Building, University of Minnesota, 51 East River Road, Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5301. ADVANCED CHILD DEVELOPMENT. (4 cr, §3309, §1301, §8301; prereq 5 cr introductory psychology) Charlesworth
Theory and research in child development with emphasis on perception, language, learning, cognition, personality, and social development in children.

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, §Educ 5440, §HSU 5009, §PA 5414, §SAHP 5009, §SW 5024, §Soc 5960) Tapp, 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. BEHAVIORAL AND EMOTIONAL PROBLEMS. (4 cr, §3311; prereq 1301 or equiv) Masten, Sroufe
Description, etiology, development of behavioral and emotional problems of children and treatment where germane; excluded are problems deriving primarily from sensory or physical handicap, mental retardation, or neurological impairment.

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, §PsyS 5120; prereq 1301 or equiv) Turnure
Psychological and educational problems related to the mentally retarded.

5319. CLINICAL PROCEDURES WITH CHILDREN AND YOUTH. (4 cr; prereq 12 cr child psychology, educational psychology, sociology, or psychology) Masten
Survey of assessment and intervention procedures of child clinical psychology in clinical and community settings. Primarily for students not majoring in clinical psychology.

5320. CURRENT ISSUES IN CHILD DEVELOPMENT/EARLY EDUCATION. (1-3 cr; prereq Project CEED participant) Weinberg
For professionals and practitioners whose work affects young children and families. Seminar format with nationally known speakers and topics specified at time of scheduling. May register for academic credit or CEUs.

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.

5331. PROCESSES OF SOCIALIZATION OF CHILDREN. (4 cr, §3331; prereq 1301 or equiv) Collins, Hartup
Processes of social learning; identification, social influence, imitation, reward and punishment, internalization, and object choice.

5333. PERSONALITY DEVELOPMENT. (4 cr; prereq 3331 or 5331; offered when feasible)
Psychoanalytic and behavior theory formulations, related research literature in content areas (e.g., attachment, dependency, aggression, competence, and sex typing).

5334. CHILDREN AND YOUTH IN SOCIETY. (4 cr; prereq 4 cr child psychology) Tapp
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.

5335. PEER RELATIONS. (4 cr; prereq 3331 or 5331; offered when feasible)
Peer influences; social interactions and social relations; developmental changes.

5339. PARENT-CHILD RELATIONS. (4 cr; prereq 3331 or 5331) Tapp
Discussion of parent-child relationships and evaluation of relevant research (e.g., cross-cultural child rearing perspectives, alternative parenting roles, economics of parent-child relations, rights of parents and children).

5341. PERCEPTUAL DEVELOPMENT. (4 cr; prereq 1301 or #) H Pick, Yonas
Perceptual learning and the development of sensory and perceptual processes.

5343. COGNITIVE DEVELOPMENT. (4 cr; prereq 1301 or #) A Pick, H Pick
Development of cognitive processes; discussion of relevant theory, research literature, and methodology.

5345. LANGUAGE DEVELOPMENT. (4 cr; prereq 1301 or #) Maratsos, Morgan
Development of structure and function of language; factors influencing development; methodological problems, language scales, theories.

5349. CHILDREN'S LEARNING AND INTELLECTUAL SKILLS. (4 cr, §3347; prereq 1301, 3343 or #) H Pick
Current research on learning, problem solving, intellectual performance in children; practical applications.

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; prereq #) A Pick
Review of principal research methods and designs in child psychology.

8310. SEMINAR: HISTORY OF CHILD DEVELOPMENT. (1 cr; prereq #) Maratsos, Masten
Problems and issues in professional child psychology for first-year graduate students.

8320. SEMINAR: CURRENT ISSUES IN TEACHING DEVELOPMENTAL PSYCHOLOGY. (1 cr; prereq #) Charlesworth
Problems and issues in professional child psychology for advanced graduate students.

8327. ETHOLOGY OF CHILD BEHAVIOR. (3 cr; prereq #) Charlesworth
Theory and research on phylogenetic and ontogenetic factors in children's adaptive behavior.

8329. GENETICS AND DEVELOPMENT. (3 cr; prereq #; offered when feasible)
Theory of and research on genetic factors in human behavioral development, including patterns of development, individual differences, and species-specific behavior.

8333. ADVANCED SOCIAL DEVELOPMENT I. (3 cr; prereq #) Collins, Hartup
Processes in socialization and personality development emphasizing theory and including predispositional, acquisitional, mediational, and interactional processes.

8334. CHILD DEVELOPMENT, SOCIAL POLICY, AND LEGAL VIEWS. (4 cr) Tapp
Developmental principles, social policy, and law related to children, parents, and families. Interdisciplinary research/applied perspective tying theories and findings to such problems as abuse, competence, custody, day care, divorce, eye/child witness, and rights.

8336. ADVANCED SOCIAL DEVELOPMENT II. (3 cr; prereq #; offered when feasible)
Topics in social and personality development research including social relations, social reasons, rules and regulations, social roles, and individual differences.

8338. DEVELOPMENTAL PSYCHOLOGY OF COMMUNICATION. (3 cr; prereq #; offered when feasible) Collins
Research related to development of interpersonal communication behaviors, and developmental aspects of processes and effects of mass communication.

8341. ADVANCED PERCEPTUAL DEVELOPMENT. (3 cr; prereq Psy 5031 and #) 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) Maratsos
Theory and research emphasizing Piagetian and psychometric (differential) perspectives.

8345. ADVANCED LANGUAGE DEVELOPMENT. (3 cr; prereq Ling 5001, 12 cr child psychology or psychology and #) Maratsos, Morgan
Critical evaluation of current theory and research in language development.

8347. ADVANCED COGNITIVE DEVELOPMENT II. (3 cr; prereq Psy 5013 or #; offered when feasible)
Theory and research emphasizing experimental psychology and including the areas of memory development, learning, human information processing, categories, and concept development.

8351. THEORY AND PRACTICES IN THE PRESCHOOL. (3 cr; prereq #; offered when feasible)
Educational philosophy of the preschool; intellectual growth and development of communicative skills; curricular experiences in science, literature, art, and music; use of free play and play materials with young children.

8355. BEHAVIOR OF PRESCHOOL CHILDREN. (3 cr; prereq #; offered when feasible)
Use of group setting for study and guidance of personality and social development of young children.

8360. SEMINAR: DEVELOPMENTAL PSYCHOLOGY. (Cr ar; prereq #)
Intensive study of selected topics.

8605. DEVELOPMENTAL PSYCHOPATHOLOGY. (3 cr; prereq 8333 and #) 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, §PsyS 8153) Egeland, Masten
Alternative formulation of childhood disorders, emphasizing competency training rather than medical nosology.

8970. INDEPENDENT STUDY. (Cr ar; prereq #)
Independent reading.

8990. RESEARCH PROBLEMS. (Cr ar; prereq #)
Individual empirical investigation.

Chinese

See East Asian Studies.

Civil Engineering (CE)

Professor: Steven L. Crouch, *head;* Roger E. A. Arndt; Patrick Brezonik; Andrzej Drescher; Steven J. Eisenreich; Charles Fairhurst; Cesar Farell; Theodore V. Galambos; Walter J. Maier; Panos G. Michalopoulos; Gary Parker; Charles C. S. Song; Anthony M. Starfield; Heinz Stefan; Otto D. L. Strack; Ioannis Vardoulakis

Associate Professor: John S. Gulliver, *director of graduate studies;* Ladislav Cerny; Matthew J. Huber; Gerald W. Johnson; Theodor Krauthammer; Michael J. Semmens; Yorgos J. Stephanedes; Raymond L. Sterling

Assistant Professor: Randal J. Barnes; Catherine E. French; Joseph F. Labuz; Roberto T. Leon

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.S.C.E. (Plan A; Plan B if approved by adviser), M.C.E., 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. All subdisciplines of civil engineering (e.g., environmental engineering, water resources, structures, soil mechanics) are available.

Emphases in the Ph.D. program are structural design and analysis; 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; and soil and rock mechanics. 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 economics, 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 encouraged but not required to submit results of the Graduate Record Examination. Those who have not taken the GRE will be at a disadvantage in fellowship competitions.

Professional Registration—Applicants who have as their goal a professional career as a civil, structural, or mining engineer will 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., B.Min.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.C.E. and M.S.C.E. degrees is oral.

Language Requirements—None.

For Further Information—Contact the secretary for graduate studies, Civil and Mineral Engineering Building, University of Minnesota, 500 Pillsbury Drive S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

General

5001. BUILDING AND CONSTRUCTION CONTRACTS AND SPECIFICATIONS. (4 cr; prereq 3rd yr or #, IT student or adult special or grad)
Synopsis of the law of contracts, sales, agency, negotiable instruments, real property, personal property, partnerships, corporations, insurance contracts, and torts, with applications to the performance of engineering and construction contracts.

5002. ENGINEERING ECONOMICS. (2 cr; prereq jr, IT student or adult special or grad)
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.

5005. PUBLIC WORKS MANAGEMENT INFORMATION SYSTEMS. (4 cr; prereq 3020 or equiv or #, IT student or grad)
Development, purposes, and components of management information systems. Geographic data base and geocoding. Public works facility inventory, management of maintenance operations, and computer-aided mapping and design. Priority development, capital budgeting, and financing for public works.

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 laboratory 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 mechanics, structures, and transportation.

5700. SYSTEMS ANALYSIS FOR CIVIL ENGINEERS. (4 cr, §GeoE 5700; prereq IT student or grad)
Introduction to systems analysis and decision making; expert systems; operations research techniques, modeling, and simulation. Applications in civil engineering and related areas.

5701. CEMENTED MATERIALS PROPERTIES: EVALUATION AND MIXTURE DESIGN. (4 cr; prereq 3700, IT student or grad)
Characteristics and performance evaluation concepts of construction materials; properties and design of cemented mixtures such as concrete, bituminous mixtures, stabilized soils and rocks.

5702. MANUFACTURE AND QUALITY CONTROL OF CONSTRUCTION MATERIALS. (4 cr; prereq 3700, IT student or grad)
Methods of manufacture, especially of cemented materials such as concrete and stabilized soils and rock; expected variations and quality control concepts; optimization techniques developed to establish procedures and best material for a given situation.

5703. PROJECT MANAGEMENT. (4 cr; prereq sr or 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.

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, or transportation problems. Investigations, reports, tests, designs.

Surveying and Land Use Planning

5100. LAND SURVEYING. (4 cr; prereq 3100, 5102 or #, IT student or grad)
Minnesota Public Land Survey. Federal and state laws governing resurveys, registered land surveys, and subdivision plats. Court decisions and legal principles involving boundary line determinations. Interpreting and writing deed descriptions.

5101. GEODESY. (4 cr; prereq 3100, IT student or grad)
Size and shape of the earth; properties of ellipsoids; reference ellipsoids; Legendre theorem; geodesic and normal sections; direct and inverse geodetic lines; geodetic datums; deflection of the vertical; LaPlace stations. Survey adjustments.

5102. SITE AND ROUTE ENGINEERING. (4 cr; prereq 3100, IT student or grad)
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.

5103. LAND PLANNING AND SUBDIVISION DESIGN. (4 cr; prereq 3100 and 5102, IT student or grad)
Minnesota statutes, county and municipal ordinances governing land use and subdivision. Elements of design. Design of a subdivision.

5104. PHOTOGRAMMETRY. (4 cr; prereq Math 1211, IT student or grad)
Stereoscopy and parallax; geometry of single and overlapping photographs; stereoscopic plotting instruments; flight planning; aerial camera and calibration; mosaics; terrestrial photogrammetry; principles of photo interpretation; elements of remote sensing; and applications to resource evaluation.

5105. SURVEY ADJUSTMENTS. (4 cr; prereq 3100, CSci 3101 or #, IT student or grad)
Application of statistical theory to adjustment of surveying and photogrammetric measurements. Includes concepts of precision and accuracy, error propagation, observation and condition equations, weighting of observations, solutions of systems of equations by method of least squares, and precision of adjusted quantities.

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 student or grad)
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.

5202. AIRPORT DESIGN. (4 cr; prereq 3200, 3300 or #, IT student or grad)
Nature of air transport. Airfield site selection and runway patterns. Geometric design of runways; capacity. Drainage and pavement design.

5210. INTRODUCTION TO TRANSPORTATION SYSTEMS ANALYSIS. (4 cr; prereq #)
Techniques of analysis and planning for transportation services; demand-supply interactions; evaluating transportation alternatives; travel demand forecasting; integrated model systems; citizen participation in decision making; proposal writing.

5212. TRANSPORTATION PRODUCTIVITY AND ENERGY CONSERVATION. (4 cr; prereq #; offered when demand warrants)
Measuring transportation productivity and energy consumption; simulation of energy-conservation policies and their effect on transportation ridership and economics over time; transportation use and energy consumption in relation to urban or rural structures; case studies.

8200. THEORY OF TRAFFIC FLOW. (4 cr; prereq #)
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 #)
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.

8202. FREEWAY TRAFFIC OPERATIONS. (4 cr; prereq #)
Capacity analysis techniques, freeway traffic models, freeway surveillance and control, simulation, use of computer programs, design considerations, operational techniques for maximizing flow.

8210. MODELING CONSUMER CHOICES IN TRANSPORTATION. (4 cr; prereq Stat 3091 or #)
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 #)
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 transit systems.

8214. TRANSPORTATION SYSTEMS DYNAMICS AND CONTROL. (4 cr; prereq Math 3211 or #)
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 student or grad)
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 student or grad)
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 student or grad)
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 student or grad)
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.

5410. OPEN CHANNEL HYDRAULICS. (4 cr; prereq 3400, 5401 or #, IT student or grad)
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.

5420. INTRODUCTION TO WATER RESOURCES MANAGEMENT. (4 cr)
United States and world water resources; human use of water; economic, environmental, social, and political problems related to water.

5425. GROUNDWATER MECHANICS. (4 cr; prereq 3400 or #, IT student or grad)
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 student or grad)
Basic laws and equations of fluid flows; exact and approximate solution; very viscous flow; flow through porous media; potential flows; interfacial flows; boundary layer flow; turbulence and transport phenomena.

8401. INTERMEDIATE FLUID MECHANICS II. (4 cr; prereq 5435 or #)
Laminar and turbulent boundary layers and their interaction with potential flow. Application to engineering problems.

8402. INTERMEDIATE FLUID MECHANICS III. (4 cr; prereq 8401 or #)
Free-turbulence shear flows, dimensional analysis; statistical description of turbulence; random data analysis, measurement in transient flows.

8403. INVISCID FLOW. (3 cr; prereq 5435 or #)
Applications of Euler's equation, two- and three-dimensional potential flow, surface water waves.

8406. SEMINAR: ADVANCED HYDROLOGY. (1 cr)
Weekly seminar by staff, students, and guest speakers.

8407. STOCHASTIC HYDROLOGY. (4 cr; prereq Stat 5021 or #)
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.

8410.* FLUID TURBULENCE. (3 cr; prereq 5435; offered when demand warrants)
Statistical theory of turbulence with application to free turbulence.

8413.* MECHANICS OF SEDIMENT TRANSPORT. (3 cr; prereq 5410 or #)
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.

8416. HYDRAULIC MEASUREMENTS. (3 cr; prereq 3400 or #; offered when demand warrants)
Laboratory and field methods and instruments for measurement of hydraulic pressure, velocity, and discharge.

8417. HYDRAULIC PUMPS AND TURBINES. (3 cr; prereq 5435 or #; offered when demand warrants)
Introductory theory of hydraulic pumps, turbines, motors, and transmissions, including energy concepts, drag and lift of hydrofoils, and limitations of cavitation.

8418-8419. COMPUTATIONAL HYDRODYNAMICS I-II. (4 cr; prereq 5401 or #) Song
Theory and applications of finite difference methods to solving unsteady one-dimensional flow problems.

8423.* HYDRAULIC TRANSIENTS. (3 cr; prereq 5401 or #; 3 rec hrs per wk; offered when demand warrants)
Hydraulic transients encountered in coastal and water resource engineering, including oscillatory, solitary, tidal, and flood waves; water hammer; hydraulic jumps; forced vibration of gates and other components of hydraulic structures; hydrodynamic flutter.

8425. ADVANCED GROUNDWATER MECHANICS. (4 cr; prereq 5425 or #)
Conformal mapping techniques for two-dimensional steady groundwater flow. The hodograph method. Problems involving a free boundary and horizontal drains. Boundary value problems. Application of boundary integral equation techniques.

8430. LAKE AND RESERVOIR HYDRODYNAMICS. (3 cr; prereq #)
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, 8436, 8437. SPECIAL TOPICS IN HYDRODYNAMIC THEORY. (3 cr per qtr; 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 #)
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.

8497-8498-8499.* ADVANCED HYDRAULIC LABORATORY. (2 cr per qtr; prereq #)
Experimental and analytical studies of hydraulic phenomena relating to fluid measurement, pumps, spillways, stilling basins, wave absorption, flow transients, and other selected topics.

Environmental Engineering

5500. ANALYSIS AND DESIGN OF WATER SUPPLY SYSTEMS. (4 cr; prereq 3400 or #, IT student or grad)
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 student or grad)
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.

5507. TECHNIQUES OF WATER AND WASTEWATER ANALYSIS. (4 cr; prereq 5500, 5501, 5506 or #, IT upper div student or grad)
Methods of sampling and examining natural waters and wastewaters; technique used in analysis of general water quality parameters, nutrients, major and minor ions, and natural and synthetic organic matter, with emphasis on modern analytical procedures.

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.

5530. MODELING AND PROCESS CONTROL OF WATER AND WASTEWATER TREATMENT. (4 cr; prereq 5500, 5501 or #)
Mathematical modeling and simulation of water and wastewater treatment processes; introduction to control theory, design of control systems and their application to computer-aided process control.

5540. ANALYSIS OF GROUNDWATER-SOIL POLLUTION ABATEMENT TECHNOLOGY. (4 cr; prereq IT major or grad, 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.

5580. INTRODUCTION TO ENVIRONMENTAL LAW FOR ENGINEERS. (3 cr; 3 lect hrs per wk)
Common statutory and regulatory law relevant to the work of civil and environmental engineers; history and development of environmental control with emphasis on public policies behind decision making in courts, legislatures, and administrative agencies and tribunals.

5581. ENVIRONMENTAL LAW. (4 cr; prereq 5580)
Specific provisions of federal and Minnesota statutory and regulatory law such as NEPA, TOSCA, RCRA, the Clean Air Act, and the Minnesota Environmental Rights Act; history of these acts in courts.

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.

8506. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS. (4 cr; prereq 8505 or #)
Natural interactions with rock and soil, precipitation and atmospheric fallout; industrial and domestic sources. Nature of aqueous metals in terms of electrolyte solutions, hydrolysis reactions, complexation, chelation, redox, solubility, and precipitation. Interactions at solid-solution interfaces in terms of phenomenological and general models for adsorption. Hydrodynamic, biological, and chemical factors affecting distribution, transport, and removal from aqueous phase. Computer techniques emphasized.

8510.* INDUSTRIAL WASTEWATER TREATMENT AND DISPOSAL. (3 cr; prereq #)
Quantity and quality characteristics of industrial wastewaters. Problems with separate treatment and joint treatment with municipalities. Legal responsibilities and ordinances. Determination of equitable charges.

8530. MODELING AND CONTROL OF WATER AND WASTEWATER TREATMENT PROCESSES. (4 cr; prereq 8500, 8501 or #)
Mathematical modeling and process simulation of water and wastewater treatment processes; introduction to control theory, design of control systems, and their application to computer-aided process control.

8550. ANALYSIS AND MODELING OF AQUATIC ENVIRONMENTS. (4 cr; prereq #)
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)
Case studies of specific aquatic streams and lake systems.

8560.* SEMINAR: SPECIAL TOPICS IN ENVIRONMENTAL ENGINEERING. (1 cr; prereq #)
Selected environmental engineering topics discussed by students, staff members, and guests.

Structural Engineering, Soil and Rock Mechanics, Construction Materials

5300. CRITICAL STATE SOIL MECHANICS. (4 cr; prereq 3300, IT upper div student or grad)
Strength of granular soils; volume changes under shear (dilatancy, contractancy), liquifaction; cyclic loading; strength of cohesive soils; normal consolidation; overconsolidation; critical state concept.

5301. FOUNDATION ENGINEERING. (4 cr; prereq 5300, IT upper div student or grad)
Settlement analysis; retaining walls and earth pressure theories; stability of slopes; bearing capacity of shallow foundations; deep foundations.

5302. SOIL PLASTICITY AND LIMIT ANALYSIS. (4 cr; prereq 5300, IT upper div student or grad)
Rigid perfectly plastic soil; theorems of limit analysis; static and kinematic solutions; method of characteristics; application for stability of slopes and foundations.

5304. DESIGN OF HIGHWAY AND AIRPORT PAVEMENTS. (4 cr; prereq 3300, 3700, IT student or grad)
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 student or grad)
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 student or grad)
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 student or grad)
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 heads of bars and plates.

5603. INTRODUCTION TO CONSTRUCTION MATERIALS. (2 cr; prereq upper div IT student, AEM 3016; 3 lab hrs per wk)
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 student or grad)
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 student or grad)
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 student or grad)
Design of complete metal structures; plate girder bridges, industrial buildings, multistory structural frames.

5613. INTERMEDIATE REINFORCED CONCRETE DESIGN. (4 cr; prereq 5611, IT student or grad)
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 student or grad)
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 student or grad)
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 student or grad; 3 lect and 3 lab hrs per wk)
Characteristics and performance evaluation concepts of construction materials, properties and design of cemented mixtures such as concrete, bituminous mixtures, stabilized soils and rocks.

5702. MANUFACTURE AND QUALITY CONTROL OF CONSTRUCTION MATERIALS. (4 cr; prereq 5603, IT upper div student or grad; 3 lect and 3 lab hrs per wk)
Methods of manufacture, especially of cemented materials such as concrete, stabilized soils and rock; expected variations and quality control concepts, optimization techniques developed to establish procedures and best material to use for a given situation.

5703. PROJECT MANAGEMENT. (4 cr; prereq sr)
Broad, practical understanding of design and construction management, including project planning, budgeting, scheduling, staffing, task and cost control, and motivating, managing, and communicating with team members.

8302. ADVANCED HIGHWAY LABORATORY. (3 cr; prereq 3700)
Special experimental studies dealing with highway materials.

8303. SPECIAL PROBLEMS IN CONCRETE MATERIALS. (2 or 3 cr; prereq 3700)
Short laboratory research studies.

8320. THREE-DIMENSIONAL CONSOLIDATION. (4 cr; prereq 5300)
Basic equations for three-dimensional consolidation. Laplace transforms. Solution for spherical consolidation. Application to field experiments. Solution for axially symmetric consolidation. Superposition. Displacement functions and boundary value problems.

8321. MECHANICS OF GRANULAR MEDIA. (4 cr; prereq 5301 or 5302 or #)
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 #)
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.

8323. COMPUTER APPLICATIONS IN FOUNDATION ENGINEERING. (4 cr; prereq 5021 and 5301)
Method of characteristics; kinematical method; method of slices; applications to foundations and retaining structures; slope stability methods.

8605. THE FINITE ELEMENT METHOD IN CIVIL ENGINEERING. (4 cr; prereq 5601 or #)
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. APPROXIMATE METHODS OF STRUCTURAL ANALYSIS. (4 cr; prereq #)
Advanced topics in finite element analysis; elastic stability, shells, structural dynamics, inelastic material behavior, and large deformations. Use of finite difference method for analyzing beams, columns, disks, plates, and shells.

8608. ADVANCED THEORY OF STRUCTURES. (4 cr; prereq #; offered alt yrs)
Theoretical foundations of structural analysis; energy methods, bending and twisting of structural elements, analysis of plates.

8609. PRINCIPLES OF STRUCTURAL STABILITY. (4 cr; prereq #; offered alt yrs)
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)
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)
Analysis and design of flat plate structures based on the small-deflection elastic Kirchoff-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)
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)
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.

8620. STRUCTURAL DYNAMICS I. (4 cr; prereq AEM 3036 or #)
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 #)
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.

8622. DYNAMIC SOIL-STRUCTURE ANALYSIS. (4 cr; prereq 5300, 8620, 8621)
Analysis and design method for wave propagation and soil-structure interaction under the effects of earthquake and blast-induced environments.

8625. BEHAVIOR OF REINFORCED CONCRETE STRUCTURES. (4 cr; prereq 5611, 5613, 5615)
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.

8626. BEHAVIOR OF REINFORCED CONCRETE STRUCTURES II. (4 cr; prereq 8625 or #)
Limit analysis and failure mechanisms for reinforced concrete structures; response and behavior under cyclic, blast, and impact loading; membrane effects; design code requirements.

8697-8698-8699. SEMINAR: STRUCTURES. (Cr ar; prereq #)
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 laboratory, wind forces on structures, design in prestressed concrete, modern construction practices.

Classical and Near Eastern Studies

Regents' Professor: Rutherford Aris

Professor: Gerald M. Erickson, *director of graduate studies;* Thomas S. Clayton; Frederick Cooper; William D. E. Coulson (on leave); Jackson Hershbell; Thomas Kelly; Eva Keuls; Sheila McNally; Jeremiah Reedy; Robert P. Sonkowsky; Theofanis Stavrou

Associate Professor: George A. Sheets, *chair;* Elizabeth S. Belfiore; Sandra L. Peterson;

Assistant Professor: Nita Krevans; Oliver P. Nicholson; Philip H. Sellew

Other: Lesley K. Caferelli

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

Degrees Offered—Classics[1], Greek, Latin, and Classical Studies: M.A. (Plan B and, in exceptional cases only, Plan A); Ph.D.

Curriculum—In addition to Classical Greek and Latin literary studies, formal areas of concentration are available in archaeology, history, language teaching, linguistics, modern Greek and Hellenic studies, medieval and renaissance Latin, myth and folklore, oral performance, philosophy, religious studies, and women in the Classical world. 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. Special facilities are the Center for Ancient Studies, the Center for Modern Greek Studies, the Center for Humanistic Studies, and the Humanities Computer Lab.

Prerequisites for Admission—Ability, motivation, imagination, and creativity are the main criteria. Many course prerequisites can be made up on provisional 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.

[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.*

For a major in Classical Studies, graduate reading ability in one of the Classical (Greek, Latin) or Near Eastern (Hebrew, Aramaic, Akkadian, Sumerian) languages and evidence of ability and experience in the proposed area of concentration are required for unqualified 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 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.

Classical Language Proficiency—For admission to the Ph.D. program, applicants must provide all of the above materials as well as documentation of appropriate language proficiency. Students who have completed the M.A. degree at Minnesota and are applying to the Classics, Greek, or Latin Ph.D. programs must pass proficiency examinations in Greek and Latin. For the Classical Studies program, students must pass a proficiency examination in either Greek or Latin and must pass either a proficiency examination in the other Classical language or demonstrate higher competence in another language. If the M.A. degree has been completed at another institution, language proficiency examinations may be taken after admission.

Master's Degree Requirements—There are four degree programs:

M.A. in Greek: Advanced courses and seminars in Greek literature and supporting work in Latin and other related fields are required.

M.A. in Latin: Advanced courses and seminars in Latin literature and supporting work in Greek and other related fields are required.

M.A. in Classics: This program requires nearly equal emphasis on courses and seminars in Greek and Latin, as well as work in related fields.

M.A. in Classical Studies: This program requires nearly equal emphasis on one of the two Classical languages and one of the areas of concentration mentioned above, as well as some graduate study in another (usually but not always Classical) language. Interested students may draw upon the resources of the faculty and propose other areas of concentration or may add a formal minor in another field.

Emphasis in Classical Archaeology: This program is available under the requirements for the degree program in Classical Studies and in cooperation with the Center for Ancient Studies.

Modern Greek and Hellenic Studies: This program is available under the requirements for the degree program in Classical Studies and in cooperation with the Center for Modern Greek Studies.

Near Eastern Studies: This program, which is available under the requirements for the degree program in Classical Studies, requires emphasis on two Near Eastern languages as well as work in related fields.

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—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 Classical Studies program, the four foci are either both Classical literatures or one Classical literature and the literature of one non-Classical language; a special (elective) topic or sub-dis-

cipline, author, or genre; and an area of concentration. Consult the department's *Graduate Student Handbook* for details.

Modern Language Requirements—For the M.A. degree, reading knowledge of one modern foreign language appropriate to the student's program is required (normally French or German). For the Ph.D. degree, reading knowledge of two modern foreign languages appropriate to the program is required (normally French and German).

For Further Information—Contact the Department of Classical and Near Eastern Studies, 310 Folwell Hall, University of Minnesota, 9 Pleasant Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

CLASSICAL LANGUAGES, LITERATURES, AND CULTURES

Greek (Grk)

5012. PROSE COMPOSITION. (4 cr; prereq 3106 or △)

5013. ADVANCED PROSE COMPOSITION. (4 cr; prereq 5012)
Advanced Greek composition; sequel to 5012.

5121. BIBLICAL AND PATRISTIC GREEK. (4 cr; prereq 3106 or 3120 or △)
The Septuaqint, 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 [12 max 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.

5621. GREEK PALEOGRAPHY. (4 cr; prereq 5 cr 3xxx-5xxx Greek or #)
Styles of writing in literary papyri and later manuscripts; transmission of ancient Greek texts.

5715. INTRODUCTION TO CLASSICAL PHILOLOGY. (4 cr, §Lat 5715; prereq #)
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 and 2 yrs Greek)
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 #)
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]; prereq 2 yrs Classical Greek or #)
Study of representative texts of Byzantine literature in the original.

5970. DIRECTED STUDY. (1-5 cr; prereq # and △, CLA approved)

5980. DIRECTED TEACHING. (Cr ar; prereq #, △, CLA approval)

5990. DIRECTED RESEARCH. (Cr ar; prereq #, △, CLA approval)

8120. GREEK TEXT COURSE. (4 cr; prereq 3052 or △; restricted to students in depts *other* than Classics)
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; prereq 5012)

8265. SURVEY OF GREEK LITERATURE: LITERATURE OF THE FIFTH CENTURY. (4 cr; prereq 5012)

8266. SURVEY OF GREEK LITERATURE: LITERATURE OF THE FOURTH AND THIRD CENTURIES. (4 cr; prereq 5012)

8370. SEMINAR: GREEK RHETORIC. (4 cr per qtr) Sonkowsky

8510. SEMINAR: PHILOSOPHY. (4 cr) Hershbell
Topics in Greek philosophy. Philological and philosophical problems of major works such as Plato's middle and later dialogues (e.g., the *Republic, Phaedo, Theaetetus, Sophist*) or Aristotle's treatises (e.g., *Metaphysics, de gen. et corr., Nichomachaean Ethics*).

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 △)

5013. LATIN COMPOSITION II. (4 cr; prereq 5012)
Sequel to 5012; introduces more advanced concepts in composition.

5038. ORAL INTERPRETATION OF CLASSICAL LATIN LITERATURE. (5 cr; prereq 2 yrs Latin or equiv and Th 3801 or 3321 or #) Sonkowsky
Phonetics, prosody, and oral performance of selected texts in Classical Latin.

5310, 5320, 5330, 5340, 5350, 5360, 5370, 5380, 5390. LATIN LITERATURE. (4 cr per qtr [12 cr max 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 [12 max]; prereq #)
Pagan and Christian Latin literature from 3rd to 8th centuries.

5420. MEDIAEVAL LATIN. (4 cr [12 max]; prereq #)
Literature from 6th to 15th centuries. Authors and genres will vary.

5430 (formerly 5236). RENAISSANCE LATIN. (4 cr [12 max]; prereq #)
Literature after 14th century.

5621. LATIN PALEOGRAPHY. (4 cr; prereq 3 cr 3xxx-5xxx Latin or #)
Analysis of various hands used in manuscripts of Latin authors with attention to date and provenance; transmission of ancient Latin literature.

5710. STRUCTURE OF LATIN. (4 cr [may be repeated for max 8 cr]; prereq sr or grad student, 10 cr 3xxx-5xxx Latin or equiv, #) Erickson
Review of basic Latin structures; application of current linguistic theories to Latin texts; special problems in reading Latin.

5715. INTRODUCTION TO CLASSICAL PHILOLOGY. (4 cr, §Grk 5715; prereq #)
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 # and 2 yrs Latin)
Reading and analysis of documents illustrating the evolution of the Latin language from its origins to late antiquity.

5733. VULGAR LATIN. (4 cr; prereq 3 yrs Latin or #)
Reading and analysis of sources for colloquial Latin. Romance dialectology.

5735. ITALIC DIALECTS. (4 cr; prereq Grk/Lat 5715 or #)
Reading and analysis of inscriptions illustrating Oscan, Umbrian, archaic Latin, Sabellian, and Venetic. Italic dialectology.

5970. DIRECTED STUDY. (1-5 cr; prereq # and △, CLA approval)

5980. DIRECTED INSTRUCTION. (Cr ar; prereq #, △, CLA approval)

5990. DIRECTED RESEARCH. (Cr ar; prereq #, △, CLA approval)

8120. LATIN TEXT COURSE. (4 cr; prereq 3052 or △; restricted to students in depts *other* than Classics)
Students will 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 #)

8160. RENAISSANCE LATIN TEXTS. (4 cr; prereq #)

8264. GRADUATE SURVEY: LITERATURE OF THE REPUBLIC. (4 cr; prereq 5012)

8265. GRADUATE SURVEY: LITERATURE OF THE AUGUSTAN AGE. (4 cr; prereq 5012)

8266. GRADUATE SURVEY: LITERATURE OF THE EMPIRE. (4 cr; prereq 5012)

8440. THE ETRUSCAN ORIGINS OF ROME. (4 cr, §Clas 8440; prereq #) Coulson
Literary and archaeological sources for the presence and influence of the Etruscans in early Rome.

8710. SEMINAR: LATIN METRICS. (3 cr) Sonkowsky
Nature and function of meters of Latin poetry.

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; prereq 2 courses in Engl lit beyond Engl 1002 or in foreign lit or △)
Reading in translation from Greek lyric poets, Catullus, Horace, and minor Latin lyricists; cultural patterns of the times; survival of such poetry in modern times.

5002. ANCIENT SATIRE. (4 cr; prereq two courses in English literature beyond Engl 1002 or in foreign literature or △)
Development of ancient satire from Homer to Juvenal. Readings in translation from Homer, Aesop, Archilochus, Aristophanes, and Lucian. Introduction to the form of Roman satire, with readings from Lucilius, Horace, Persius, Petronius, Martial, and Juvenal. Survival of Roman satire in English literature.

5003. THE ANCIENT NOVEL AND ROMANCE. (4 cr; prereq two courses in English literature beyond Engl 1002 or in foreign literature or △)
Development of the ancient novel. Readings in translation from the ancient Greek novelists and from Apuleius and Petronius.

5004. EROTICISM AND FAMILY LIFE IN THE GRECO-ROMAN WORLD. (4 cr; prereq soph)
Role of Greek and Roman family life in shaping of personality; diachronic change in modes of erotic expression; Narcissism and homosexuality; status and roles of women; evolving views of sexual morality in ancient world compared to present trends. Representative views taken for analysis and discussion from art and literature.

5005. MADNESS AND DEVIANT BEHAVIOR IN ANCIENT GREECE AND ROME. (4 cr; prereq soph, 2 cr in Clas) Erickson
Definitions of madness in Greece and Rome and theories of its etiology; assessment of predisposing factors in Greece and Rome; examples of madness from mythology, legend, and history; cross-cultural comparison with contemporary U.S.

5006. GREAT FIGURES IN ANCIENT BIOGRAPHY. (4 cr)
Important historical and legendary figures in Classical literature; their accomplishments, factors that shaped their characters, criteria for "greatness," social and political milieu in which they functioned, hero myth and history; psychohistorical approach to biography; development of views toward the figures in later ages.

5013. ROMAN LAW AND SOCIETY. (4 cr; prereq # or △)
Roman law as a social institution: basic concepts of persons, property, obligations in historical and social perspective.

5014. CRIME AND JUSTICE IN THE ROMAN WORLD. (4 cr; prereq 5013 or Hist 3053 or # or △)
Public and private delicts and their remedies in Roman legal system with emphasis on the later republic; civil and criminal courts; reading of selected cases.

5017, 5018. WOMEN IN CLASSICAL ANTIQUITY. (4 cr per qtr)
Role of women in the Classical world, in literature and in the social structure. Readings of major literary works and original sources bearing on women's legal and economic position. 5017: Greek. 5018: Roman.

5020. PROBLEMS IN POST-ARISTOTELIAN PHILOSOPHY. (4 cr, §Phil 5020; prereq 5085 or 5086 or Phil 3001 or 3002 or 3900H or 5008 or 5012 or #) Hershbell
Problems in philosophy after Aristotle and before Augustine. Topics may include the Stoics, Epicureans, Cynics, Sceptics, neo-Pythagoreans, middle and late Platonists.

5061. INTRODUCTION TO BYZANTINE CIVILIZATION. (4 cr, §1061)
Greco-Roman backgrounds of Byzantine civilization. Culture of Easten Empire through study of history, religion, education, art, literature in translation.

5065. ANCIENT LITERARY CRITICISM. (4 cr; prereq 8 cr in English literature beyond Engl 1002 or in foreign literature or △)
Aristotle's *Poetics*, Horace's *Ars Poetica*, and Longinus' *On the Sublime*; history of literary value judgments in antiquity; applications of principles of criticism to ancient writers; Alexandrianism; formation of concept of the Classics.

5070. RELIGION IN ANTIQUITY: ADVANCED TEXTUAL STUDIES. (4 cr, §3070, §Grk 5376, §Lat 5379; prereq 3071, 3072, 3073 or 5071, 5072, 5073 or any RelS course or #)
Selected religious texts central to early Christianity or other ancient religion in context of Greco-Roman world. Theology and present interpretations of texts; influence in later religion and culture.

5071. RELIGION IN ANTIQUITY: GREEK, HELLENISTIC. (4 cr, §3071; prereq #)
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, §RelS 3072, §RelS 5072)
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. RELIGION IN ANTIQUITY: ROMAN, EARLY CHRISTIAN. (4 cr, §3073; prereq #)
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 #)
Selected topics in study of the New Testament and related ancient literatures. Topics announced in *Class Schedule*.

5081. CLASSICAL EPIC IN TRANSLATION. (4 cr, §3081; prereq 8 cr in English literature beyond Engl 1002 or in foreign literature or △)
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 (AESCHYLUS, SOPHOCLES, EURIPIDES). (4 cr, §3082; prereq 8 cr in English literature beyond Engl 1002 or in foreign literature or △)
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.

5083. ARISTOPHANES AND ROMAN DRAMA IN TRANSLATION (ARISTOPHANES, MENANDER, PLAUTUS, TERENCE, SENECA). (4 cr, §3083; prereq 8 cr in English literature beyond Engl 1002 or in foreign literature or △)
Greek and Roman comic theatre. Discussion of several comedies. Roman tragic drama as exemplified by tragedies of Seneca.

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.

5086. GREEK PHILOSOPHY: ARISTOTLE AND POST-ARISTOTELIAN THOUGHT. (4 cr; prereq △) Hershbell
Excerpts from the writings of Aristotle, especially his metaphysical and ethical writings. Fragments of Stoic and Sceptic writers; the extant works of Epicurus; Diogenes Laertius; Sextus Empiricus; Plutarch's polemical works against the Stoics.

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.

5280. SEMINAR IN GREEK MYTHOLOGY. (4 cr; prereq 1042 or 3145 or 5145 or #)
Detailed examination of several Greek gods and heroic myths. All of the significant ancient and modern sources.

5400. SUPERVISED DIRECTION: ORAL INTERPRETATION PROJECTS. (1-3 cr [6 max for BA, 12 max for MA, 18 max for PhD]; prereq #)
Projects such as group performances of Greek and Roman poetry.

5794. INTRODUCTION TO CLASSICAL STUDIES. (4 cr, §Grk/Lat 5794; prereq grad major or #)
Research in Classical scholarship, methods, bibliography, textual history, and criticism.

5970. DIRECTED STUDY. (1-5 cr; prereq # and △, CLA approval)

5980. DIRECTED INSTRUCTION. (Cr ar; prereq #, △, CLA approval)

Spch 5611. CLASSICAL RHETORIC. (4 cr; prereq Spch 1101 or 1101H) Scott
Greek and Roman theories of speechmaking; historical and philosophic context and influence on education.

Art and Archaeology

5089. INTRODUCTION TO BIBLICAL ARCHAEOLOGY. (4 cr)
Survey of archaeological data relevant to the Jewish Scriptures and the New Testament; major sites in the Holy Land and in other areas of the Mediterranean and the Near East. Evidence of pottery, inscriptions, manuscripts, and coins. Excavation methods. Archaeology as a tool for the study of ancient religions. Additional work for graduate credit.

5101. INTRODUCTION TO PREHISTORIC GREEK ARCHAEOLOGY. (4 cr; prereq #)
Aims and methods of modern field archaeology; the record of human habitation in the Aegean area from earliest times until the end of the Bronze Age, with concentration on the Mycenaean period; the use of archaeological evidence as the basis for historical reconstruction.

5102. ARCHAIC AND CLASSICAL GREEK ARTS AND ARCHAEOLOGY. (4 cr; prereq jr or #)
Architecture, sculpture, and painting in Greek lands from the 9th through 5th centuries B.C. Examinations of material remains of Greek culture; archaeological problems such as identifying and dating buildings; analysis of methods and techniques.

5103. HELLENISTIC ART AND ARCHAEOLOGY. (4 cr; prereq jr or #)
Survey of sculpture, architecture, painting, and topography in developing centers of Hellenistic culture in eastern Mediterranean area from beginning of 4th century B.C. to end of Hellenistic period.

5104. ROMAN ARCHITECTURE. (5 cr, §ArtH 5104; prereq jr or #)
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, §ArtH 5105; prereq jr or #)
Specific problems; sites such as Pompeii and Antioch.

5106. GREEK PAINTING. (5 cr, §ArtH 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, §ArtH 5107; prereq jr or #)
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, §ArtH 5108; prereq jr or#)
Archaic and Classical examples of religious and secular architecture, their setting in major archaeological sites.

5109. ETRUSCAN ART, ARCHITECTURE, AND ARCHAEOLOGY. (4 cr, §ArtH 5109; prereq jr or #)
The developing culture of Etruscan people from time of their first appearance in Italy in about 1100 B.C. until their eclipse in 1st century B.C studied through the material remains of Etruscan civilization.

5110. PROSEMINAR: CLASSICAL ARCHAEOLOGY. (4 cr; prereq #)

5111. BRONZE AGE ART AND ARCHITECTURE IN GREECE, CA. 3000-1100 B.C. (4 cr, §ArtH 5111; prereq one ancient art or archaeology course)
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, §ArtH 5112; prereq jr or #)
Style in Greek sculpture; human figure. Basic methodology; interpretations of meaning.

5113. ARCHAIC AND CLASSICAL GREEK ART AND ARCHAEOLOGY. (4 cr, §ArtH 5113; prereq jr or #)
Architecture, sculpture, and painting in Greek lands from the 9th through the 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; prereq #)
Field excavation, survey, and research at archaeological sites in Greece, Turkey, Italy, or the Mediterranean area. Intensive training in techniques of excavation and exploration as well as analysis and interpretation of archaeological materials.

5122. GREEK ART, ARCHITECTURE, AND ARCHAEOLOGY. (4 cr, §3122)
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.

8114. SEMINAR: THE TOPOGRAPHY OF ATHENS. (4 cr; prereq #)

8151. TOPOGRAPHY OF ANCIENT ROME. (4 cr; prereq #)

8190. SEMINAR: PROBLEMS IN ANCIENT ART. (4 cr [may be repeated for cr], §ArtH 8190; prereq #)

8440. THE ETRUSCAN ORIGINS OF ROME. (3 cr, §Lat 8440; prereq #)
Literary and archaeological sources for the presence and influence of the Etruscans in early Rome.

8910. SEMINAR: PROBLEMS IN CLASSICAL ARCHAEOLOGY. (4 cr [may be repeated for cr], §ArtH 8910; prereq #)

MODERN GREEK

Modern Greek (MdGk)

5970. DIRECTED STUDY. (1-5 cr; prereq # and △, CLA approval)

5980. DIRECTED TEACHING. (Cr ar; prereq # and △, CLA approval)

5990. DIRECTED RESEARCH. (Cr ar; prereq # and △, CLA approval)

NEAR EASTERN STUDIES

See Near Eastern Studies *in the* Related Courses *section for descriptions of the following courses:*

Akka 5011-5012-5013. ELEMENTARY AKKADIAN

ANE 5501, 5502. ANCIENT ISRAEL

ANE 5505. ANCIENT ISRAEL: BACKGROUND OF THE BIBLE

ANE 5701. INTRODUCTION TO COMPARATIVE STUDY OF SEMITIC LANGUAGES

ANE 5711. NORTHWEST SEMITIC INSCRIPTIONS

ANE 5970. DIRECTED STUDIES

Arm 5011, 5012, 5013. ARAMAIC

Hebr 5200. PROBLEMS IN BIBLICAL STUDIES

Hebr 5970. DIRECTED READINGS

Hebr 5990. HONORS COURSE: RESEARCH

Hebr 8321. JUDEO-ARABIC LITERATURE

Sum 5011-5012. ELEMENTARY SUMERIAN

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 and Southwest Asian Studies *for descriptions of the following courses:*

Per 5900. READINGS IN AN IRANIAN LANGUAGE

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 5970. DIRECTED READINGS

Skt 5990. DIRECTED RESEARCH

Skt 8990. RESEARCH

SoAS 5090 (formerly MESA 5090). INSTRUCTION IN A SOUTH ASIAN LANGUAGE

Representative courses of interest offered by Classical and Near Eastern Studies faculty through other departments:

Eng 5240, 5712; Hist 5061, 5062, 5063 (Ancient Greece); Hist 5276, 5756, 5757 (Modern Greece); Phil 5005; RelS 5001; SoAS 5520.

Classics

See Classical and Near Eastern Studies.

Clinical Laboratory Science (CLS)

Professor: Richard D. Brunning; John W. Eaton; J. Roger Edson; Stanley L. Erlandsen; Patricia Ferrieri; Esther F. Freier; Leonard Greenberg; John H. Kersey

Associate Professor: Walid Yasmineh, *director of graduate studies;* Robert J. Boudreau; Larry D. Bowers; John H. Eckfeldt; Alexandra H. Filipovich; Helen M. Hallgren; Tucker W. LeBien; Patrick J. Manning; Harry T. Orr; William R. Swaim; Michael Y. Tsai; Daniel A. Vallera; Michael J. Wilson

Assistant Professor: Fred S. Apple; Ralph J. Butkowski; Douglas J. Christie; Connie Clark; Berengere de Martinville; Karen Karni; Larry C. Lasky; Karen G. Lofsness; R. Scott McIvor; Loann C. Peterson; Michael W. Stanley; William H. Vine; Carol L. Wells

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, 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 TOEFL score of 550 is required for applicants whose native language is not English.

Degree Requirements—Students are encouraged to file their program after completing 9 to 15 graduate credits. At least 20 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 written comprehensive examination and a final oral examination for defense of the thesis.

Language Requirement—None.

For Further Information—Contact the director of graduate studies, Clinical Laboratory Science, Department of Laboratory Medicine and Pathology, Box 198, University of Minnesota Medical School, 420 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

5011f. INTRODUCTION TO URINALYSIS. (1 cr, §MedT 5011; prereq △)

5077f. HEMATOLOGY I: BASIC TECHNIQUES. (3 cr, §MedT 5077; prereq △)
Theory and application of basic principles and techniques in clinical hematology. Lecture and laboratory.

5078w. HEMATOLOGY II: HEMOSTASIS/INSTRUMENTATION. (3 cr, §MedT 5078; prereq 5077 or MedT 5077, △)
Theory and application of basic principles and techniques. Lecture and laboratory.

5090. SPECIAL LABORATORY METHODS. (2 cr, §MedT 5090; prereq #)

5101f. PRINCIPLES OF CLINICAL LABORATORY SCIENCE. (5 cr; prereq #) Yasmineh
Overview of the major areas in clinical laboratory science, including clinical chemistry, hematology, immunology, microbiology, and medical genetics.

5103s. PRINCIPLES OF DIAGNOSTIC MICROBIOLOGY. (5 cr, §MedT 5102; prereq MdBc 3103, 5232 or #)

5110f. HOSPITAL INFECTIONS CONTROL. (2 cr; prereq #) Rhame
Nosocomial infections, transmission of hospital infections, surveillance and general methods of infection control.

5112. INTRODUCTION TO CLINICAL CHEMISTRY. (5 cr, §MedT 5112; prereq Chem 3100, Chem 3101, MdBc 5300, MdBc 5301, Phsl 3051, MedT 5011, △)
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. Lecture and laboratory.

5113. PRINCIPLES OF CLINICAL CHEMISTRY. (6 cr, §MedT 5113; prereq MedT 5112, △)
Measurement and physiological relevance of various serum constituents. Electrolytes, proteins, enzymes, steroids, lipids, toxicology, and RIA. Laboratory covers relevant techniques, both manual and instrumental.

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.

5127. INTRODUCTION TO MANAGEMENT AND EDUCATION. (2 cr, §MedT 5127; prereq △)

5128. ELEMENTS OF LABORATORY ADMINISTRATION. (3 cr, §MedT 5128)
Introduction to laboratory administration. Leadership styles, employee selection and evaluation, communications, motivation, morale, discipline, job decriptions, record keeping, budgets, cost accounting, purchasing, product evaluation, laboratory safety, labor relations, and government regulations.

5130. PRACTICUM IN LABORATORY ADMINISTRATION. (3 cr, §MedT 5130)
Supervised experience and assignment of specific problems related to laboratory service and management in hospitals.

5133s. MEDICAL MYCOLOGY. (4 cr, §MedT 5133; prereq medical microbiology, diagnostic microbiology #)
Laboratory diagnosis of infections caused by yeasts, dermatophytes, and systemic fungi.

5135. ADVANCED CLINICAL MICROBIOLOGY. (1-5 cr, §MedT 5135; prereq #)
Observation, study, and practice in special problems, advanced techniques, and methodology in clinical microbiology.

5138f,w,s,su. CLINICAL MICROBIOLOGY SEMINAR. (1 cr, §MedT 5138; prereq #) Ferrieri, Wells

5140, 5141. TECHNIQUES FOR TEACHING. (3 cr per qtr, §MedT 5140, 5141; prereq △)
Development of objectives, classroom activities, and evaluation criteria for medical technology education.

5145. DEVELOPMENT OF MEDICAL TECHNOLOGY, (3 cr, §MedT 5145)
Current problems; topics and research.

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.

5179f,w,s,su. CHEMISTRY SEMINAR. (1 cr; prereq #)

5180f,w,s,su. ADVANCED CHEMISTRY. (1-5 cr; prereq #) Staff

5195f,w,s. 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.

5196f. COMPUTER METHODOLOGY IN THE DELIVERY OF HEALTH CARE I: PHYSIOLOGICAL MONITORING AND TESTING. (3 cr, §PubH 5433; prereq PubH 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.

5197w. COMPUTER METHODOLOGY IN THE DELIVERY OF HEALTH CARE II: INTRODUCTION TO MEDICAL DECISION-MAKING TECHNIQUES. (3 cr, §PubH 5343; prereq PubH 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.

5198s. COMPUTER METHODOLOGY IN THE DELIVERY OF HEALTH CARE III: HEALTH INFORMATION SYSTEMS. (3 cr, §PubH 5435; prereq PubH 5432 or #) Gatewood
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 data-base management systems for clinical research used for class problems.

5270f. IMMUNOHEMATOLOGY. (2 cr; prereq #) McCullough
Immune response. Blood cells as antigens. Antibodies to blood groups. Mechanisms of their reactions. White cells as antigens and antibodies. Autoimmune hemolysis. Humoral and cellular factors in immunohematology.

5272f. IMMUNOHEMATOLOGY I: IMMUNOLOGY AND HEMATOLOGY IN IMMUNOHEMATOLOGY. (3 cr)
Immunology and HLA; principles of inheritance and molecular genetics; review hematopoeisis; structure, function, and disorders of red and white blood cells and platelets.

5273w. IMMUNOHEMATOLOGY II: BLOOD GROUP SYSTEMS. (3 cr)
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)
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.

5280f, 5281w, 5282s. ADVANCED IMMUNOHEMATOLOGY 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.

5346. COMPUTER APPLICATIONS FOR HEALTH PROVIDERS. (3-4 cr; prereq HSU 5018, health professional or student in health care discipline) Gatewood
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 #) 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 #)
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) Benson and staff

8240. EDUCATIONAL ADMINISTRATION IN MEDICAL TECHNOLOGY. (3 cr; prereq #)
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: Herbert L. Pick, Jr. (child development), *director of graduate studies;* Irving Biederman (psychology); Keith Gunderson (philosophy); Paul Johnson (decision sciences); Michael B. Kac (linguistics); C. Wade Savage (philosophy); Gerald M. Siegel (communication disorders); James R. Slagle (computer science); Albert Yonas (child development)

Associate Professor: David S. Knopman (neurology); Mary Jo Nissen (psychology); William B. Thompson (computer science)

Assistant Professor: Charles R. Fletcher (psychology); Maria L. Gini (computer science); James L. Morgan (child development); Joseph P. Stemberger (linguistics)

Course of Study—Minor in cognitive science, applicable to either master's or 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 program is contingent upon prior admission to the Graduate School and to a master's or 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 cognitive science.

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: CogSci 8000, CSci 5511, and Psy 5015. In addition, CogSci 8001 (the 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 minor program.

For Further Information—Contact Professor Herbert L. Pick, Jr., Institute of Child Development, University of Minnesota, 51 East River Road, Minneapolis, MN 55455.

Core Courses

CgSc 8000. PHILOSOPHY OF COGNITIVE SCIENCE. (4 cr)
Philosophical framework for analyzing and evaluating current cognitive sciences and relations among them. Contribution of cognitive science to recent developments in metaphysics and epistemology.

CgSc 8001. PROSEMINAR IN COGNITIVE SCIENCE. (1 cr per qtr for 3 qtrs; prereq admission to cog sci grad minor prog at PhD level)
Survey of major topics in cognitive science, including theoretical assumptions, methods, and sample of current research.

CSci 5511. ARTIFICIAL INTELLIGENCE I. (4 cr; prereq CLA-CSci or upper div IT-CSci major or grad, 5121 or #; informal lab)

Psy 5015. ADVANCED LEARNING AND COGNITIVE PROCESSING. (4 cr; prereq 3011 or 3051 or 5014 except for honors sequence students and grad students)

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. 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 5609. PHILOSOPHY OF SCIENCE: PHILOSOPHICAL ISSUES OF PERCEPTION AND COGNITION

Phil 5615. MINDS, BODIES, AND MACHINES

Phil 8180. SEMINAR IN THE PHILOSOPHY OF LANGUAGE

Psy 8004. PHILOSOPHICAL PSYCHOLOGY

Psy 8005. PHILOSOPHICAL PSYCHOLOGY

Elective Courses—Perception

CPsy 5341. PERCEPTUAL DEVELOPMENT

CPsy 8341. ADVANCED PERCEPTUAL DEVELOPMENT

CSci 8501. COMPUTER VISION

Psy 5031. PERCEPTION

Elective Courses—Language

Anth 5161. LANGUAGE AND CULTURE

CPsy 5345. LANGUAGE DEVELOPMENT

CPsy 8345. ADVANCED LANGUAGE DEVELOPMENT

Ling 5001. INTRODUCTION TO LINGUISTICS

Ling 5401. COMPUTATIONAL LINGUISTICS

Ling 5402. COMPUTATIONAL LINGUISTICS

Ling 8820. TOPICS IN LANGUAGE AND COGNITION

Psy 5054. PSYCHOLOGY OF LANGUAGE

Psy 8056. SEMINAR IN THE PSYCHOLOGY OF LANGUAGE

Elective Courses—Applications

CSci 5512. ARTIFICIAL INTELLIGENCE II

CSci 8502. EXPERT SYSTEMS

DSci 8715. FOUNDATIONS FOR RESEARCH IN DECISION PROCESSES

DSci 8799. SEMINAR: DECISION SCIENCES
(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. HUMAN-MACHINE INTERACTION

Psy 8201. SOCIAL COGNITION

Communication Disorders (CDis)

Professor: Charles E. Speaks, *chair;* Gerald M. Siegel, *director of graduate studies;* Patricia A. Broen; Robert H. Brookshire; Frank M. Lassman; Richard R. Martin; Richard P. McDermott; Karlind T. Moller; David A. Nelson; Clark D. Starr; Dianne J. Van Tasell; W. Dixon Ward

Associate Professor: Joe E. Reichle

Assistant Professor: Timothy N. Doyle; Marjorie R. Leek

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 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 program with minimal background in communication disorders should expect their program of study 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 will be 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—Contact the director of graduate studies, Department of Communication Disorders, 115 Shevlin Hall, University of Minnesota, 164 Pillsbury Drive S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5101. COMMUNICATION PROBLEMS OF CHILDREN. (3 cr; prereq non-Speech and Hearing Science major) 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) Haroldson, staff
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.

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) Lassman, McDermott
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. Laboratory transcription of isolated sounds, words, and connected speech.

5304. SPEECH SCIENCE. (4 cr; prereq 5301, 5302, 5303 or #) Speaks, Van Tasell
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 DEVELOPMENT AND RETARDATION. (4 cr) Siegel
Theory and experimental research dealing with delayed or retarded language development.

5306. HEARING SCIENCE. (4 cr; prereq 5301, 5302 or #) Ward
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) Martin, Haroldson
Description, nature, and treatment of stuttering in children and adults. Students will be involved at various levels in therapeutic and research activities.

5504. ARTICULATION DISORDERS. (4 cr; prereq 5301, 5302) McDermott
Impaired articulation performance and associated factors. Principles of diagnosis and clinical management. Observation of clinical activities.

5507. CLEFT PALATE, ORAL-FACIAL ANOMALIES AND SPEECH. (4 cr) 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) 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.

5606. LANGUAGE ASSESSMENT, INTERVENTION: EARLY STAGES. (4 cr) Reichle
Analysis of communication disorders in preschool-age children. Emphasis on assessment and management of language disorders observed in intellectually delayed, autistic, sensory impaired, and intellectually normal children.

5607. LANGUAGE ASSESSMENT, INTERVENTION: LATER STAGES. (4 cr; prereq 5305 or #) Broen
Analysis of language disorders in school-age children. Emphasis on assessment and intervention.

5608. LANGUAGE ASSESSMENT, INTERVENTION: ADULTS. (4 cr) 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. (4 cr; prereq 5301, 5302 or #) Leek
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. Laboratory participation required.

5702. ADVANCED AUDIOMETRY. (5 cr; prereq 5701 or #) Leek
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. Laboratory participation required.

5703. COMMUNICATION PROBLEMS OF THE HEARING-IMPAIRED. (5 cr; prereq 5701 or #) Van Tasell, Carlstrom
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 MAN. (4 cr; prereq 5301 or #) Ward
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) Leek
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. Laboratory participation required.

5706. HEARING AIDS. (3 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.

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 #) Leek, 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. Laboratory participation required.

8307. SEMINAR: EXPERIMENTAL PHONETICS. (3 cr; prereq 5304) Speaks, Van Tasell
Significant research in physiological and acoustic phonetics. Theory, method, instrumentation, and data.

8502. SEMINAR: STUTTERING. (3 cr; prereq 5502 or #) Martin
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: ARTICULATION. (3 cr; prereq 5504 or #) McDermott
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. (2, 4, or 6 cr [may be repeated for cr]; prereq #) Staff

8590. SEMINAR: CURRENT ISSUES IN SPEECH-LANGUAGE PATHOLOGY. (3 cr; prereq #)
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
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; prereq #) Lassman, Leek, Van Tasell, Ward
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 #) Staff

8790. SEMINAR: CURRENT ISSUES IN AUDIOLOGY. (3 cr; prereq #)
Significant problem areas in audiology; relation of audiological concerns to other rehabilitation programs and personnel. Class projects involving in-depth exploration of a specific problem.

8990. RESEARCH. (Cr ar [may be repeated for cr]; prereq #) Staff
Open to graduate students engaged in research.

Comparative Literature (CLit)

Professor: Jochen Schulte-Sasse (comparative literature, German), *chair;* Chester G. Anderson (English); Thomas S. Clayton (English); Tom C. Conley (French and Italian); Peter E. Firchow (English); Anatoly Liberman (German); Chun-Jo Liu (East Asian studies); Harvey B. Sarles (comparative literature); Marilyn Schneider (French and Italian); Ronald W. Sousa

(Spanish and Portuguese); Nicholas Spadaccini (Spanish and Portuguese); Gerhard H. Weiss (German); Anthony N. Zahareas (Spanish and Portuguese)

Associate Professor: Réda Bensmaia (comparative literature, French and Italian); Leonard L. Duroche (German); David B. Haley (English); William E. Mishler (Scandinavian)

Assistant Professor: Rey Chow (comparative literature)

Adjunct Assistant Professor: Nancy H. Kobrin (comparative literature), *director of graduate studies*

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 will be considered.

Applying for Admission—It is strongly recommended that applicants submit scores from the Graduate Record Examination.

Degree and Language Requirements—Consult the director of graduate studies for degree and language requirements.

For Further Information—For information describing current requirements and offerings, write to the director of graduate studies, Comparative Literature Program, 301 Folwell Hall, University of Minnesota, 9 Pleasant Street S.E., Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5147. DYNAMICS OF PEDAGOGY IN HIGHER EDUCATION. (4 cr)
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 (formerly Anth 5165). PERSPECTIVES IN HUMAN BEHAVIOR. (4 cr)
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.

5181. THE PSYCHOANALYTIC STUDY OF LITERATURE. (4 cr; prereq reading knowledge of French, German, or Scandinavian)
Readings in Freud and Freudian theory. Application of theory to literary texts.

5221. BASIC CONCEPTS OF CINEMA. (4 cr)
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.

5223. THEORIES OF MONTAGE. (4 cr; prereq 5221)
Examination of theoretical problems of montage (editing) in history of film criticism. Theoretical debates in France in the 1950s between supporters of the "classical" theory of montage and supporters of the theory of "non-montage."

5233. LITERATURE AND FILM. (4 cr)
Historical development of relationships between literature and cinema; major theoretical and esthetic problems these relationships have provoked; verbal and visual languages, literary discourse and film discourse, film and modern fiction.

5241. THEORIES OF METAPHOR. (4 cr; prereq one course in linguistics, literary theory, or philosophy)
Problem of structure and interpretation of metaphors. Question of figural language; metaphor and semantic fields; cognitive force of metaphor.

5243. ART AND IDEOLOGY: LIVING CINEMA. (4 cr, §Hum 5756)
Principal aesthetic and ideological characteristics of Direct Cinema-Living Cinema, its impact on contemporary development of cinema of fiction, and its role in the evolution of documentary and political cinema.

5311. FANTASY LITERATURE. (4 cr; prereq reading knowledge of French or German)
Fantasy literature (chiefly in the novel) from ca. 1800 to the present. Authors considered include: E. T. A. Hoffman, Gautier, Gogol, Carroll, Chesterton, Morgenstern, Hesse, C. S. Lewis, and Tolkien.

5321. LITERATURE AND PHENOMENOLOGY. (4 cr; prereq reading knowledge of French or German)
Specific literary texts from a variety of literatures and languages examined from a phenomenological perspective. Theoretical foundations of selected critics, notably Ingarden and Merleau-Ponty.

5322. FREUDIANISM AND LITERATURE. (4 cr; prereq reading knowledge of French, German, or Scandinavian)
Reading and discussion of literary works in terms of Freud's theory.

5325. THE RENAISSANCE AND THE BAROQUE; PROBLEMS OF PERIODIZATION. (4 cr; prereq reading knowledge of at least one: French, German, Spanish, Italian, Dutch, or #) Staff
Reflections in the arts, mainly literature, of events in several European cultures and how they related to events in the other cultures at a given time. Encounter of resurgent economic and sociopolitical forces with established ways of viewing, thinking, and believing in each culture; the network of intersecting values among the cultures.

5331, 5332. THE EUROPEAN NOVEL 1750-1950. (4 cr per qtr; prereq reading knowledge of French or German)
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.

5401. TRANSLATION: THEORY AND PRACTICE. (4 cr; prereq knowledge of French, German, Spanish or #)
Analysis of translation as a language act, through examination of studies on theory of language and on theory and practice of translating; translation problems, discussion of translations already made.

5451. THE EPIC. (4 cr; prereq knowledge of French, German, Spanish or #)
History of epic form, bases in pre-Classical and medieval oral poetry, evaluation. Reading of selected epic poems, criticism.

5452. GENRE THEORY. (4 cr; prereq knowledge of French, German, Spanish or #)
Problems involved in designation of literary genres: modes of constitution, relation to periodization and extra-literary factors, status of genre markers.

5501. DISCOURSE AND LANGUAGE. (4 cr)
Discursive, interactional approach to nature of language. Origin of language, relation of language to discourse and to the body, and other topics.

5555. INTRODUCTION TO SEMIOTICS. (4 cr)
Nature of the sign; sign function; sign production; text; culture; complex sign systems. Application of semiotics to various signifying practices (literature, film, images, television, cities).

5643. LITERATURE OF THE HOLY GRAIL. (4 cr; prereq one course in medieval literature or #)
The Grail from early Celtic elements through the *Perceval* of Chretien de Troyes, the *Continuations*, the *Joseph of Arimathea*, the *Quest for the Holy Grail*, the Vulgate Cycle, Wolfram von Eschenbach's *Parzival*, etc. Problems of interpretation and major motifs. Modern versions of the Grail, including Monty Python.

5910. TOPICS IN COMPARATIVE LITERATURE. (3-6 cr; prereq reading knowledge of French, German, or Spanish or #)
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 #, △, CLA approval)

8001, 8002, 8003. SEMINAR IN COMPARATIVE LITERATURE. (4 cr)
Guided research in selected areas with attention to methods applicable in the study of comparative literature.

8101. CRITICAL LITERACY IN THE MODERN EPOCH I. (4 cr; prereq reading knowledge of French, German, or Spanish)
Historical constitution of literary practices and the rise of the modern state, literary use of vernacular languages, and concomitant institutionalization of national literatures.

8102. CRITICAL LITERACY IN THE MODERN EPOCH II. (4 cr; prereq reading knowledge of French, German, or Spanish)
From sociohistorical perspective, current theoretical challenges to fundamental concepts of literary understanding, including those of culture, literary history, reading, and literature.

8125. ON DISCOURSE AND LANGUAGE. (4 cr) 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)
In light of selected narrative texts, comparison of narratologies that emerge from different representational perspectives and literary traditions.

8253. PROBLEMS OF FICTIONAL TIME. (4 cr; prereq grad student or #)
Survey of criticism relevant to the presentation of time in literature.

8910-8920-8930. ADVANCED COMPARATIVE LITERATURE SEMINAR. (4 cr; prereq 8001, 8002, 8003, or #)
Advanced seminar emphasizing the practical applications of specific methodologies and theories to a determined area. Topics vary.

8953-8954. THE BAROQUE IN EUROPEAN LITERATURE. (4 cr per qtr; prereq reading knowledge of French, German, Spanish, Italian, or Dutch)
Cross-cultural survey and analysis of European literature of the baroque period (late 16th through early 18th centuries). Background and function of rhetorical modes, structural and thematic affinities between works of literature, philosophy, plastic arts, and music.

8961. MODERNISM. (4 cr; prereq reading knowledge of French or German)
Groupings and movements of literature in 20th-century Europe and America and their relations to each other.

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.

8963. JURISPRUDENCE: CRITICAL LEGAL STUDIES. (3 cr, §Law 5615)
Contribution of critical legal studies, and other modern social and literary theorists, to modern legal thought. Claims of traditional jurisprudence subjected to scrutiny of modern critical inquiry as is the inquiry itself.

8970. DIRECTED READING IN COMPARATIVE LITERATURE. (1-4 cr; prereq grad student in comparative literature, △)

Comparative Studies in Discourse and Society (CSDS)

Professor: Richard D. Leppert (humanities), *director of graduate studies;* Jackson P. Hershbell (Classical and Near Eastern studies, humanities); Bruce Lincoln (humanities, religious studies); Jochen Schulte-Sasse (comparative literature, German); Hernan Vidal (Spanish and Portuguese)

Associate Professor: W. John Archer (art history, humanities), *chair;* Reda Bensmaia (comparative literature, French and Italian); George Lipsitz (American studies, humanities); William W. Malandra (ancient studies, Classical and Near Eastern studies, religious studies, South and Southwest Asian studies); Susan K. McClary (music); Roger P. Miller (geography)

Assistant Professor: John W. Mowitt (English, humanities); Gianna Pomata (history, humanities)

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. Students should consult the quarterly *Class Schedule* and the *CSDS Graduate Student Handbook* for listings. 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. Since the program involves broad, often interdisciplinary, courses of study and a variety of emphases, the graduate admissions committee will carefully review each applicant's background in terms of communication 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. 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 foreign language for the master's degree and of two foreign languages 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—Contact the director of graduate studies, Comparative Studies in Discourse and Society, 314 Ford Hall, University of Minnesota, 224 Church Street S.E., Minneapolis, MN 55455.

Note—Other graduate-level courses offered by the Humanities Department are listed in the Related Courses section of this bulletin.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5301. SOCIETY, IDEOLOGY, AND THE PRODUCTION OF ART. (4 cr, §Hum 5301; prereq jr or sr or grad student)
Recent critical theories on relation of arts to social and ideological forces; consideration of 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, §Hum 5302; prereq jr or sr or grad student)
Society, ideology, and aesthetic value in light of recent critical theories of visual art, music, literature. Mediations of place, social class, gender, and ideology on aesthetic judgment in post-Renaissance Western culture.

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.

5712. INTERPRETATION OF RITUAL. (4 cr, §RelS 5112; prereq jr or sr or grad student)
Structure and function of rituals. Ritual as symbolic communication, religious action, technique of social restructuring. Sacrifice, initiation, funeral, sacred dance. Theoretical and primary source readings.

5910. TOPICS IN COMPARATIVE STUDIES IN DISCOURSE AND SOCIETY. (4 cr; prereq jr or sr or grad)
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)
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.

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

Hum 5756. ART AND IDEOLOGY: LIVING CINEMA

Hum 5831. INDO-EUROPEAN CIVILIZATIONS

Computer and Information Sciences (CSci)

Professor: David W. Fox, *head;* Marvin L. Stein, *director of graduate studies;* Eugene Ackerman; Gordon B. Davis; Laël C. Gatewood; Oscar H. Ibarra; Paul E. Johnson; Michael B. Kac; Richard Y. Kain; K. S. P. Kumar; E. Bruce Lee; Marian B. Pour-El; J. Ben Rosen; Sartaj K. Sahni; James R. Slagle; Hans F. Weinberger

Associate Professor: Frederic N. Bailey; Valdis A. Berzins; Daniel L. Boley; John V. Carlis; David H. Du; Krzysztof S. Frankowski; Maria Gini; Larry G.

Hutchinson; Larry L. Kinney; John M. Long; J. David Naumann; William A. Plice; Eugene B. Shragowitz; Gerald E. Sobelman; Clark D. Thomborson; William B. Thompson

Adjunct Associate Professor: Donald L. Boyd

Assistant Professor; Vladimir Cherkassky; Yoon-Hwa Choi; Anthony T. Chronopoulos; Ravi Janardan; Haesun Park; Ting-Chuen Pong; Patrick Powell; Anand R. Tripathi; Wei-Tek Tsai; Shankar M. Venkatesan; Anastasios S. Vergis

Adjunct Assistant Professor: Elaine Frankowski; James Larson; Karen L. Ryan; Donald H. Singley; Marienne B. Thuraisingham

Lecturer: Stanley J. Krolikoski

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 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.

Researchers from other University departments and from industry augment the full-time computer science faculty to form the graduate faculty of computer and information sciences. This broadens the scope of the department and enhances the possibilities for interdisciplinary research. Among the fields represented by the graduate faculty are medicine, biometry, electrical engineering, mathematics, management, and management information systems. The adjunct faculty, who are professionals from the local computer industry, provide expertise in specialty areas such as design automation, automated testing, and CAD/CAM systems.

Graduate students have access to today's most powerful supercomputers through the Minnesota Supercomputer Center. In addition, Academic Computing Services and Systems 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 Computer-Aided Design for VLSI and Systems 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. Applicants with an inadequate background must remove any deficiencies before beginning their degree program.

Special Application Requirements—Scores from the General (Aptitude) and Subject (Advanced) Tests of the Graduate Record Examination are required. For undergraduate majors in computer science, the advanced test should be in computer science.

Master's Degree Requirements—In addition to general Graduate School requirements, all master's students must demonstrate competence in the basic material through a written final examination. Plan A students must also take a final oral examination on the thesis.

Doctoral Degree Requirements—Doctoral students must take the written preliminary examination no later than two years after entering the program.

Language Requirements—For the master's degree, none. For the doctoral degree, one foreign language. Requests for alternatives may be made to the major adviser.

For Further Information—Contact the director of graduate studies, Computer and Information Sciences, 136 Lind Hall,

University of Minnesota, 207 Church Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5001f. THEORY AND APPLICATION OF LINEAR PROGRAMMING ALGORITHMS. (4 cr; prereq 5301 or #)
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.

5002w. COMPUTATIONAL METHODS FOR NONLINEAR PROGRAMMING. (4 cr; prereq 5001 or #; informal lab)
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.

5101f,w. STRUCTURE AND PROGRAMMING OF SOFTWARE SYSTEMS I. (4 cr, §3107; prereq non-CSci major, 3105 or #; informal lab)
Organization and logical structure of computer systems. Stored program Von Neumann architecture, CPU, data paths, memory, fetch/execute cycle. Assembly language programming: basic instruction set, registers, addressing schemes, primitive data types. Representation/manipulation of high level data: integers, characters, records and arrays, stacks and queues. Representation of high level control structures: conditionals, branches, loops, case statements, subroutines, parameter passing, recursion, reentrant code. Discussion of assembly and loading process, I/O and interrupts.

5102. STRUCTURE AND PROGRAMMING OF SOFTWARE SYSTEMS II. (4 cr; prereq CLA-CSci or upper div IT-CSci major or grad, 3107 or 5101 or #; informal lab)
Concepts of layers of functionality and abstract machines: interplay between hardware, operating system, compiler/interpreter, user program. Process synchronization and communication. Resource management. Modular compilation, libraries, and loaders. Experiments with basic concepts using model operating systems and C language.

5104f. SYSTEM SIMULATION: LANGUAGES AND TECHNIQUES. (4 cr; prereq CLA-CSci or upper div IT-CSci major or grad, 3107 or 5101, Stat 3091 or #)
Methodologies relevant to simulation including queuing theory, variable generation, design of experiments, data collection, statistical analysis of output. Simulation languages, both flow and event oriented, including GPSS, SIMULA, SIMSCRIPT. Application of job shops; operations research and modeling of computer and communications systems.

5105s. THEORY OF MACHINE ARITHMETIC. (4 cr; prereq 3107 or 5101 or #; informal lab)
Residue class arithmetic. Congruences and complement arithmetic. Integral additive and subtractive accumulators. Multiplication and division by shifting and accumulation. Applications to absolute value and sign arithmetic, scaling and the floating point operation.

5106s. STRUCTURE OF HIGHER LEVEL LANGUAGES. (4 cr; prereq CLA-CSci or upper div IT-CSci major or grad, 5102 and 5121 or #)
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 CLA-CSci or upper div IT-CSci major or grad, 3107 or 5101, and 5121 or #)
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.

5117. COMPUTER GRAPHICS II. (4 cr; prereq CLA-CSci or upper div IT-CSci major or grad, 3107 or 5101 and 5121 or #)
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.

5121w. INTRODUCTION TO DATA STRUCTURES. (4 cr; prereq CLA-CSci or upper div IT-CSci or EE or Math major or grad, 3106 and 3400 or #)
Basic concepts of data and their representation. Sequential and linked representations. Arrays, stacks, and queues. Chains, circular lists, and doubly linked lists. Dynamic storage management. Garbage collection and storage compaction. Generalized lists. Strings. Binary trees and trees. Tree traversal. Graphs. Activity networks.

5122w. ADVANCED DATA STRUCTURES. (4 cr; prereq CLA-CSci or upper div IT-CSci or EE or Math major or grad, 5121 or #; informal lab)
Internal and external sorting. Symbol tables. Optimal binary trees. AVL trees. Hashing. B-trees, tries. Files and indexes. ISAM, multilists, inverted files, cellular partitions, differential files.

5180-5181. SOFTWARE ENGINEERING. (5 cr; prereq CLA-CSci or upper div IT-CSci major or grad, 5106 or #)
Software life cycle. Requirements analysis; functional design; design languages and data bases; use of abstractions; architectural design; project planning and management; design reviews, software testing, and validation strategies; maintenance.

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.

5201. COMPUTER ARCHITECTURE. (4 cr; prereq CLA-CSci or upper div IT-CSci major or grad, 3400, 3107, 5101 or #)
Elementary computer architecture, gates and digital logic, register transfers and micro operations, processor studies of existing systems.

5205. PARALLEL COMPUTER ARCHITECTURE. (4 cr; prereq upper div CLA/IT-CSci major or grad student, 5201, or #)
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 paradigms of pipelines and vector processors, array processors, and multiprocessors.

5211. DATA COMMUNICATIONS AND COMPUTER NETWORKS. (4 cr; prereq CLA or upper div IT-CSci or EE or Math major or grad, 5102, Stat 3091 or equiv)
Network classification and services. Hardware components: multiplexors, concentrators, communications media. Network protocols and architectures. Research areas.

5280. COMPUTER-AIDED DESIGN I. (4 cr; prereq CLA-CSci or upper div IT-CSci or EE or Math major or grad, 5122, 5201; informal lab)
CAD for digital systems with emphasis on VLSI. Hardware description languages: synthesis, simulation, test generation.

5281. COMPUTER-AIDED DESIGN II. (4 cr; prereq CLA-CSci or upper div IT-CSci or EE or Math major or grad, 5122, 5201)
CAD for digital systems with emphasis on VLSI. Physical design: partitioning, placement and routine, 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.

5301f,w. NUMERICAL ANALYSIS. (4 cr; prereq Math 3142 or equiv or #; knowledge of Pascal or FORTRAN assumed)
Floating point arithmetic and rounding errors. Iterative methods. Numerical solution of nonlinear equations. Gauss elimination. Factorization methods. Interpolation and approximation. Numerical integration and differentiation. Introduction to numerical solution of ordinary differential equations.

5302w,s. NUMERICAL ANALYSIS. (4 cr; prereq 5301 or #; informal lab)
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.

5304s. 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.

5305s. 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.

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.

5400f. INTRODUCTION TO AUTOMATA THEORY. (4 cr; prereq CLA-CSci or upper div IT-CSci or EE or Math major or grad, 3105 and 3400 or #)
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.

5401w. INTRODUCTION TO FORMAL LANGUAGES. (4 cr; prereq CLA-CSci or upper div IT-CSci or EE or Math major or grad, 5400; informal lab)
Formal grammars and languages and their related automata. Language hierarchy. Context-free languages and grammars. Pushdown automata. Normal form theorems. Operations on languages. Decidability and undecidability results. Parsing algorithms. Applications to programming.

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.

5502f. INTRODUCTION TO OPERATING SYSTEMS. (4 cr; prereq CLA-CSci or upper div IT-CSci major or grad, 5102 and 5121 or #)
Definition and historical development of operating systems. Abstractions and implementations of properties 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. Protection. Performance measurement and analysis.

5503. INTRODUCTION TO COMPILERS. (4 cr; prereq CLA-CSci or upper div IT-CSci major or grad, 5106 or 5504 or #)
A higher level language (PL/.5), machine language, loaders, linkage editors; mapping PL/5 onto machine language, code generation techniques; derivation of an intermediate language and implementation of code generation, error detection and correction. Students design and implement a front end for a PL/.5 compiler.

5504. INTRODUCTION TO COMPILERS. (4 cr; prereq CLA-CSci or upper div IT-CSci major or grad, 5106 or #)
Lexical scanning together with preprocessing and macroexpansion, symbol tables, parsing, intermediate text generation, error detection and correction. Students design and implement a front end for a PL/.5 compiler.

5511. ARTIFICIAL INTELLIGENCE I. (4 cr; prereq CLA-CSci or upper div IT-CSci major or grad, 5121 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 CLA-CSci or upper div IT-CSci major or grad, 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 CLA-CSci or upper div IT-CSci major or grad, 5301 or Stat 3091 or #)
Definition pattern recognition, feature selection, measurement techniques, and similar problems. 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 CLA-CSci or upper div IT-CSci major or grad, 5512 or #; informal lab)
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.

5702. THE PRINCIPLES OF DATA BASE SYSTEMS. (4 cr; prereq CLA-CSci or upper div IT-CSci major or grad, 5122 or #; informal lab)
Fundamental concepts. Conceptual data organization. Data models. Data manipulation languages. Data base design. Security and integrity. Performance evaluation. Query optimization. Distributed data base systems.

5703. DATA BASE SYSTEM DESIGN. (4 cr; prereq CLA-CSci or upper div IT-CSci major or grad, 5702 and #)
Application of data base concepts in the design and development of data base systems and applications. Design of current commercial as well as research-oriented data base systems. Techniques of using data base systems for applications.

5799. PROBLEMS: ARTIFICIAL INTELLIGENCE. (1-4 cr per qtr [may be repeated for cr]; prereq #)
Special courses or individual study arranged with faculty member.

8101-8102. COMPUTER OPERATING SYSTEMS: MODELING AND ANALYSIS. (3 cr per qtr; prereq 5502 or #)
Introduction to general system properties; mechanisms for resource sharing (e.g., interrupts, processor switching, multiprogramming, virtual and auxiliary memory, file systems). Process sequencing and control: deadlocks, mutual exclusion, synchronization. Deterministic models of processor scheduling: optimality for two-processor systems and tree-structured computations; independent tasks; list scheduling; preemption and processor sharing. Probability models of computer sequencing problems: queuing results and comparisons. I/O problems: disk and drum optimal scheduling, etc. Paging algorithms: optimality, stack algorithms, multiprogramming. Program models: locality model, working set model.

8103. DISTRIBUTED SYSTEMS. (3 cr; prereq 5211 or #)
System models, communication issues, distributed control, protection and error recovery, resource allocation, job scheduling.

8301-8302. COMPUTATION OF SPECIAL FUNCTIONS AND FORMULAS. (4 cr per qtr; prereq 5305 or #)
Polynomials and rational functions. Errors, Nth root, logarithmic, circular, and hyperbolic functions. Multiple precision. Heuristic considerations.

8303-8304. COMPUTATIONAL METHODS FOR INITIAL AND BOUNDARY VALUE PROBLEMS. (4 cr per qtr; prereq 5305 or #)
Two-point boundary conditions. Error estimates. Explicit and implicit difference schemes. Stability. Maximum principle. Nonlinear equations.

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 #)

8401-8402. ALGORITHMS—TECHNIQUES AND THEORY. (4 cr per qtr; prereq 5121, 5400 or #)
Searching, polynomial manipulation, graph algorithms, parallel computations, linear pattern matching, computationally related problems, hard problems, abstract complexity, miscellaneous techniques.

8403-8404. THEORY OF COMPUTATION. (4 cr per qtr; prereq 5400 or equiv or #)
Models of computation. Computability and unsolvability. Computational complexity. Speed-up theorems. Hierarchy theorems. Intractable problems (NP-complete, PSPACE-complete, provably intractable, etc.). Relativized problems. Advanced topics.

8499. SEMINAR: COMPUTATIONAL THEORY AND LOGIC. (1-3 cr; prereq #)

8501. COMPUTER VISION. (4 cr; prereq 5512 or #)
Introduction to techniques for automatically describing visual data. Tools for image analysis. Perception of spatial organization. Models of general purpose vision systems. Computational and psychological models of perception. Industrial inspection and sensor based robots. Other applications.

8502. EXPERT SYSTEMS. (4 cr; prereq 5511 or #)
Definition of expert systems; problem specification, knowledge acquisition, knowledge representation; inference techniques; tools for building expert systems; examples of existing systems; robustness and extensibility.

8505. OPTIMIZATION IN COMPILERS. (4 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.

8511. SPECIAL TOPICS IN ARTIFICIAL INTELLIGENCE. (4 cr; prereq #)
In-depth coverage of selected areas of active research in artificial intelligence. Possible topics include machine perception, expert systems, robotics, natural language processing.

8551. ARTIFICIAL INTELLIGENCE TECHNIQUES IN ROBOTICS. (4 cr; prereq 5531 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.

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 5700. INFORMATION THEORY AND CODING

EE 5702. STOCHASTIC PROCESSES AND OPTIMUM FILTERING

EE 5750. TOPICS IN LINEAR SYSTEMS

EE 5752. COMPUTER-AIDED DESIGN OF CONTROL SYSTEMS

EE 5852-5853. DIGITAL COMPUTER SYSTEMS

EE 8240. SEMINAR: COMMUNICATION

EE 8260. TOPICS IN NONLINEAR SYSTEMS

EE 8290. SEMINAR: CONTROL THEORY

EE 8291. SEMINAR: SYSTEM THEORY

EE 8352. FAULT DIAGNOSIS AND RELIABLE DESIGN

Math 5162-5163-5164. MATHEMATICAL LOGIC

Math 8181-8182-8183. FORMAL LANGUAGES AND AUTOMATA

Math 8190-8191-8192. TOPICS IN LOGIC

Math 8445. NUMERICAL ANALYSIS OF ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS

Control Science and Dynamical Systems

Regents' Professor: Lawrence Markus (mathematics), *chair;* Rutherford Aris (chemical engineering)

Professor: Donald G. Aronson (mathematics); William Garrard (aerospace engineering); Robert T. Holt (political science); Daniel D. Joseph (aerospace engineering and mechanics); Mostafa Kaveh (electrical engineering); K. S. P. Kumar (electrical engineering); E. Bruce Lee (electrical engineering); Walter Littman (mathematics); Warren S. Loud (mathematics); Richard P. McGehee (mathematics); Katsuhiko Ogata

(mechanical engineering); J. B. Rosen (computer science); George R. Sell (mathematics); Patarasp R. Sethna (aerospace engineering); Yasutaka Sibuya (mathematics); Marvin L. Stein (computer science); William H. Warner (aerospace engineering and mechanics)

Associate Professor: Daniel Boley (computer science), *director of graduate studies;* Fredric N. Bailey (electrical engineering); Max Donath (mechanical engineering); Klavs F. Jensen (chemical engineering); Larry L. Kinney (electrical engineering); Charlotte Striebel (mathematics)

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 modelling—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 normally 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 will also be considered. A high level of proficiency in mathematics is necessary to successfully complete the Ph.D. 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. Since 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 will 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—Contact the director of graduate studies, Control Science and Dynamical Systems, School of Mathematics, 127 Vincent Hall, University of Minnesota, 206 Church Street S.E., Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Curriculum and Instruction

Professor: Dianne L. Monson, *chair*; Michael F. Graves, *director of graduate studies;* Andrew Ahlgren; Richard W. Beach; Carol A. Carrier; John J. Cogan; Bruce R. Dalgaard; Robert Dykstra; William E. Gardner; Eugene D. Gennaro; Allen D. Glenn; Harlan S. Hansen; Peggy A. House; Robert L. Jackson; Roger T. Johnson; Stanley B. Kegler; Richard D. Kimpston; Dale L. Lange; Darrell R. Lewis; James A. Mackey; John C. Manning; R. Norine Odland; Gene L. Piché; Thomas R. Post; S. Jay Samuels; Robert L. Schreiner; James E. Stochl; Robert D. Tennyson; Howard Y. Williams

Associate Professor: Douglas H. Anderson; Eugene M. Anderson; J. Michael Bennett; Robert L. Borg; Charles R. Bruning; Reginald T. Buckner; Harlan G. Copeland; Margaret K. DiBlasio; Fred N. Finley; Charles E. Furman; Ilene B. Harris; Helen L. Jorstad; R. Michael Paige; Rosemarie J. Park; Stephen W.

Schultz; Barbara M. Taylor; Constance L. Walker; Reynold A. Willie

Assistant Professor: Patricia G. Avery; Kerry J. Freedman; Charles E. Furman; Patricia A. Heller; Frances P. Lawrenz; Millie P. Mellgren; Robert E. Orton; Gregory C. Sales

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, mathematics education, and music 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, mathematics education, and music 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: adult, continuing, and community education; curriculum and instructional systems; English education; international development education; 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 (adult education, early childhood education, general curriculum, instructional systems, supervision, teacher education), elementary education, mathematics education, music education, second languages education, science 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 Miller Analogies Test are required. Graduate Record Examination scores are helpful, but not required.

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 and evaluation; 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—Contact the director of graduate studies, Department of Curriculum and Instruction, 145 Peik Hall, University of Minnesota, 159 Pillsbury Drive S.E., Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Art Education (ArEd)

5001. ART MEDIA TECHNIQUES. (1-12 cr [max 12]) DiBlasio, Freedman
Lectures, demonstrations, discussions, critique sessions on techniques and processes in creativity; handling specific media; each offering focuses on a single topic.

5020. ADVANCED CONTEMPORARY CRAFTS. (4 cr; prereq 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.

5201. INTRODUCTION TO ART THERAPY. (3 cr; offered alt yrs) DiBlasio
Examination of the history and current conceptions of art therapy.

5302. CURRICULUM INNOVATIONS IN ART EDUCATION. (4 cr) DiBlasio
Study and analysis of innovations, evaluation of material for teaching units and projects.

5303. ART PROGRAMS FOR EXCEPTIONAL LEARNERS. (4 cr; offered when feasible)
Development and evaluation of art teaching units and projects for learners of all ages.

5310. HISTORY OF AMERICAN ART EDUCATION. (3 cr; 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, economic contexts.

5316. INTERCULTURAL EDUCATION THROUGH ART. (3 cr; offered when feasible) Freedman
Approaches to international understanding through recognition of aesthetic contributions of diverse peoples to American life.

5318. ART EDUCATION IN EUROPE. (3 cr; offered when feasible) Freedman
Current practices, problems, and achievements in art education in Western Europe compared with practices in American art education.

5386. IMPROVING ART PROGRAMS IN THE SCHOOLS. (4 cr; prereq tchg exper or #; offered when feasible) DiBlasio
Critical examination of present art programs in schools.

5389. APPLICATION OF AESTHETIC THEORY IN EDUCATION. (3 cr; 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.

5600. INTERNSHIP. (3-9 cr; prereq #) DiBlasio, Freedman
Professional assignment for degree candidates under joint supervision of departments and cooperating agency.

5605. PRACTICUM. (3-9 cr; prereq #) DiBlasio, Freedman
Independent project under direction; gathering data, developing proposals, experimenting with evaluating innovative practices.

8300. RESEARCH IN ART EDUCATION. (3 cr; offered alt yrs) Freedman
Research techniques.

8306. SEMINAR: ART EDUCATION. (1 cr; offered alt yrs) DiBlasio
Reports, evaluation of problems, recent literature.

8900. PROBLEMS: ART EDUCATION. (Cr ar; prereq #) DiBlasio, Freedman
Independent projects under staff guidance may include advanced studio practice or technical problems requiring experimental or library research.

Curriculum and Instructional Systems (CISy)

5000. INTRODUCTION TO INSTRUCTIONAL SYSTEMS. (1 cr) Carrier
Major theories and areas of research relevant to instructional design.

5003. INTRODUCTION TO COMPUTERS AND THEIR USES. (1 cr; S-N only) Willie
Computer technology in instruction; hardware, software, terminology, word processing, instructional applications. For students with no background in computing.

5004. INTRODUCTION TO INTERACTIVE VIDEO INSTRUCTION. (1 cr; offered when feasible) Sales
Use of videodiscs and related technologies: hardware, software, terminology, and applications in instruction.

5006. INTRODUCTION TO INSTRUCTIONAL COMPUTER PROGRAMMING. (3 cr; prereq 5003 or #; A-F only) Sales
Designing computer-based instructional programs through programming. Students need not have a mathematics or science background.

5100. CURRICULUM AND INSTRUCTIONAL SYSTEMS WORKSHOP. (1-3 cr [max 9]; offered when feasible)
Special topics course in design, development, implementation, and evaluation of curricular and instructional systems.

5201. SYSTEMS APPROACH TO DESIGN OF INSTRUCTION. (3 cr; prereq 5000 or #) Carrier
Instructional materials design in accordance with systems principles including design of a specific unit of courseware.

5205. COMPUTER-BASED INSTRUCTION: INTRODUCTION TO DESIGN. (3 cr; prereq 5006 or #) Sales
Computer uses in education and training; models for designing computer-based instruction with emphasis on interface design.

5206. MICROCOMPUTER USES IN ELEMENTARY CLASSROOMS. (3 cr, §Elem 5140; offered when feasible) Stochl
Using microcomputers to enhance instruction; applications in language arts, mathematics, science, social studies; evaluation of available programs.

5207. INTERACTIVE VIDEO INSTRUCTION. (4 cr; prereq 5004, 5201 or 5205 or 5209 or #) Sales
Videodiscs and related technologies; design and development of interactive instruction.

5208. COMPUTER-BASED TOOLS FOR TEACHERS. (3 cr; prereq 5003 or 5206 or #)
Use of microcomputers for instructional material generation, record keeping, and classroom management tasks in K-12 classrooms.

5209. PRINCIPLES AND PROCEDURES IN DESIGNING INSTRUCTION. (4 cr; prereq 5000) Carrier
Major models of instructional development; generic components; design models; review of instructional design and learning environments.

5212. COMPUTER-BASED INSTRUCTION: DESIGN AND DEVELOPMENT. (3 cr; prereq 5205 or #; offered with feasible) Sales
Design and development of computer-based instruction package, including documentation and support materials.

5216. COMPUTER-BASED INSTRUCTIONAL SIMULATIONS. (3 cr; prereq 5212 or #) Sales
Design, implementation, and evaluation of instructional computer-based simulations.

5218. COMPUTER-BASED INSTRUCTIONAL GAMES. (3 cr; prereq 5212 or #) Sales
Design, implementation, and evaluation of instructional computer-based games.

5509. DIRECTED INDIVIDUAL STUDY. (1-6 cr [max 6]; prereq #)
Review of literature on research and theory related to curricular and instructional systems.

5600. INTRODUCTION TO CURRICULUM SYSTEMS. (3 cr) Kimpston
Principles of curriculum design, forces influencing goals and curriculum planning, curricular trends and issues, traditional and emergent curricular designs, current proposals for change; model for curriculum planning.

5605. PRINCIPLES AND PROCEDURES IN DESIGNING CURRICULUM. (3 cr) Kimpston
Systematic curriculum planning; development of models for planning, formulation of plans, and outlining a curriculum design for an educational setting.

5700. CURRICULUM PLANNING PROCESSES. (4 cr; prereq 5600 or 5605 or Elem 5100) Kimpston
Analyzing models for planning; designing a curriculum system; employing system to produce plans to develop curriculum.

5800. SUPERVISION OF SECONDARY INSTRUCTION. (3 cr; prereq 5600) Anderson
Achievement of appropriate teaching expectations focusing on problems of personnel responsible for their improvement.

8100. CURRICULUM AND INSTRUCTION CORE: CURRICULUM. (2 cr; prereq PhD student or △)
Theoretical principles and major empirical findings in the core discipline of generic curriculum decision making; relationships among curricular processes, instructional design variables, and interactive teaching behavior.

8101. CURRICULUM AND INSTRUCTION CORE: INSTRUCTION. (2 cr; prereq PhD student or △)
Theoretical principles and major empirical findings in the core discipline of instructional design; relationships among instructional design variables, curriculum processes, and interactive teaching behavior.

8102. CURRICULUM AND INSTRUCTION CORE: TEACHING. (2 cr; prereq PhD student or △)
Theoretical principles and major empirical findings in the core discipline of research on teaching; relationships among major teacher/teaching variables, curricular processes, and instructional design variables.

8305. INSTRUCTIONAL DELIVERY SYSTEMS. (3 cr, §SeEd 8305) Carrier, Sales
Selection criteria and survey of alternative technological and nontechnological systems for communicating content to students.

8307. DESIGNING INSTRUCTIONAL MATERIALS: RESEARCH AND THEORY. (3 cr; prereq 5209) Carrier, Sales
Theory and practice; conventional group instruction; individualized instruction, or instruction using new media for self-instruction.

8411. ADVANCED DESIGNS IN COURSEWARE: COMPUTER. (3 cr; prereq 5216 or 5218 or #; offered when feasible) Sales
Most recent trends and issues in research and development of computer-based instructional materials.

8412. ADVANCED DESIGNS IN COURSEWARE: VIDEO. (3 cr; prereq 5207 or #; offered when feasible) Sales
Most recent trends and issues in research and development of video-based instructional materials.

8416. CURRICULUM AND INSTRUCTIONAL SYSTEMS SEMINAR. (2 cr [max 6]; prereq #; offered alt yrs)
Problems and issues in curriculum and instructional theory and research.

8501.* PROBLEMS: CURRICULUM AND INSTRUCTIONAL SYSTEMS. (Cr ar; prereq #)
Individual empirical investigation.

8600. SEMINAR: CURRICULUM IMPLEMENTATION AND CHANGE. (2 cr [max 4]; prereq 5600 or Elem 5100 or #) Kimpston
Review and evaluation of theories, models, and strategies for change; recognition and use of this knowledge as a practical guide to problem solving.

8700. CURRICULUM AND INSTRUCTIONAL SYSTEMS FIELD EXPERIENCE. (3-6 cr [max 6]; prereq #)
Internship experience in an educational setting; planning, implementing, and supervising curriculum and/or instructional change.

8800. PROBLEMS: SECONDARY SCHOOL SUPERVISION. (Cr ar; prereq △) Anderson
Individual problems course on improvement of instruction.

Education: Adult and Teacher (Educ)

5103. ADULT EDUCATION WORKSHOP. (1-12 cr [max 12]; prereq practicing adult educator or #)
Topics appropriate to activities and interests of the participants.

5104. SURVEY OF ADULT EDUCATION. (3 cr; 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; 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.

5180. ANALYSIS OF THE TEACHING PROCESS. (3 cr; prereq tchg exper or #; offered when feasible) Anderson
Conceptual analysis of instructional strategies and methodologies.

5182. LABORATORY APPROACHES IN TEACHER EDUCATION. (3 cr; offered when feasible)
Training modes in teacher education; microteaching, simulation, games, and protocol materials.

5184. SUPERVISION OF CLINICAL EXPERIENCES. (3 cr; prereq #; offered when feasible)
Supervision of professional laboratory experiences.

5186. ALTERNATIVE SCHOOL DESIGNS: IMPLICATIONS FOR TEACHER EDUCATION. (3 cr; offered when feasible)
Value positions and basic assumptions underlying alternative schooling processes and their implications for the selection and training of personnel.

5190. THE LEARNING ENVIRONMENT OF THE MIDDLE SCHOOL. (2 cr; S-N optional)
Implications of the philosophy and organization of middle schools; pre- and early adolescent psychology for structuring the learning environment: curriculum design, teaching and learning, student evaluation.

5191. THEMATIC INSTRUCTION FOR MIDDLE SCHOOLS. (2 cr)
Logical and contextual relationships among mathematics, science, and social studies as taught in middle schools.

5199. WORKSHOP: TEACHER EDUCATION. (1-12 cr [max 12]; prereq tchg exper and #; offered when feasible)
Topics appropriate to activities and interests of participants.

5201. INTRODUCTION TO THE UNDEREDUCATED ADULT. (3 cr) Park
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; 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; 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]; prereq #)
Supervised fieldwork practice and seminars; presentations on and evaluations of adult education practices.

5301. DESIGNING THE ADULT EDUCATION PROGRAM. (3 cr) Copeland
Designing and implementing educational programs for adults: concepts, theories, determining needs, educational objectives, learning experiences, and evaluating outcomes.

5401. ADULT LEARNING AND DEVELOPMENT THROUGH THE LIFE SPAN. (3 cr) 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) Willie
Identification, classification and analysis of techniques used in teaching adults.

5440. MULTIDISCIPLINARY PERSPECTIVES ON AGING. (4 cr, §CPsy 5305, §HSU 5009, §PA 5514, §SAHP 5009, §Soc 5960, §SW 5024) Copeland
Multidisciplinary introduction to aging and the aging process.

5501. CONTINUING EDUCATION AND THE PROFESSIONS. (3 cr) Bruning
Review of literature; analysis of philosophies, issues, and trends; emphasis on integrating personal growth, professional needs, and statutory requirements in continuing education programs.

5601. INTERNATIONAL EDUCATION: TOPICS IN CLASSROOM PRACTICES AND PROCEDURES. (1-12 cr [max 12]; prereq tchg licensure, #) Cogan
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) 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) 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) Braun
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.

5901. INTRODUCTION TO COMMUNITY EDUCATION. (3 cr) Bruning
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; prereq 6 cr in adult ed or #) Williams
Social, legal, moral/ethical, technical, and empirical sources of issues in adult education.

8100. RESEARCH IN ADULT EDUCATION. (3 cr; prereq #, coursework in experimental design) Williams
Review and analysis of current research and research procedures in adult education.

8188. ALTERNATIVE PROGRAMS IN TEACHER EDUCATION. (3 cr; offered when feasible)
Comprehensive review of the range of programs that prepare and renew teachers; analysis in terms of underlying assumptions; program design, management, and cost analyses.

8284. PROBLEMS: TEACHER EDUCATION. (3-9 cr; prereq #)
Research in supervision, organization, and administration; laboratory experiences at elementary and secondary levels.

8285, 8286. PROFESSIONAL EDUCATION OF TEACHERS. (3 cr per qtr; prereq 15 cr in education incl 5184 and 8250 or HiEd 8250 or HiEd 5182 or SPFE 5182 or CSPP 8140 or PsyS 8140 or # for 8285, 8285 or # for 8286; offered when feasible)
For present and prospective instructors, administrators, and personnel workers in teacher education institutions. Both quarters recommended in sequence, but either may be taken without the other. Current issues and problems, selection and retention, curriculum, licensure, experimental programs, and research.

8302. PROBLEMS: ADULT EDUCATION. (1-9 cr, prereq #)
Individual research in area of adult education.

8603. SEMINAR: INTERNATIONAL DEVELOPMENT EDUCATION. (3 cr; prereq 5603) Cogan, Paige
Key theoretical issues relating to education and development worldwide; formal and nonformal education.

8605. PROBLEMS: INTERNATIONAL EDUCATION RESEARCH. (3-6 cr; prereq 5605) Cogan, Paige
Examination of comparative research studies focusing on major educational issues worldwide with emphasis on development education.

Elementary Education (Elem)

5100. ELEMENTARY SCHOOL CURRICULUM. (3 cr; prereq 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. (1-3 cr; prereq elem school tchg exper and #; 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. (3 cr; prereq 5100 or SeEd 5113 or CISy 5600)
Selecting and organizing units, courses of study, curriculum guides and writing materials, individually and in groups.

5107. DIAGNOSIS AND TREATMENT OF LEARNING DIFFICULTIES. (3 cr) Park, Schreiner
Diagnosis of pupil difficulty; development and prevention; tests as aids to teaching; following up a testing program; socioemotional problems associated with learning difficulties.

5108. SUPERVISION AND IMPROVEMENT OF INSTRUCTION. (3 cr; prereq 9 cr in education; offered when feasible) Manning
Functions and duties of a supervisor; techniques; analysis of classroom activities.

5109. SUPERVISORY STRATEGIES IN PLANNING, OBSERVING, CONFERENCING. (3 cr; prereq #; offered when feasible) Simms
Overview of responsibilities of the supervising teacher; material development and practice in basic supervisory skills and functions.

5140. MICROCOMPUTER USES IN ELEMENTARY CLASSROOMS. (3 cr, §CISy 5206) Stochl
Using microcomputers to enhance instruction; applications in language arts, mathematics, science, social studies; evaluation of available programs.

5141. USING LOGO IN THE CLASSROOM. (3 cr; prereq CISy 5003 or equiv) Stochl
Using LOGO in the 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.

5145. CLASSROOM MANAGEMENT. (3 cr, §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.

5164. GLOBAL EDUCATION: CONTENT AND PROCESS. (3 cr, §SeEd 5164; offered alt yrs) 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.

5227. TEACHING ABOUT THE NEWSPAPER IN THE CLASSROOM. (1-3 cr [max 4 cr], §SeEd 5227) Mackey
Institution of the newspaper; articulation of series of useful instructional strategies, curriculum development techniques, and teaching materials.

5300. LITERATURE FOR THE ELEMENTARY SCHOOL. (3 cr) Monson, Odland
Evaluative survey of books for children; research related to children's reading interests; selection of literature.

5305. SURVEY OF SPECIAL COLLECTIONS IN CHILDREN'S LITERATURE. (3 cr; prereq 5300 or #) Odland
Content and accessibility of collections that relate the creation of books; emphasis on possibilities and methods for interpreting content of collections to children.

5315. TEACHING COMPOSITION IN THE ELEMENTARY SCHOOL. (3 cr; prereq postbaccalaureate or MEd or grad student) Monson
Theory and research on writing process, applications to development of elementary school writing curriculum.

5316. TEACHING AND SUPERVISION OF ENGLISH IN THE ELEMENTARY SCHOOL. (3 cr; prereq 3316 or elem tchg exper) Dykstra, Monson
Improvement of instruction, study of trends in English education.

5317. MATERIALS LABORATORY FOR TEACHING ENGLISH IN ELEMENTARY SCHOOLS. (3 cr; prereq 3316 or elem tchg exper; offered when feasible) Dykstra, Monson
Examination and evaluation of textbooks, programmed materials, and audio-visual resources for elementary school language arts instruction.

5318. CREATIVE WRITING FOR AND BY CHILDREN. (3 cr [max 6]; prereq 3300 or 3316 or elem tchg exper or #) Monson, Odland
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.

5319. TEACHING SECOND LANGUAGES AND CULTURES IN ELEMENTARY SCHOOLS. (3 cr) 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.

5320. PRACTICUM: TEACHING SECOND LANGUAGES AND CULTURES IN ELEMENTARY SCHOOLS. (3 cr; offered S-N only; prereq 5319 or ¶5319, #) Jorstad
Minimum of three hours weekly of supervised teaching and observation in elementary schools.

5330. COMPUTER-ASSISTED INSTRUCTION IN READING AND LANGUAGE ARTS FOR ELEMENTARY SCHOOL STUDENTS. (3 cr; prereq education major or elem or secondary tchg exper or #) Schreiner
Developing, evaluating, and using materials to present reading and language arts content to elementary students; interface of theoretical issues with instructional techniques presented on computers.

5331. TEACHING AND SUPERVISION OF READING IN THE ELEMENTARY SCHOOL. (3 cr; prereq 9 cr education) Manning
Objectives, materials, and teaching procedures; current practices and curricula; class and individual projects.

5333. INSTRUCTIONAL LEADERSHIP IN ELEMENTARY READING. (3 cr; prereq 5331 or #) Manning
Survey of formal and informal procedures for evaluating reading instruction; demonstration teaching as instructional leadership; grouping procedures in improvement of reading programs; intended for supervisors and principals.

5334. READING DIFFICULTIES. (3 cr; prereq 5331 or SeEd 5344) Schreiner, Taylor
Causes, prevention, and correction; remedial practices useful to the classroom teacher, school counselor, and reading specialist.

5335. CLINICAL DIAGNOSIS OF READING DIFFICULTIES. (3 cr; prereq 5334) Schreiner, Taylor
Relationship to psychological factors and clinical remedial correction.

5336. CLINICAL PRACTICE IN REMEDIAL TEACHING. (3 cr; prereq 5334 or 5107, #) Schreiner, Taylor
Remedial tutoring of individual children who have difficulty in school learning.

5337. BEGINNING READING INSTRUCTION. (3 cr; prereq 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.

5338. TEACHING READING IN THE INTERMEDIATE GRADES. (3 cr; prereq 3331 or elem teacher or #) Taylor
For teachers and specialists interested in problems of teaching reading beyond the decoding stage; emphasis on comprehension strategies, basic study skills, and reading in the content areas.

5339. WORKSHOP: CURRICULUM IMPLEMENTATION IN ELEMENTARY SCHOOL READING. (1-9 cr [max 9]; prereq elem tchg exper or #; offered when feasible) Manning, Schreiner, Taylor
Analysis of new instructional materials, techniques, recent trends, and innovations in elementary reading instruction.

5346. TEACHING SCIENCE IN THE ELEMENTARY SCHOOL. (3 cr; prereq elem tchg exper or #; offered when feasible) Finley, Heller, Johnson, Lawrenz
Materials, resources, and methods of teaching science at the elementary level.

5347. WORKSHOP: CURRICULUM IMPLEMENTATION IN ELEMENTARY SCHOOL SCIENCE. (1-3 cr [max 12]; prereq elem tchg exper; offered when feasible) Finley, Heller, Johnson, Lawrenz
Offered in summers with focus on a single program for each offering: treating concept foundation, goals, and teaching and evaluation procedures.

5348. WORKSHOP: OUTDOOR SCIENCE EDUCATION. (3 cr; 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.

5349. ELEMENTARY SCHOOL SCIENCE: CURRICULUM AND SUPERVISION. (3 cr; prereq 3346 or 5346; offered when feasible)
Program foundations including elements from philosophy, psychology, the science disciplines; design of in-school curriculum improvement models; program evaluation; pupil reporting procedures.

5350. ELEMENTARY SCHOOL SCIENCE: MATERIALS AND RESOURCES. (3 cr; prereq 5349) Finley, Heller, Johnson, Lawrenz
Experiences in the use of educational materials and media common to the teaching of modern elementary school science.

5361. TEACHING SOCIAL STUDIES IN THE ELEMENTARY SCHOOL. (3 cr; prereq 3101 or equiv) Avery, Cogan
Content and organization of social studies programs; programs of understanding, improving the learning situation, and effective use of materials.

5362. MATERIALS LABORATORY FOR ELEMENTARY SOCIAL STUDIES TEACHERS. (3 cr; prereq 3361 or 5361 or #)
Printed, audio-visual, and other materials; investigation and evaluation of teaching materials and devices.

5363. WORKSHOP: CURRICULUM IMPLEMENTATION IN ELEMENTARY SCHOOL SOCIAL STUDIES. (Cr ar [max 9]; prereq elem tchg exper, #)
Analysis of new instructional materials and recent curriculum developments in the field; training in innovative instructional procedures.

5376. CURRENT TRENDS IN EARLY CHILDHOOD EDUCATION. (3 cr; prereq tchg exper in kindergarten or primary or #) Hansen
Continuing needs of children in our changing culture; current practices and recent research.

5377. EARLY CHILDHOOD EDUCATION: MATERIALS AND RESOURCES. (3 cr; prereq 3377 or 5376 and tchg exper) Hansen
Experience in the selection and use of commercial and teacher-made educational materials and media common to teaching in early childhood education programs.

8300. RESEARCH IN SPECIAL COLLECTIONS OF CHILDREN'S LITERATURE. (1-3 cr [max 6]) Monson, Odland
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.

8316. RESEARCH IN ENGLISH COMPOSITION IN ELEMENTARY SCHOOLS. (3 cr; prereq 5316 or equiv; offered alt yrs) Dykstra, Monson
Review of research in oral and written language of children; needed research indicated by current classroom procedures.

8317. RESEARCH IN SKILL DEVELOPMENT IN SPELLING, HANDWRITING, AND LISTENING. (3 cr; prereq 5316; offered alt yrs) Dykstra
Review of findings with implications for the classroom teacher; evaluation criteria and needed research.

8331. RESEARCH FOUNDATIONS FOR READING INSTRUCTION. (3 cr; prereq 5331, #; offered alt yrs) Schreiner
Critical review and analysis of classical research studies in the psychology, pedagogy, and sociology of reading; criteria for appraising research findings; educational implications.

8332. RECENT RESEARCH IN READING. (3 cr; prereq #; offered alt yrs) Taylor
Critical analysis of methodology and findings of current research; appraising research methods, population limitations, and educational implications.

8333. SEMINAR: READING RESEARCH AND INSTRUCTION. (1-3 cr [max 9]; prereq #; offered alt yrs) Manning
Problems of research at all levels; topics vary according to offering; presentation of proposed designs and current studies.

8346. RESEARCH FOUNDATIONS OF ELEMENTARY SCHOOL SCIENCE TEACHING. (3 cr; prereq 5346 or #)
Research findings and their implications for the improvement of instruction in science in elementary schools.

8347. THE ELEMENTARY SCHOOL SCIENCE PROGRAM: ARTICULATION AND COORDINATION. (3 cr; prereq 5350 or 8346)
Relation to K-12 science programs and to other aspects of the elementary school curriculum.

8361. CURRICULUM CONSTRUCTION IN ELEMENTARY SOCIAL STUDIES. (3 cr; prereq 3361 or 5361 or #)
Detailed analysis of curriculum building; goals, selection of content, grade-level placement, development of teaching procedures, and evaluation.

8362. RESEARCH IN ELEMENTARY SOCIAL STUDIES. (3 cr; prereq 5361 or #)
Critical review of research findings and relevant theoretical formulations of major studies; criteria for appraising research methods, educational implications.

8363. SEMINAR: ELEMENTARY SOCIAL STUDIES EDUCATION. (3 cr; prereq 3361 or 5361 and 8362 or #) Avery, Cogan
Development of proposals and design models for empirical research; problems of social studies instruction for grade levels K-6.

8916. PROBLEMS: TEACHING ENGLISH. (Cr ar; prereq #) Dykstra, Monson
For those qualified to undertake individual research.

8931. PROBLEMS: TEACHING READING. (Cr ar; prereq 5331 or SeEd 5344 and #) Manning, Schreiner, Taylor
Recent issues, studies, and findings; for those with previous training in reading who have a special problem or who wish to survey the most recent literature.

8961. PROBLEMS: TEACHING SOCIAL STUDIES. (Cr ar; prereq 5361 or SeEd 5155 or SeEd 8104 and #) Avery, Cogan
Individual research.

8976. PROBLEMS: TEACHING KINDERGARTEN. (3 cr; prereq #) Hansen
Opportunity for in-depth study or research related to self-selected interest areas in kindergarten education.

8991. PROBLEMS: IMPROVEMENT OF INSTRUCTION. (Cr ar; prereq #)
For students qualified to make intensive studies of problems related to school supervision.

8992. RESEARCH IN EDUCATIONAL DIAGNOSIS. (3 cr)
Recent research in methods of diagnosis in education and techniques of preventive and remedial teaching.

Mathematics Education (MthE)

5081. TEACHING SECONDARY SCHOOL ARITHMETIC. (2 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. (2 cr; 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. (2 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]; not open to majors in mathematics education; prereq #)
Modern trends, methods, and materials used to convey mathematical ideas.

5102. WORKSHOP: MATHEMATICS EDUCATION. (1-12 cr [max 12])
Issues, materials, and instructional techniques focusing on a single current topic of particular relevance to secondary school and college mathematics teachers.

5301. INSTRUCTIONAL LEADERSHIP IN ELEMENTARY SCHOOL MATHEMATICS. (3 cr; not open to majors in mathematics education; prereq #; offered when feasible)
Current trends in methods, materials, content, and evaluation; program development and research; intended for supervisors and principals.

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)
Mathematics objectives, concepts and principles, skills and processes; instructional alternatives including calculators and microcomputers; applications of mathematics to individual differences; evaluation techniques to improve instruction and learning in middle school.

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; laboratory 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, laboratory 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)
Curriculum and methods of instruction for academically talented children; development of enrichment units; source material for teachers.

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. COMPUTER-ASSISTED MATHEMATICS INSTRUCTION. (3 cr; prereq 5312 or SeEd 3365, SeEd 3366 or CISy 5006, 1 yr calculus or #)
Computer as instructional resource; programming and problem solving using computer as means of teaching and learning concepts, principles, and skills; design of lessons; evaluation of software.

5680. PRACTICUM IN MATHEMATICS EDUCATION. (3-9 cr [max 9]; prereq #)
Supervised experience in teaching or related work in school.

5980. DIRECTED STUDIES IN MATHEMATICS EDUCATION. (3-9 cr [max 9]; 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)
Current issues, problems, and findings in curriculum; gradation of subject matter, methods and materials of instruction; criteria for evaluating research.

8590. SEMINAR: MATHEMATICS EDUCATION. (Cr ar [max 8]; 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.

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
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 #) Schultz
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
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.

5601. TECHNIQUES AND MATERIALS: INTERMEDIATE AND ADVANCED RECORDER. (3 cr, §5323; prereq intermediate-level competence, two-octave range or #)
Lecture-demonstrations and assignments in breath and articulation technique; ornamentation, improvisation, solo and ensemble editing, arranging, and playing.

5603. TECHNIQUES AND MATERIALS: ORFF-SCHULWERK APPROACH. (3 cr)
Demonstration and class practice in teaching and performance skills; the recorder; movement, improvisation, singing, and creation of musical forms; techniques to encourage children to create and improvise songs, instrumental music, and related bodily movement; class exercises in adapting indigenous and ethnic music material for school use.

5611. TECHNIQUES AND MATERIALS: MUSIC AND RELATED ARTS. (3 cr; prereq #)
Teaching music to reflect the major developments of Western culture.

5613. TEACHING MUSIC LITERATURE. (3 cr; prereq #; offered alt yrs) Borg
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.

5618. TEACHING JAZZ IMPROVISATION. (3 cr; prereq music major or music educ major or #)
Principles, methods, materials, and evaluation of teaching jazz improvisation in public school and private settings.

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.

5631. TECHNIQUES AND MATERIALS: CHORAL CONDUCTING. (3 cr; prereq #)
Student conducting with class as performing ensemble; criteria for selecting choral and combined choral and instrumental materials; rehearsal techniques.

5633. TECHNIQUES AND MATERIALS: CHORAL ENSEMBLES. (3 cr; prereq #)
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
Practical performance with lectures on and discussion of research in performance techniques.

5645. TECHNIQUES AND MATERIALS: BRASS. (3 cr; prereq #; offered when feasible) Schultz
Practical performance with lectures on and discussion of research in performance techniques.

5647. TECHNIQUES AND MATERIALS: PERCUSSION. (3 cr; prereq #; offered alt yrs) Schultz
Contemporary approaches to teaching in elementary, junior high, and senior high school; emphasis on performing techniques; playing of teaching materials, solo and ensemble repertoire.

5651. TECHNIQUES AND MATERIALS: INSTRUMENTAL ENSEMBLES. (3 cr; offered alt yrs) Schultz
Survey of solo, chamber, and larger wind ensemble music and use in teaching instrumental music at precollegiate level.

5653. BAND ARRANGING. (3 cr, §Mus 5564; prereq #; offered alt yrs) Schultz
Current scoring techniques for wind and percussion music; creative arrangements and scoring for marching or concert band music.

5655. NEW DIMENSIONS IN MUSIC EDUCATION. (3 cr; offered when feasible) Schultz
Study of contemporary instrumental music through analysis, performance, listening, composition; evaluative procedures; curriculum structure and design; scheduling.

5657. TECHNIQUES AND MATERIALS: INSTRUMENTAL CONDUCTING. (3 cr; offered alt yrs) Schultz
Basic conducting and rehearsal techniques for school bands and orchestras; selection of instrumental materials; organization of school ensembles, elementary and secondary.

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 data base for music libraries, instrument inventories, budgets.

5669. CONDUCTING THE MUSICAL SHOW. (3 cr; offered alt yrs) Schultz
Rehearsal techniques, coordination of singing actors and instrumental accompaniment, conducting of pit orchestra; laboratory performance and listening activities focused on traditions and trends in musical theater.

5750. WORKSHOP: MUSIC EDUCATION. (1-12 cr [max 12])
Selected topics in music education. Each offering will focus on a single topic.

5821. HISTORY OF MUSIC THERAPY. (3 cr; offered alt yrs) Furman
Historical development of the profession; outstanding persons and their contributions; incorporation of technique in increasing number of treatment populations.

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 educ or grad student)
Independent study project organized by the student in consultation with the appropriate instructor.

8281-8282-8283†. SEMINAR: HISTORICAL, PHILOSOPHICAL, AND PSYCHOLOGICAL ISSUES. (2 cr per qtr; prereq MA in music or music education or #) Furman, Schultz
Analysis and synthesis of issues in music education and curriculum development in the field.

8990. RESEARCH PROBLEMS. (1-12 cr; prereq knowledge of elementary statistics)
Individual projects.

Secondary Education (SeEd)

5122. TEACHING CULTURE: THEORY AND APPLICATION. (4 cr; prereq postbaccalaureate or grad student) Walker
Analysis of concept; related factors and materials for classroom use; culture shock; empathy; culture conflict, awareness, learning.

5132. TECHNIQUES OF INSTRUCTION. (3 cr; offered when feasible) Mackey
Cross-departmental course that develops individual competencies; application of current psychological research to classroom instruction, defining objectives in terms of achievable student competencies.

5145. CLASSROOM MANAGEMENT. (3 cr, §Elem 5145; prereq secondary tchg or admin exper or #)
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.

5150. ADVANCED METHODS OF TEACHING THE SOCIAL STUDIES. (3 cr) Glenn
Advanced methods for social studies teachers; prerequisite to other graduate-level courses in social studies education.

5151. SCHOOL-BASED PROJECTS IN SOCIAL STUDIES EDUCATION. (1-12 cr [max 12]) Avery, Dalgaard, Glenn, Mackey
Provides opportunity to work individually or in teams on curricular, instructional, or evaluation problems within the school.

5152. TECHNIQUES OF INSTRUCTION IN SOCIAL STUDIES. (3 cr) Mackey
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.

5153. NEW PERSPECTIVES IN THE SOCIAL STUDIES. (1-3 cr [max 12]) Glenn, Mackey
Issues, materials, and instructional techniques related to current topics of particular relevance to social studies teachers.

5155. MATERIALS LABORATORY FOR SOCIAL STUDIES TEACHERS. (3 cr; prereq 5150, 5152; offered when feasible) Glenn, Mackey
Locating, developing, and using audio-visual materials, learning programs, and simulations for use in social studies classes.

5156. PRACTICUM IN SOCIAL STUDIES INSTRUCTIONAL TECHNIQUES. (1 cr; prereq 5150, 5152; offered when feasible) Glenn, Mackey
Includes production of videotape episodes to demonstrate competency in use of materials and techniques of instruction; required of all M.A., M.Ed., and Ph.D. candidates.

5164. GLOBAL EDUCATION: CONTENT AND PROCESS. (3 cr, §Elem 5164) 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.

5167. ECONOMIC EDUCATION PROGRAMS. (1-3 cr; prereq Econ 1002 or equiv or #)
Conceptual framework of economic education through analyzing its research, objectives, philosophy, scope, and curricular sequence.

5175. SECONDARY REMEDIAL READING INSTRUCTION. (3 cr; prereq 5344 or Elem 5331 or #) Graves
Principles and techniques for developing and conducting programs for secondary students seriously deficient in reading skills.

5176. CLASSROOM RESEARCH IN ENGLISH EDUCATION AND READING. (3 cr; offered alt yrs) Graves
Review and analysis of current studies; design and analyses for school-based research.

5177. DIRECTING SECONDARY SCHOOL SPEECH ACTIVITIES. (3 cr; offered when feasible)
Philosophy, organization, and administration of extemporaneous speaking, oratory, interpretive reading, and debate.

5184. COMPUTER COURSEWARE EXAMINATION, DEVELOPMENT, AND OTHER MATERIALS EVALUATION IN SECOND LANGUAGES. (4 cr; prereq 3334)
Review of use of computer in second language learning; evaluation of tools of access on proficiency concepts-grammars, readers; development and use of evaluation criteria and authoring systems to develop sample courseware.

5186. ALTERNATIVES IN SECOND LANGUAGE EDUCATION. (3 cr)
Overview of 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.

5189. PLANNING AND ASSESSING SECOND LANGUAGE CURRICULUM. (4 cr)
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.

5191. WORKSHOP: TEACHING OF SECOND LANGUAGES AND CULTURES. (1-10 cr [max 10])
Related specifically to the needs of the in-service teacher; topics, location, and duration will be highly flexible.

5194. PERSPECTIVES ON ENGLISH STUDIES IN SCHOOLS. (3 cr)
Nature, development, future direction; evaluation of the "given-ness" of English studies in the context of widespread ambiguities of tradition, class, culture.

5196. SECOND LANGUAGE PROFICIENCY: IMPLICATIONS FOR CURRICULUM, INSTRUCTION, EVALUATION. (6 cr; prereq in-service teacher or grad student)
Training in oral interview procedure; implications of procedure for development of curriculum, instructional practices, materials, and evaluation of listening, reading, speaking, writing.

5216. FOUNDATIONS OF BILINGUAL EDUCATION. (4 cr)
Development of bilingual schooling in the U.S.: 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.

5217. PROGRAMS AND CURRICULA IN BILINGUAL EDUCATION. (4 cr; prereq 5216 or #)
Current curricular strategies utilized to instruct language minority students in the U.S. 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.

5218. ASSESSMENT OF LEARNERS WITH LIMITED ENGLISH PROFICIENCY. (4 cr)
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.

5219. TEACHING READING TO SECOND LANGUAGE LEARNERS. (4 cr)
Reading process in a second language; relationship between first and second languages, implications for reading; developing comprehension; building skills; assessing second language reading; materials and resources for different languages and levels.

5220. PARENT INVOLVEMENT IN BILINGUAL EDUCATION. (2 cr)
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.

5227. TEACHING ABOUT THE NEWSPAPER IN THE CLASSROOM. (1-3 cr [max 4 cr], §Elem 5227) Mackey
Institution of the newspaper; articulation of series of useful instructional strategies, curriculum development techniques, and teaching materials.

5320. LITERATURE FOR ADOLESCENTS. (3 cr) 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.

5321. TEACHING LITERATURE IN SECONDARY SCHOOLS. (3 cr) Beach
Current theory and methods of instruction; research and response to literature and reading; adolescent literature; growth assessment; curriculum design and evaluation.

5322. TEACHING WRITING. (3 cr) Beach, Piché
Historical and contemporary context; analysis of composing processes; prewriting and revision; audience analysis; comprehension and coherence; selected problems in assigning and evaluating writing.

5323. PRACTICUM IN DIAGNOSING, ASSESSING, AND TEACHING WRITING IN SECONDARY SCHOOLS. (3 cr; prereq 5322 or ¶5322, educ jr or sr, or grad) 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.

5324. CURRICULUM PROBLEMS AND ISSUES IN TEACHING THEATRE ARTS IN SECONDARY SCHOOLS. (3 cr; offered when feasible)
Philosophy, methods, materials of teaching drama in the curriculum and as an extracurricular activity in secondary schools; theatrical improvisation, including theatre games, sound and motion, characterization, plot structure, and experience with the informal use of scripted plays.

5325. IMPROVISATIONAL DRAMA TECHNIQUES IN THE CLASSROOM. (3-6 cr [max 6]; offered when feasible)
Experiences in improvisation, including training in beginning theatre games, sound and motion, characterization and plot structure; development of improvisational activities based on themes and literature of subject interest and suited to the needs of students.

5326. TEACHING FILM AND TELEVISION. (3 cr; offered when feasible)
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.

5340. TEACHING SPEECH AND FORENSICS IN SECONDARY SCHOOL. (3 cr)
Methods of teaching speech and forensics in the high school classroom; attention to social framework of spoken communication; administration and instructional procedures in high school forensic programs.

5344. TEACHING READING IN CONTENT AREAS. (3 cr) Graves
Methods of accommodating to student abilities and facilitating reading in regular content classes.

5347. LINGUISTICS AND READING. (3 cr)
Nature of linguistic inquiry, investigation of the contributions made to reading and programs resulting from linguistic input; potential contributions of current linguistic research to reading instruction.

5349. WORKSHOP: SECONDARY READING INSTRUCTION. (1-12 cr [max 12]; prereq #)
Principles, instructional techniques, and materials for teaching reading in secondary schools. Each offering will focus on a single topic.

5350. CURRENT DEVELOPMENTS IN ENGLISH AND SPEECH EDUCATION. (1-6 cr [max 12]; offered when feasible)
New instructional approaches, new materials, current issues and problems in English and language arts education. Each offering will focus on a single topic or issue.

5351. DIRECTED STUDY. (Cr ar [max 6];S-N optional; prereq educ or grad student)
Individual or group work on curricular, instructional, or evaluation problems.

5371. CURRICULUM WORKSHOP. (1-3 cr per qtr; prereq 5113 or Elem 5100 or CISy 5600 or #)
Workshops pertaining to curriculum and instruction; topic to be identified for each offering.

5382. SECOND LANGUAGE TESTING, ASSESSMENT, AND EVALUATION. (3 cr)
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.

5385. PLANNING AND ASSESSING SECOND LANGUAGE INSTRUCTION. (4 cr)
Methods of teaching language as communication in oral and written modes; planning student interaction; classroom organization for learning and acquisition. Students plan and teach example lessons for analysis.

5390. CURRENT DEVELOPMENTS IN SECONDARY SCHOOL SCIENCE TEACHING. (3 cr; prereq 3356, 3357 or equiv undergrad courses or exper in tchg science) Gennaro
Curricula, methods, materials of instruction, evaluation.

5394. WORKSHOP: SCIENCE EDUCATION. (1-12 cr [max 12])
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.

5404. LANGUAGE, CULTURE, AND EDUCATION. (4 cr, §Spch 5404) Piché
Psychological and social-psychological perspectives for study of language-communication; dimensions of language variation (dialects, codes, registers); implications for program development and instructional practices.

5504. THEORETICAL AND RESEARCH BASES FOR THE TEACHING OF WRITING. (4 cr; prereq postbaccalaureate or MEd or grad student; offered when feasible) Piché
Emerging multidisciplinary perspectives on writing and teaching of writing with particular attention to text-grammatical and cognitive science contributions.

5604. PERSPECTIVES ON LITERACY. (3 cr; prereq jr or sr or grad) Piché
Sociocultural and sociolinguistic perspectives emphasizing problematic status of traditional concepts of literacy and education for literacy.

5615. PRACTICUM IN SECONDARY READING: TUTORING REMEDIAL STUDENTS. (3 cr [max 9]; prereq #)
Supervised experience in diagnosing; planned individual instruction and teaching secondary students with reading difficulties.

8104. CURRICULUM DEVELOPMENT IN THE SOCIAL STUDIES. (3 cr; prereq 5150, 5152)
Analysis of curriculum building process in the social studies.

8187. SECOND LANGUAGE TEACHING IN THE CLASSROOM: THEORY AND APPLICATION. (4 cr)
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.

8188. INFORMATION SOURCES AND RESEARCH IN SECOND LANGUAGE LEARNING AND TEACHING. (5 cr)
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.

8362. RESEARCH IN SOCIAL STUDIES. (3 cr, §Elem 8362; prereq 5152, 8104; offered when feasible) Avery, Glenn, Mackey
Critical review of research findings and relevant theoretical formulations of major studies; criteria for appraising research methods; educational implications.

8364. SEMINAR: SOCIAL STUDIES EDUCATION. (3 cr; prereq MA or equiv; offered when feasible) Avery, Cogan, Dalgaard, Glenn, Mackey
Current issues and readings in literature of the social studies.

8387. RESEARCH SEMINAR: SECOND LANGUAGES AND CULTURES EDUCATION. (3 cr per qtr for 3 qtrs [max 9]; prereq 8188)
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.

8673. INTERNSHIP: COLLEGE TEACHING IN SOCIAL STUDIES EDUCATION. (1-3 cr, §5673; prereq 5150, 5152, 5155, 5156, 8104, 8801 and/or #; offered when feasible) Avery, Cogan, Dalgaard, Glenn, Mackey
Individual and group experience in planning, teaching, and evaluating a college course in social studies education.

8801. PROBLEMS: TEACHING SOCIAL STUDIES. (3-9 cr; prereq 5150, 5152, 5156, 8104 or #) Avery, Dalgaard, Glenn, Mackey
Individual research.

8871. PROBLEMS: CURRICULUM CONSTRUCTION. (Cr ar; prereq #; offered when feasible)
Individual research.

8887. RESEARCH FOUNDATIONS OF SECONDARY SCHOOL SCIENCE TEACHING. (3 cr) Finley
Implications for the improvement of instruction in junior and senior high schools.

8892. INTRODUCTION TO RESEARCH IN ENGLISH EDUCATION AND READING. (4 cr; offered alt yrs) Graves
Review and analysis of representative current research related to the teaching of English and speech.

8893. SEMINAR: ADVANCED TOPICS IN ENGLISH-LANGUAGE ARTS EDUCATION. (1-9 cr [max 9]; prereq #)
Selected special topics with implications for curriculum development and change.

8894. PROBLEMS: SECOND LANGUAGES AND CULTURES EDUCATION. (Cr ar [max 8])
Individual research.

8895. READINGS IN ENGLISH EDUCATION. (1-3 cr)
Readings in secondary school English curriculum and instruction.

8896. PROBLEMS: TEACHING ENGLISH. (Cr ar)
For those qualified to undertake individual research.

8897. RESEARCH IN ENGLISH AND SPEECH EDUCATION. (1-3 cr [max 6])
Analysis and evaluation of research.

8898. READINGS IN SECOND LANGUAGES AND CULTURES EDUCATION. (1-3 cr)
Readings in development, research, curriculum, instruction, evaluation, culture, teacher education as needed by student.

8899. SEMINAR: RESEARCH IN SCIENCE EDUCATION. (3 cr [max 9]; prereq MA or PhD candidate, #) Finley, Lawrenz
Problems of science instruction, kindergarten through college; opportunity to discuss needed research, develop proposals, and design models for empirical research.

Dentistry

Regents' Professor: Robert J. Gorlin

Professor: Richard P. Elzay, *dean;* Mellor R. Holland, *associate dean;* James R. Jensen, *associate dean;* William F. Liljemark, *director of graduate studies;* Dwight L. Anderson; M. Bashar Bakdash; Carl L. Bandt; David O. Born; Jaroslav Cervenka; William H. Douglas; P. Jean Frazier; Richard J. Goodkind; Myer S. Leonard; James W. Little; Michael J. Loupe; Leslie V. Martens; Harold H. Messer; Louise B. Messer; Maurice W. Meyer; Karlind T. Moller; Andrew T. Morstad; Bruce L. Pihlstrom; Charles F. Schachtele; Erwin M. Schaffer; John K. Schulte; Heddie O. Sedano; Burton L. Shapiro; Quenton T. Smith; T. Michael Speidel; Michael J. Till; Robert A. Vickers; Carl J. Witkop

Clinical Professor: Richard R. Bevis; Frank W. Worms

Associate Professor: James L. Baker; Muriel J. Bebeau; Anthony J. DiAngelis; Mahmoud E. ElDeeb; Mohamed E. N. ElDeeb; Robert J. Feigal; James R. Fricton; Mark C. Herzberg; James E. Hinrichs; Mark T. Jaspers; Ramesh K. Kuba; Thomas D. Larson; Paul O. Walker; Larry F. Wolff

Clinical Associate Professor: Gerald D. Cavanaugh
Assistant Professor: Ralph DeLong; Kathleen J. Newell; Chester J. Schultz, Jr.; Omar A. Zidan
Clinical Assistant Professor: Daniel E. Gatto

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—The course of study combines the basic work for the master's degree plus specialized training in some phase of clinical dentistry. A minimum of two academic years in residence is required. Graduate courses in dentistry are offered in the fields of endodontics, oral pathology, oral radiology, oral and maxillofacial surgery, orthodontics, pediatric dentistry, periodontics, prosthodontics, and restorative dentistry. A nondegree postgraduate program with a major emphasis in cariology is also available, which combines work in a basic science laboratory with applied clinical problems.

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.

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 German is required for students 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—Contact the School of Dentistry, 15-238 Moos Health Sciences Tower, University of Minnesota, 515 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Dentistry (Dent)

5945. GERIATRIC HOSPITAL DENTISTRY. (Cr ar) Bird
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.

5946. GERIATRIC HOSPITAL DENTISTRY. (Cr ar) Bird
Care of elderly, medically compromised patient; diagnosis and treatment under direct faculty supervision of difficult patients, including those with organ transplants and immunocompromised conditions at University Hospital Dental Clinic. Discussion and experience in general anethesia cases, operating room techniques, and pharmaceutical adjuncts for dental procedures.

5950, 5951, 5952, 5953. ADVANCED GENERAL DENTISTRY SEMINAR I, II, III, IV. (Cr ar) Gambucci
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.

5955, 5956, 5957, 5958. ADVANCED GENERAL DENTISTRY CLINICAL ADMINISTRATION I, II, III, IV. (Cr ar) Gambucci
Field experience in community dental clinic practice and administration.

5960, 5961, 5962, 5963, 5964, 5965, 5966, 5967. ADVANCED GENERAL DENTISTRY CLINIC I, II, III, IV, V, VI, VII, VIII. (Cr ar) Gambucci
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)
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 #) Bird
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 #) Bird
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 #) Bird
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.

5995. ADVANCED CLINICAL RESTORATIVE DENTISTRY. (Cr ar)
Application of advanced technical and clinical procedures with emphasis on the more complex problems in operative dentistry; diagnosis and treatment planning, management of patients, and dental auxiliary utilization.

5997. OPERATIVE DENTISTRY: PHILOSOPHY, PRINCIPLES, RATIONALE, AND TECHNIQUES. (Cr ar)
Lectures, readings, and laboratory work on application of principles for single tooth restoration.

8126. TEACHING AND EVALUATION IN DENTISTRY I. (3 cr; prereq #) Loupe
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) Loupe
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 #) Loupe
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.

8140. TOPICS IN RESTORATIVE DENTISTRY. (Cr ar)
Literature review and discussion of past and current philosophies and research.

8150. RESEARCH IN RESTORATIVE DENTISTRY. (Cr ar)
Organized literature review in area of specific interest to student, selection of thesis project, and completion of research and thesis.

8400. CRANIOMANDIBULAR DISORDERS: SELECTED TOPICS. (1 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 #) Fricton, 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 #) Fricton, 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 #) Fricton, 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 #) Fricton, 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) ME ElDeeb
Students present cases for review by endodontic faculty and other graduate students.

8001f, 8002w, 8003s, 8004su, 8005f, 8006w. RESEARCH IN ENDODONTICS. (Cr ar) Messer
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) Messer
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.

8333s. TOPICS IN ENDODONTICS. (Cr ar) M E ElDeeb
Special topics for advanced students.

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, staff
A clinical rotation involving experience in outpatient management and utilizing intravenous sedation and general anesthesia.

5270. ORAL AND MAXILLOFACIAL RADIOLOGY REVIEW. (1 cr)
Weekly review and discussion of radiographs taken at University Hospitals relating to oral surgery procedures.

5275. ORAL PATHOLOGY REVIEW. (1 cr) Jaspers
Evaluation and microscopic interpretation of diagnostic tissue from oral and perioral areas. Other diagnostic information such as clinical appearance, history, and radiographic films utilized. Individual participation in seminar format.

5276. MEDICINE FOR THE ORAL SURGEON. (2 cr; prereq participation in oral surgery residency program) Jaspers
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) Jaspers
Six-week didactic course coupled with evaluation of patients at University Hospital under direction of Department of Medicine and its faculty.

8250. ADVANCED ORAL SURGERY. (Cr ar) Jaspers
Assigned clinics in University Hospitals and Veterans Administration Medical Center, Hennepin County Medical Center, and School of Dentistry.

8251. SEMINAR: ORAL SURGERY. (1 cr)
Oral surgical subjects.

8252. RESEARCH IN ORAL SURGERY. (Cr ar)
Research in fields related to oral surgery.

8253. PROBLEMS IN ORAL SURGERY. (Cr ar) Jaspers
Current literature review; experience in surgical techniques.

8254. TOPICS. (1 cr) Jaspers
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.

8258. ANESTHESIA II SEMINAR. (1 cr) Gatto, staff
Outpatient general anesthesia topics and related subjects covered on seminar basis.

8280. ORAL AND MAXILLOFACIAL SURGERY CLINICAL PATHOLOGY CONFERENCE. (1 cr) Jaspers
Evaluation and discussion of clinical, radiographic, and microscopic aspects of oral and perioral diseases and neoplasms. Individual participation in seminar format.

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) Cervenka, Gorlin, Sedano, Vickers, Witkop

8002, 8003. ORAL PATHOLOGY. (Cr ar; prereq 5251, 5252 or equiv) Sedano
Lectures, laboratory, and clinical demonstrations. Histology of teeth and related oral tissues, including embryologic considerations. Special pathology of the oral regions as well as relation of local pathologic findings to systemic conditions and to general pathology. Experience in educational methods; lecture, seminar, laboratory preparation, development of programmed learning materials, and evaluation of examinations.

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.

8005. ADVANCED ORAL PATHOLOGY. (3 cr; offered semiannually) Vickers
The nature of diseases encountered in head and neck regions including laboratory sessions on histopathologic interpretations. Pathology of salivary glands, odontogenesis (with odontogenic tumors), diseases of facial bones, soft tissue diseases, lymph nodes, mucosal disorder, and other topics.

8006. CURRENT LITERATURE REVIEW. (1 cr) 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)
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.

8010. CURRENT LITERATURE REVIEW. (1 cr) See 8006.

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 utilized.

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.

8014. EXFOLIATIVE CYTOLOGY OF THE ORAL MUCOSA. (2 cr) Witkop
Comparative histology of skin and normal mucosa; cytology maturation of oral mucosa compared to vaginal mucosa; sex differences in mucosa, techniques, stains and smears, menstrual cycle; benign lesions of oral mucosa, toothbrushing effects; introduction to grading system for malignant lesions; X-ray and drug effects on oral mucosa; oral squamous cell carcinoma; in situ and basal cell carcinoma.

8015. METHODS OF GENETIC COUNSELING AND TREATMENT. (1 cr) Cervenka
Preventive genetics, counseling in mental retardation, counseling in chromosomal aberrations, counseling in congenital malformations, consanguineous marriage and incest, genetic considerations in human malignancy, counseling and genetic treatment of inborn errors of metabolism, ethical and social aspects of eugenics and genetic counseling, prenatal diagnosis.

8016f,w,s,su. HISTOPATHOLOGY. (2 cr) Sedano
Designed exclusively for graduate students and residents not specializing in oral pathology but wishing additional information concerning causes, diagnosis, or cellular basis of oral diseases. Histologic aspects of various oral and paraoral diseases demonstrated and clinical and radiologic information utilized.

8300f. HUMAN DEVELOPMENT GENETICS I. (2 cr; prereq GCB 3022, BioC 5970, Path 5101 or #) Witkop
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.

8301w. HUMAN DEVELOPMENT GENETICS II. (2 cr; prereq 8300) Witkop
Continuation of 8300.

8302s. SEMINAR: HUMAN DEVELOPMENTAL GENETICS. (Cr ar) Witkop
Topics by guest speakers on gene action from conception through neonatal period.

Oral Radiology (ORad)

8100. ORAL RADIOLOGY SEMINAR. (1 cr; prereq #) Kuba

8200. ADVANCED ORAL ROENTGENOGRAPHIC TECHNIQUE. (2 cr; prereq #) Kuba
Theory and principles involved in intraoral and dentally significant extraoral roentgenographic techniques, including temporomandibular joint roentgenography, sialography, panoramic roentgenography, laminography, cineroentgenography, and cephalometric roentgenography, according to needs and interests of students.

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.

8400. ADVANCED STUDIES IN THEORY AND PRINCIPLES OF ORAL RADIOLOGY. (3 cr; prereq #) Kuba
Theory and principles involved in atomic structure, atomic radiations, X-ray production and control, roentgenographic films, mathematics of exposure, and chemistry of processing.

8500. FUNDAMENTALS OF RADIATION BIOLOGY. (3 cr; prereq 8400) Kuba
Effects of ionizing radiations on biological systems. Theories on the mechanisms of action and effects at the molecular, cellular, organ, and total body levels considered and related to radiation biological problems in dentistry.

8600. RADIOLOGICAL HEALTH, HYGIENE, AND PROTECTION. (1-3 cr; prereq 8400) Kuba
Theoretical, practical, philosophical, and legal aspects of patient, operator, and general population exposure to and protection from diagnostic, therapeutic, industrial, experimental, and environmental ionizing radiations. Emphasis on significance and role of radiology in dentistry.

8700. RADIOLOGY LITERATURE EVALUATION. (1 or 2 cr; prereq 8400) Kuba
Principles of sound research and scientific writing; detailed evaluation of scientific literature in general emphasizing radiology literature relevant to dentistry. Critical consideration of papers in the dental literature dealing with radiology subjects.

8800. TEACHING ORAL RADIOLOGY. (4 cr; prereq 8400) Kuba
Challenge and problems of teaching oral radiology to dental auxiliaries, dental students, and graduate and postgraduate students. Development and evaluation of oral radiology curricula, development of course objectives, teaching methods, and testing and evaluation. University of Minnesota oral radiology program and traditional undergraduate programs analyzed.

8900. ORAL RADIOLOGY RESEARCH. (Cr ar; prereq #) Kuba

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 supervison.

8001. RESEARCH IN ORTHODONTICS. (Cr ar) Speidel, 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.

8216f, 8217w, 8218s, 8219su. TOPICS IN ORTHODONTICS. (Cr ar) Speidel, staff

Pediatric Dentistry (Pedo)

5414. ADVANCED CLINICAL PEDODONTICS. (Cr ar; prereq #) Staff
Assignment of patients for treatment of difficult or unusual pedodontic problems under direct faculty supervision.

8001. RESEARCH IN PEDIATRIC DENTISTRY. (Cr ar; prereq #) Staff

8290. HOSPITAL PEDODONTICS I. (Cr ar; prereq #) Staff
Diagnosis and treatment, under direct faculty supervision, of difficult and unusual problems in children with various handicaps at the Children's Rehabilitation Center. Includes preoperative and postoperative discussion of general anesthetic cases and seminar discussion of operating room techniques and procedures, pharmaceutical adjuncts for dental procedures.

8291. HOSPITAL PEDODONTICS II. (Cr ar; prereq #) Staff
Diagnosis and treatment of pedodontic problems under direct faculty supervision at Hennepin County Medical Center. Includes participation on a rotation basis in seminars in pediatrics and anesthesia conducted by staff faculty. Preoperative and postoperative seminar discussion and evaluation of treatment plans.

8292. PEDODONTIC LITERATURE. (Cr ar; prereq #) Staff
In-depth literature review and seminar discussion of specific pedodontic topics.

8293. ADVANCED PEDODONTIC TECHNIQUES. (Cr ar; prereq #) Staff
Description of and exercises in advanced pedodontic skills and techniques.

8294. PEDODONTIC DIAGNOSIS AND TREATMENT PLANNING. (Cr ar; prereq #) Staff
Systematic approach to diagnosis of and treatment planning for various pedodontic problems.

8295. INDEPENDENT PEDODONTIC STUDY. (Cr ar; prereq #) Staff
Preparation of a position paper on assigned topic, including review of pertinent literature.

8298. INTERDISCIPLINARY CARE OF THE CLEFT PALATE PATIENT. (1 cr; prereq #)
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 and staff
Opportunity to take part in various phases of periodontal research being conducted in laboratories 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-prosthodontic problems for all graduate dental students.

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)

8001. RESEARCH IN PROSTHODONTICS. (Cr ar [may be repeated for cr]) Goodkind
Arranged with individual students upon application after a critical review of current and historical literature pertaining to the research problem.

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 stressed.

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.

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.

8017. SEMINAR: ADVANCED PROSTHODONTICS. (Cr ar [may be repeated for cr]; prereq #) Goodkind
Treatment planning for the partially 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 stressed.

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 laboratory procedures.

Dermatology (Derm)

Professor: Mark V. Dahl

Associate Professor: William C. Gentry, Jr., *director of graduate studies*

Assistant Professor: Richard S. Kalish; J. Corwin Vance

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

Degree Offered—M.S.Derm (Plan A only).

Curriculum—The course of study includes attendance at the wards and clinics of the University Hospital, Hennepin County Medical Center, the Veterans Administration Medical Center, and St. Paul-Ramsey Medical Center. Students devote full time to graduate study and may not carry on outside medical practice. They are required to conduct independent research under the direction of the dermatology staff and the faculty of the basic science department or division in which they wish to take minor credits. A limited number of students are appointed as fellows in dermatology. Within the department, research may be carried on in the areas of dermatopathology, immunopathology of the skin, cell biology, microbiology, and electron microscopy of the skin.

Prerequisites for Admission—Applicants must hold the M.D. degree from an approved medical school. They may enter the program either on completion of medical school or after a year or more of residency training elsewhere.

Special Application Requirements—Applicants are required to present medical school transcripts and letters of recommendation from physicians familiar with their professional and personal qualifications. Applications may be submitted at any time, but appointments are made through a National Resident Matching Program. Interested persons should contact the department office for application forms.

Master's Degree Requirements—Candidates are required to complete the full course of training required for certification by the American Board of Dermatology. In addition, they are expected to conduct independent research leading to preparation of a thesis. An oral examination is required.

Language Requirements—None, but students are encouraged to develop at least a reading knowledge of German, French, or Spanish.

For Further Information—Contact the Department of Dermatology, Box 98 UMHC, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address).

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

8225f,w,s,su. CLINICAL DERMATOLOGY. (Cr ar) Dahl, Gentry, 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, Gentry, 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.

8228f,w,s,su. RESEARCH: DERMATOLOGY AND RELATED BASIC SCIENCES. (Cr ar) Dahl, Hordinsky, Kalish, Lynch, staff

8229f,w,s,su. ELECTRON MICROSCOPY IN DERMATOLOGY. (Cr ar) Zelickson, staff

8230f,w,s,su. FUNCTIONAL BIOLOGY OF THE SKIN. (Cr ar) Dahl, Lynch, staff

Design, Housing, and Apparel

Professor: Marilyn R. DeLong, *director of graduate studies;* Marian-Ortolf Bagley; William J. Angell; Signe T. Betsinger; Joanne B. Eicher; Margaret P. Grindereng; Robert F. Johnson; Eugene D. Larkin; Bonnie M. Morrison; Marion J. Nelson

Associate Professor: Richard A. Abell; Harold H. Alexander; Homa Amir-Fazli; Timothy T. Blade; Donald L. Breneman; Margaret K. DiBlasio; Ann M. Erickson; Evelyn M. Franklin; M. Virginia Nagle; Wanda W. Olson; Gloria M. Williams

Assistant Professor: Marla C. Berns; Charlene A. Burningham; Louis B. Casagrande II; Delores A. Ginthner; Wanda A. Sieben; Becky L. Yust

Senior Fellow: Mary E. Roach-Higgins

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 apparel, design, and housing. Concentrations include clothing aesthetics; sociocultural aspects of apparel; costume history; textile analysis; textile museology; applied design; color and design; history of decorative arts; history of design; interior design; visual communication; housing for special populations; cross-cultural housing; housing management and marketing; environmental design, energy, and community development. For family social science, see Family Social Science; for food science, see Food Science; for nutrition, see Nutrition; for home economics education, see Vocational and Technical Education.

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, biological science, and education 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.

Degree Requirements—Consult the director of graduate studies. An oral final 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—Contact the director of graduate studies, Design, Housing, and Apparel, 240 McNeal Hall, University of Minnesota, 1985 Buford Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Apparel (TexC)

5600. ADVANCED APPAREL DESIGN AND CONSTRUCTION PROBLEMS. (2-4 cr per qtr [max 12 cr]; prereq 3621 and #)
Analytical study and construction of advanced apparel design utilizing draping and flat pattern techniques. Relating latest technological developments in textiles to garment design.

5603. EXPERIMENTAL STUDIES IN APPAREL. (3-5 cr; prereq 6 cr construction or tchg exper, #; offered when feasible)
Study of selected procedures in areas of apparel production and design.

5621. MACRO-MICRO PROPERTY RELATIONSHIPS. (5 cr; prereq 3622 or 3623)
Relating visual and tactile properties of textiles to microscopically and submicroscopically detectable physical and chemical characteristics.

5622. ISSUES AND TRENDS IN TEXTILE CONSUMER PROTECTION. (3 cr)
Needs of the textile consumer for protection from deception and hazard; critical analysis of federal, state, and local legislation as well as voluntary industrial systems; case histories; change mechanisms.

5623. THE DYEING MEDIUM AND COLOR. (3 cr; prereq 3621, Dsgn 1521 or #; offered when feasible)
Principles of dye selection for specific fibers; precision dyeing and exploring perceived color relationships, expanding the utility of this medium.

5624. TEXTILE COLORATION AND FINISHING. (5 cr; prereq 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.

5625. COLOR METROLOGY. (3 cr; prereq #)
Theory of color perception and measurement; analysis of color order systems; instrumentation; application to unambiguous numerical color specification and description of small color differences; noncolor components of surface appearance.

5626. RECYCLING PROCESSES. (3 cr; prereq 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.

5627. ANALYTICAL METHODS FOR CONSUMER TEXTILES. (3 cr, §3623; prereq 3621; offered when feasible)
Standard laboratory methods for rapid performance prediction of textile fabrics and products.

5628. CHARACTERIZATION OF YARNS AND WOVEN FABRICS. (3 cr; prereq 3621; offered when feasible)
Techniques of dimensional and structural characterization of yarns and woven fabrics; the relationship of these characteristics to performance of such fabrics in textile products.

5629. CHARACTERIZATION OF KNITTED FABRICS. (3 cr; prereq 5628 or #; offered when feasible)
Techniques of dimensional and structural characterization of knitted fabrics; the relationship of these characteristics to performance of such fabrics in textile products.

5630. PRINCIPLES OF TEXTILE METROLOGY. (3 cr; prereq #; offered when feasible)
Metrology as a dynamic and vital adjunct of the distribution and use of textile materials. Test evaluation, development, and use; interpretation of results; data reduction; case studies; investigative metrology.

5631. TEXTILES FOR INTERIOR ENVIRONMENTS. (3 cr; §3622; prereq 3621; offered when feasible)
Study of textiles for interiors with reference to fiber, yarn, construction, and finish.

5641. TOPICS IN MERCHANDISING. (3 cr per qtr [max 6 cr]; prereq 3643, 3644, △)
Study of a current issue related to merchandising of textile and clothing products. Topic may vary each quarter.

5660. TOPICS IN APPAREL AND ADORNMENT. (3-5 cr per qtr [max 10 cr]; prereq △)
Discussion and laboratory work in sociocultural and aesthetic aspect of clothing. Topics vary.

5661. CLOTHING AND HUMAN BEHAVIOR. (4 cr; prereq sr, Soc 1001, Psy 1001 or #)
Clothing in relation to individual and group behavior patterns; personal and social meaning attributed to dress; conventions and standards influencing clothing choice and use.

5662. CLOTHING CONSUMPTION PROBLEMS. (3 cr; prereq 3621, AgEc 1030 or Econ 1002, Soc 1001, Psy 1001 or #)
Clothing problems as part of the consumption process of individuals and families; consequences of personal and socioeconomic conditions; impact of technology and public and private policy on the planning, acquisition, use, maintenance, and discard of clothing.

5668. AFRICAN DRESS. (3 cr; prereq 3661, Anth 1102, Soc 1001 or #; offered when feasible)
Sociocultural analysis of dress (apparel, accessories, and body modification) of various African peoples with emphasis on cultural patterns of technology, aesthetics, ritual, morality, and symbolism as related to dress. External influences on Africa as well as African influence on other continents.

5680. SPECIAL TOPICS IN TEXTILES AND CLOTHING. (2-5 cr per qtr [max 10 cr]; prereq depends on topic, △)
Review of research and methodology in organized group sessions. Topics in developing areas of the discipline vary and are announced prior to registration.

5685. INTERNATIONAL DEVELOPMENTS IN TEXTILES AND CLOTHING. (4 cr; prereq #)
Comparison of production, distribution, and consumption in the United States and Europe. Effects of world trade on supply and distribution.

5686. EUROPEAN FIELD EXPERIENCE IN TEXTILES AND CLOTHING. (6-12 cr; prereq 5685 and #; offered when feasible)
One quarter abroad in comparative study of design, production, distribution, and consumption of textiles and clothing in European market centers. Includes lectures, field trips, individual study projects, and observation periods in selected textile and clothing industries, businesses, and related organizations.

8621. READINGS IN TEXTILES. (1-3 cr; prereq #)
Independent reading useful for individual programs but not available in other course offerings.

8622. STRUCTURE AND PROPERTIES OF TEXTILE MATERIALS. (5 cr; prereq 5621, 5629 or #)
Chemical and physical structure and properties of fibers; mechanical and physical properties of fabrics with emphasis on tensile, frictional, electrical, and optical behavior.

8623. MECHANICAL-PHYSICAL METROLOGY. (5 cr; prereq #)
Methodology and instrumentation for measurement of mechanical and physical properties of textile materials; development of perspective for standard methods, new methods development.

8624. CHEMICAL METROLOGY. (5 cr; prereq #)
Methodology and instrumentation for measurement of chemical properties of textile materials; development of perspective for standard methods; new methods development.

8625. PROBLEMS: TEXTILES AND CLOTHING. (3-9 cr per qtr [max 9 cr]; prereq #)
Independent study in physical behavioral aspects of textiles or clothing.

8627. THERMAL PROPERTIES OF TEXTILE MATERIALS. (3 cr; prereq #)
Comfort dependence on heat and moisture transport and transfer in the body-clothing-environment system; nonthermal components of comfort, particularly those related to surface and elastic properties of fabrics; thermal insulation of textile products in housing.

8661. READINGS IN CLOTHING. (1-3 cr; prereq minimum 12 cr in textiles and clothing courses, #)
Independent study; survey of literature in selected areas related to human behavioral aspects of clothing and textiles. Written reports.

8662. SOCIOCULTURAL LITERATURE OF DRESS. (3 cr; A-N only)
Orientation to classic readings; historic bases for key ideas.

8663. PROBLEMS: CLOTHING AND TEXTILES. (3-9 cr per qtr [max 9 cr]; prereq #)
Independent study in the human behavioral aspects of clothing or textiles.

8664. FASHION THEORY AND ANALYSIS. (3 cr; prereq 8662 or #)
Fashion theories and factors that influence adoption and diffusion of innovations. Methodologies used in analysis of the fashion process.

8666. AESTHETIC CONCEPTS RELATED TO APPAREL DESIGN. (3 cr; prereq 3662 or #)
Comprehensive survey and application of theory to the analysis of clothing design. Development of a methodology for visual perceptual evaluation.

8667. THEORETICAL ORIENTATIONS IN CLOTHING AND HUMAN BEHAVIOR. (4 cr; prereq 8662 or equiv)
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.

8668. METHODOLOGICAL ORIENTATIONS IN CLOTHING AND HUMAN BEHAVIOR. (4 cr; prereq 8667, HEEd 8300 and HEEd 8305 or equiv or #)
Alternative methodological perspectives interrelated with theoretical streams in clothing and human behavior; orientation to knowledge utilization and evaluation in practical settings.

8680. SEMINAR: TOPICS IN CLOTHING AND TEXTILES. (3 cr per qtr [max 6 cr]; prereq #)
Directed study on topics of current interest. Topic selected by instructor and announced prior to registration.

8681. INTEGRATIVE SEMINAR. (1 cr; S-N only; required for all students in residence)
Ideas, issues, and trends in textiles and clothing.

Design (Dsgn)

5504. CULTURAL RESOURCES OF THE TWIN CITIES. (2-3 cr; offered when feasible)
Broad range of arts represented in Twin Cities area. Lectures by instructor and practicing professional artists, field trips, selected readings.

5505. HISTORY OF ART AND DESIGN. (4 cr; lab fees no longer required; offered when feasible)
Egyptian period to present. Painting, sculpture, and architecture of the past studied for influences on contemporary period. Field trips.

5507. HISTORY OF DECORATIVE ARTS: TEXTILES. (4 cr; prereq ArtH 1002 or equiv)
Textiles from early civilization to 20th century. Design, materials, and techniques.

5509. HISTORY OF DECORATIVE ARTS: METAL, CERAMICS, WOOD, AND GLASS. (4 cr; prereq ArtH 1002 or equiv)
Glass, ceramics, metalwork, wood, and other materials from selected historical periods. Application to interior design.

5512. HISTORY OF EUROPEAN FURNITURE AND INTERIORS. (4 cr; prereq ArtH 1002 or equiv)
Furniture and interiors from ancient civilization through the 19th century.

5514. HISTORY OF AMERICAN FURNITURE AND INTERIORS. (4 cr; prereq 5512, ArtH 1002 or equiv)
Styles of American interiors and furnishings from the 17th to the 20th century.

5518. HISTORY OF COSTUME: 19TH AND 20TH CENTURIES. (4 cr; prereq 3517 or #)
Emphasis on American costume. Study of historic costume from the Goldstein Gallery's costume collection.

5527. THREE-DIMENSIONAL DESIGN II. (4 cr; prereq 3527, △)
Lectures and studio work based on unitary systems derived from modules. Application of plans based on visual perception exercises to space division in the space lab.

5531. SURFACE FABRIC DESIGN III. (4 cr; prereq 3531 and portfolio review, △)
Designing in one special surface textile technique. Studio problems. Readings.

5541. COSTUME DESIGN III. (3 cr; prereq 3541, TexC 3604 or #, △)
Advanced problems in draping and sketching. Pencil, crayon, and watercolor techniques; studies and reports on selected topics.

5544. COSTUME DESIGN PROBLEMS. (4 cr; prereq 5541 or #, △)
Supervised experience in design production; development of a "line"; professional ethics and business practice.

5552. INTERIOR DESIGN III: RESIDENTIAL DESIGN. (4 cr; prereq 3553, 3557, TexC 3621, FSoS 1401, and #, △, ForP 3310 and TexC 3622 recommended)
Advanced problems in planning and furnishing residential spaces to meet individual or family needs.

5553. INTERIOR DESIGN COLLABORATIVE STUDIO. (6 cr; prereq 3553)
Solving design problems for the near environment using interdisciplinary team approach.

5554. INTERIOR DESIGN IV: CONTRACT DESIGN. (4 cr; prereq 3553, 3557, TexC 3621 or #, △, ForP 3310 and TexC 3622 recommended)
Design problems related to commercial interiors.

5555. HONORS THESIS IN INTERIOR DESIGN. (15 cr; prereq completion of all other professional courses, consent of program committee)
Independent interior design thesis project under tutorial guidance.

5570. SEMINAR: DESIGN-SELECTED TOPICS. (1-3 cr per qtr [max 12 cr]; prereq #)
In-depth study of selected topics through assigned readings, discussions, and lectures by resource people.

5571. SPECIAL TOPICS IN APPLIED DESIGN. (2-4 cr [max 9 cr])
In-depth investigation of single aspect of applied design. Topic announced in advance.

5572. SPECIAL TOPICS IN COSTUME DESIGN. (2-4 cr per qtr [max 9 cr]; prereq dependent on topic)
In-depth investigation of a single preselected aspect of costume design. Specific topic announced in advance.

5574. SPECIAL TOPICS IN INTERIOR DESIGN. (2-4 cr per qtr [max 9 cr]; prereq dependent on topic)
In-depth investigation of single preselected aspect of interior design. Specific topic announced in advance.

5575. INTERIOR DESIGN RESEARCH. (3 cr; prereq pass portfolio review 3553 or #, △)
Examination and development of studies.

5582. FIELD EXPERIENCE ABROAD. (1-15 cr [max 15], §Hsg 5882; prereq #)
Faculty-directed field study abroad. Focus on interior or applied design, and/or costume design. Discovery of design in other cultures, meeting professionals, field trips.

5584. READINGS IN DESIGN. (1 or 3 cr; not open to srs; prereq #)
Independent study and review of books and periodicals. Written reports.

5585. PROBLEMS IN DESIGN: GENERAL. (2-4 cr per qtr [max 12 cr]; prereq #, △)
Independent study under tutorial guidance.

5586. PROBLEMS IN DESIGN: INTERIORS. (2-4 cr per qtr [max 12 cr]; prereq #, △)
Independent study under tutorial guidance.

5588. PROBLEMS IN DESIGN: TEXTILES. (3 or 4 cr per qtr [max 12 cr]; prereq #, △, portfolio review)
Independent study in textiles under tutorial guidance.

5589. PROBLEMS IN DESIGN: COSTUME. (3 or 4 cr per qtr [max 12 cr]; prereq 5518 or equiv, #, portfolio review)
Independent study in costume design under tutorial guidance.

8521. DESIGN PROCESS: COLOR. (4 cr; prereq 1501, 1521, 1523, 1525, 3527, 5505 or equiv, △)
Color concepts and their application to design.

8523. DESIGN PROCESS: DRAWING. (4 cr; prereq 1501, 1521, 1523, 1525, 3527, 5505 or equiv, △)
Drawing media as applied to design problems.

8525. DESIGN PROCESS: TWO-DIMENSIONAL DESIGN. (4 cr; prereq 1501, 1521, 1523, 1525, 3527, 5505 or equiv, △)
Experiments with principles of two-dimensional design; emphasis on alternative solutions to design problems.

8531. SPECIAL PROBLEMS IN TEXTILE DESIGN. (1-3 cr; prereq 5531 or #)
Advanced study in textile design such as silk screen, block printing, and batik.

8552. SPECIAL PROBLEMS IN HOUSING AND INTERIOR DESIGN. (1-3 cr; prereq 5552 or 5554 or #)
Independent study and reports on home planning and furnishings.

8556. ENVIRONMENTAL STUDIES IN INTERIOR DESIGN. (2-5 cr; prereq 6 cr in housing, home furnishings, and interior design or equiv)
Space, color, light, and arrangement in interiors. Work in specially designed laboratories.

8575. SEMINAR: DESIGN. (1 cr)

8576. SEMINAR: DESIGN INSTRUCTION. (1 cr per qtr [max 6 cr])
Emphasizes processes in design. For teaching assistants instructing undergraduate courses in design.

8584. READINGS IN DESIGN. (1-3 cr; prereq #)
Independent study and review of books and periodicals.

8585. PROBLEMS: DESIGN. (1-5 cr; prereq #)

8586. PROBLEMS IN INTERIOR DESIGN. (1-5 cr per qtr; prereq #)

8587. PROBLEMS IN DESIGN. (1-5 cr per qtr; prereq #)

8588. DIRECTED STUDY IN DESIGN. (1-5 cr; prereq #)

Housing (Hsg)

5801. THE FAMILY AND ENERGY ISSUES. (3 cr; prereq 5 cr in FSoS or #)
Analysis of family behavior as it relates to energy, impact of scarcity on quality of family functioning, family energy issues in future.

5804. EVALUATION PROCEDURES FOR HOUSEHOLD EQUIPMENT. (3-4 cr [max 4 cr]; prereq 1801 or equiv, 8 addtl cr in home economics)
Procedures and instruments used to determine operating characteristics of selected household appliances and to assess selected physical characteristics of houses.

5809. CONSUMER SELECTION GUIDES FOR HOUSEHOLD EQUIPMENT. (3-4 cr [max 4 cr]; prereq 1801 or equiv, FSoS 5220 recommended, #)
Construction and operating components of current models of selected appliances. Suitability of appliances for kitchen and laundry plans in accord with research-based recommendations.

5861. HOUSING MANAGEMENT. (5 cr; prereq 3863 or #)
Career demands for professionalism in housing management. Increasing required interpersonal skills. Historical perspectives, current status of housing, management approaches, psychosocial impact of housing and community design, specific residential populations.

5865. HOUSING IN WORLD PERSPECTIVE I. (4 cr; prereq 3863 or equiv; offered when feasible)
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.

5866. HOUSING IN WORLD PERSPECTIVE II. (4 cr; prereq 5865 recommended; offered when feasible)
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.

5867. HOUSING ALTERNATIVES FOR THE FAMILY. (4 cr; prereq Dsgn 3863 or #)
Emphasis on design for special needs of the elderly, the handicapped, and differing lifestyles.

5868. HOUSING PROBLEMS OF THE FAMILY. (5 cr; prereq 1801, 1851 or Dsgn 1555, 3863, or #)
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.

5869. HOUSING RESEARCH: INTERPRETATION AND EVALUATION. (4 cr; prereq at least one statistics course)
Interpretation and evaluation of housing research; conceptual frameworks, methodological approaches, and findings of published research.

5873. SPECIAL TOPICS IN HOUSING. (2-4 cr [max 9 cr]; prereq dependent on topic; offered when feasible)
In-depth investigation of preselected aspect of housing.

5881. DESIGNED ENVIRONMENTS AND AGING. (4 cr; prereq 3863 or Dsgn 1555 or #; offered alt yrs)
Design of environments with potential to compensate for deficits in physical and mental functioning. Older adults and barrier-free, flexible, and responsive physical environments.

5882. FIELD EXPERIENCE ABROAD. (1-5 cr [max 15 cr], §Dsgn 5582; prereq #; offered when feasible)
Faculty-directed field study abroad. Housing in other countries; meeting professionals, field trips.

5888. DIRECTED STUDY IN HOUSING. (1-4 cr [max 4 cr]; prereq #)
Independent study in housing.

8880. DIRECTED STUDY IN HOUSING. (1-4 cr per qtr [max 8 cr]; prereq #)
Independent study in housing.

Home Economics (HE)

5000. FARMING SYSTEMS. (3 cr)
Introduction to farming systems research and extension, an interdisciplinary and holistic approach to understanding limited resource family farms and integrating family farm research and extension.

5001. FIELDWORK IN FARMING SYSTEMS RESEARCH AND EXTENSION. (3 cr; prereq 5000 or #)
Advanced theory of and practice in farming systems research and extension with opportunities for fieldwork.

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 #)

5140. SPECIAL TOPICS IN HOME ECONOMICS. (1-6 cr per qtr [16 cr max])
In-depth study of selected topic.

5191. DEVELOPMENT OF HOME ECONOMICS. (2 cr)
Development of home economics with emphasis on current problems.

5600. INTERNATIONAL DEVELOPMENT SEMINAR: AGRICULTURE, HOME ECONOMICS, WOMEN, AND YOUTH. (3 cr; prereq Econ 1001, Soc 1001, Psy 5303 or #)
Interdisciplinary seminar integrating aspects of agriculture and home economics in context of women, youth, and families in order to establish working concept of rural economic development.

5601. INTERNATIONAL DEVELOPMENT PRACTICUM. (Cr ar; prereq participation in International Development Collateral)
Work on research in Third World countries arranged by individual students with faculty advice, including approved academic exercise.

East Asian Studies

Professor: Edward L. Farmer (history), *director of graduate studies;* Edward M. Copeland; Mei-ling Hsu (geography); Chun-Jo Liu; Byron K. Marshall (history); Robert J. Poor (art history); Romeyn Taylor (history); Stephen S. Wang

Associate Professor: Takatoshi Ito (economics); Wesley M. Jacobsen; Alan L. Kagan (music); Chin-Chuan Lee (journalism and mass communication)

Assistant Professor: Jeffrey P. Broadbent (sociology); Rey Chow (comparative literature); Earl D. Jackson, Jr.; Tonglin Lu; Ann B. Waltner (history)

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—Chinese: M.A. (Plan A and Plan B) and Ph.D.; East Asian Studies: M.A. (Plan A and Plan B); Japanese: M.A. (Plan A and Plan B) and Ph.D.

Curriculum—Emphases in the Chinese and Japanese master's programs are aspects of the language, literature, or a combination of the two. The East Asian Studies master's program is interdisciplinary, and the student may formulate an individualized program concentration. For the doctoral program, the following concentrations are available: ancient, medieval, or modern studies in Chinese or Japanese including coursework in language, literature, art history, history, and other relevant fields; language and literature of a specific period; development of a certain genre; and history and structure of Chinese or Japanese.

Prerequisites for Admission—Normally, an undergraduate major in Chinese or Japanese is the prerequisite to 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 statement of purpose should be submitted to the department. Graduate Record Examination General Test scores (verbal and quantitative sections) are required.

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. degree, research competence in Chinese or Japanese. For the Ph.D. degree, research competence in Chinese, Japanese, and one of the following: French, German, or Russian.

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—Contact the director of graduate studies, Department of East Asian Studies, 113 Folwell Hall, University of Minnesota, 9 Pleasant Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

East Asian Studies (EAS)

5032. BUDDHISM IN EAST ASIA. (4 cr, §RelS 5032; prereq jr or sr or #)
Origins of Buddhism in India; its spread and acculturation in China and Japan. Basic doctrines and practices, major sectarian divisions.

5460. TOPICS IN EAST ASIAN LITERATURE. (4 cr; prereq #)
Themes prevalent in Chinese or Japanese literature or both.

5481. COMPARATIVE ASIAN DEVELOPMENT. (4 cr, §Soc 5481; prereq sociology of development, Asian-related courses, or #)
Comparison of political-economical and sociocultural institutions creating high-speed growth and other social and political effects in East Asian area, focusing on Japan and "four little tigers": Taiwan, South Korea, Hong Kong, and Singapore.

5961. SCOPE AND METHODS OF EAST ASIAN STUDIES. (4 cr)
Introduction to subfields, problems, and methodologies involved in study of East Asia as a world area.

5970. DIRECTED STUDIES. (1-15 cr; prereq #, △, CLA approval)
Guided individual reading or study.

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 and #)
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.

5261, 5262, 5263. READINGS IN CHINESE LITERATURE. (4 cr per qtr; prereq 3033)
Representative readings. Styles, ideas, and historical background of authors.

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]; prereq 3031)
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.

5471. CHINESE BIBLIOGRAPHY. (4 cr; prereq 3033 or #)
Primary sources and reference materials for study of Chinese humanities, intended to prepare students for independent research.

5472. RESEARCH METHODS. (4 cr; prereq 3033)
Basic methods of philological and textual research in Chinese humanities.

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 *The 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 #, △, CLA approval)
Guided individual reading for study.

5990. COLLOQUIUM ON EAST ASIA. (1-4 cr; prereq upper division or grad student and #, △, CLA approval)
Reports by students on their research. Frequency of meetings to be decided.

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.

8960. SEMINAR: CHINESE LITERATURE. (4 cr; prereq 2 qtrs 51xx courses)
Examination of particular authors or works within the total range of the Chinese written literary tradition.

Japanese (Jpn)

5041-5042-5043. CLASSICAL JAPANESE. (5 cr per qtr; 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 3023 or #)
Work in verbal expression, both oral and written; basic grammar review emphasizing idioms and nuances; practice in short compositions and correspondence. Additional work beyond that required for 3051, 3052, 3053.

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.

5363, 5364. READINGS IN MODERN JAPANESE LITERATURE II. (4 cr per qtr; 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 and Ling 3001 or #)
Structure and meaning of Japanese sentence patterns.

5452. STRUCTURE OF JAPANESE—PHONOLOGY/MORPHOLOGY. (4 cr; prereq 3023 and Ling 3001 or #)
Generative and nongenerative approaches to Japanese sound and word structure.

5460. TOPICS IN JAPANESE LITERATURE. (4 cr; prereq 3033)
Topics in context of culture and intellectual history.

5471. RESEARCH METHODS. (4 cr; prereq 3033)
Research methods and materials in area of Far Eastern philology.

5472. JAPANESE BIBLIOGRAPHY. (4 cr; prereq #)
Introduction to research in Japanese studies; primary sources and secondary materials in native research tradition.

5473. JAPANESE FOR SINOLOGISTS. (4 cr; prereq 3021 or equiv, reading knowledge of Chinese)
Readings in Japanese scholarship on China, focusing on bibliographic and linguistic skills necessary to utilize Japanese Sinological research tools.

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 #, △, CLA approval)
Individual study of selected texts with guidance of faculty member.

5990. COLLOQUIUM ON EAST ASIA. (1-4 cr; prereq upper division or grad student and #, △, CLA approval)
Reports by students on their research. Frequency of meetings to be decided.

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.

8660. SEMINAR IN JAPANESE LITERATURE (MODERN). (4 cr; prereq 5460 or #)
Intensive study of particular authors or works within the total range of the modern Japanese written literary tradition.

8960. SEMINAR IN JAPANESE LITERATURE (CLASSICAL). (4 cr; prereq △)
Intensive study of particular authors or works within the total range of the classical Japanese written literary tradition.

Ecology (EBB)

Regents' Professor: Margaret B. Davis; Eville Gorham

Professor: Franklin H. Barnwell, *head;* Kendall W. Corbin, *director of graduate studies;* Elmer C. Birney; Patrick L. Brezonik; Edward J. Cushing; Donald E. Gilbertson; Miron L. Heinselman; William S. Herman; Herbert M. Kulman; D. Frank McKinney; Donald C. McNaught; L. David Mech; Robert O. Megard; Patrice A. Morrow; Robert J. Naiman; David F. Parmelee; Richard E. Phillips; Philip J. Regal; William D. Schmid; Joseph Shapiro; Michael J. Simmons; Donald B. Siniff; John R. Tester; G. David Tilman; Harrison B. Tordoff; James C. Underhill; Melbourne C. Whiteside; John M. Wood

Associate Professor: Peter A. Abrams; Donald N. Alstad; John H. Beatty; Robert C. Bright; Yosef Cohen; James W. Curtsinger; Peter A. Jordan

Assistant Professor: David A. Andow; Craig Packer; John Pastor; Anne E. Pusey

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, 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 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—Three letters of recommendation evaluating the applicant's scholarship and Graduate Record Examination scores (including the Subject Test) are required. Deadline for application is January 15; earlier application is encouraged for individuals seeking financial aid. 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—Contact the director of graduate studies, Ecology and Behavioral Biology, 109 Zoology Building, University of Minnesota, 318 Church Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Community Ecology and Paleoecology

5008. QUATERNARY ECOLOGY. (4 cr; prereq Biol 5041 or #; offered alt yrs) 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 PLANT COMMUNITIES. (5 cr; prereq Biol 5041, 1 qtr statistics or #) Cushing
Methods of describing, sampling, and classifying plant communities; theory of their structure, development, and stability, and of the interactions among their constituent populations. Field trips to examine local vegetation types; analysis of quantitative data.

5016. ECOLOGICAL PLANT GEOGRAPHY. (5 cr; prereq Bot 3201 or ¶Bot 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 #; offered alt yrs) 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

5044. EVOLUTION. (4 cr; prereq Biol 1106 or 3011) Regal
Survey of evidence for and causes of biological evolution.

5051. ANALYSIS OF POPULATIONS. (4 cr; prereq 3004 or Biol 3041 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. (4 cr; prereq Biol 5041 or #; offered alt yrs) Tilman
Theories of population ecology, including models of growth and regulation of single populations, and of interactions between populations, including competition, predation, mutualism; emphasizes assumptions and rationales of models and their predictions for dynamics, stability, and diversity of communities.

5063. EVOLUTIONARY ECOLOGY OF INSECT POPULATIONS. (3 cr; prereq Biol 5041 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.

5065. THEORETICAL EVOLUTIONARY ECOLOGY. (3 cr; prereq Math 1231, one 5xxx course in ecology, evolution, or behavior, or #) Abrams
Evolutionary approaches to ecology and behavior based on application of optimization and game theory techniques. Optimal foraging theory, evolution of life histories, and animal behavior in contest situations.

8004. TOPICS IN ECOLOGICAL GENETICS. (1 cr; prereq #) Underhill
Ways natural populations adapt to their environments; mechanisms by which they respond to environmental change. Different topic of current interest considered each year.

8400. POPULATION BIOLOGY SEMINAR. (1 cr; prereq #)
Reading and discussion of recent literature on biology of plant and animal populations.

8420. POPULATION BIOLOGY RESEARCH SEMINAR. (1 cr; prereq #)
Reports on student and faculty reseach in population biology.

Organismal Biology and Physiological Ecology

5116. INTRODUCTION TO ANIMAL PARASITOLOGY. (5 cr; prereq Biol 1106 or 3011) Gilbertson
Parasitic protozoa, worms, and arthropods and their relation to diseases of humans and animals.

5122. PLANT/ANIMAL INTERACTIONS. (4 cr; prereq Biol 3011, 3012 or #) Morrow
Herbivory, pollination, seed dispersal. Implications of interaction for plants and animals at organismal, population, and community levels. Coevolution.

5129. MAMMALOGY. (5 cr, §FW 5129; prereq Biol 1106 or 3011 or #; offered alt yrs) 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.

5132. HERPETOLOGY. (5 cr; prereq Biol 1106 or 3011 or #; offered alt yrs) Regal
Distribution, classification, and evolution of amphibians and reptiles of the world. Physiological, morphological, and behavioral aspects of adaptive trends. Laboratory and lecture.

5134. INTRODUCTION TO ORNITHOLOGY. (5 cr; prereq Biol 1106 or 3011) Tordoff
Laboratory 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 3011) Underhill
Biology of fishes including development, systematics, anatomy, physiology, and ecology.

5156. COMPARATIVE ANIMAL PHYSIOLOGY. (5 cr; prereq Biol 1106 or 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 discussions of characteristics of subnivean environment and adaptations by plants and animals to winter stresses. Three lectures per week, with field work on weekends.

Behavior

5321. EVOLUTION OF SOCIAL BEHAVIOR. (4 cr; prereq Biol 1106 or 3011 or #) McKinney
Introduction to current theories and concepts relating to mating systems, spacing systems, and cooperative behavior in animals.

5323. MECHANISMS OF ANIMAL BEHAVIOR. (5 cr; prereq Biol 3011 or 1 qtr of animal physiology) Barnwell, Phillips
Survey of animal behavior mechanisms; their organization and their functions. Analysis of behavior sequences, motor coordination, fixed action patterns, sensory systems and release mechanisms, mechanisms of animal communication, orientation behavior, feedback mechanisms and control, behavior of small neural networks. Laboratory included.

5325. BEHAVIORAL ECOLOGY. (4 cr; prereq 3111, 5321 or #) Packer
Ecological determinants of foraging behavior, social organization, demography, and life-history strategies.

8061. SOCIAL SYSTEMS. (5 cr; limited to 20 students; prereq 5322 or equiv and #; offered alt yrs) McKinney
Comparative survey of mating systems, spacing behavior, communication methods, and social organization in selected groups of animals.

8081. NEUROETHOLOGY. (3 cr, §AnSc 8081; prereq 5312, Psy 5061 or #; offered alt yrs) Phillips
Current concepts of neurological and neurochemical bases of animal behavior including reception, coding, transmission and storage of information, levels of integration; central control of input and output; spontaneity; development; and learning.

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. Laboratory, field trips.

5606. ECOLOGY OF FISHES. (3 cr; prereq 5136, Biol 1106 or 3011, plus 10 cr biological sciences) Underhill
Ecological requirements of fishes with emphasis on nongame species; habitat, food, interactions among species, behavioral, anatomical, and physiological adaptations. Fishes in the aquatic ecosystem, with emphasis on fresh waters.

5607. ECOLOGY OF ANIMAL PLANKTON. (4 cr; prereq Biol 5041, EBB 5601 or #; offered alt yrs) McNaught
Biology of animal plankton, including distribution of zooplankton in lakes, ecosystem functions such as grazing and remineralization, determination of production, physiological responses to contaminated environments, and important aspects of behavior.

5608. ECOSYSTEMS: FORM AND FUNCTION. (3 cr; prereq 5601 or Biol 5041, Chem 1002 or 1005) 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.

5613. ASSESSING THE ECOLOGICAL EFFECTS OF POLLUTION. (4 cr; prereq Biol 5041 or equiv, Chem 3301, 3302) Gorham
Assessment of effects upon species and ecosystems, methodological problems, initial phases of investigating a new pollutant, problems of prediction.

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; offered alt yrs)
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.)

5812su. COMPARATIVE LIMNOLOGY. (5 cr; prereq 15 cr biology and 5 cr chemistry, △; limited to 20 students; offered when feasible) Staff
General limnology of lakes, with emphasis on biology of lakes in Itasca region as related to their physical and chemical stratification in summer. Team projects in field research.

5814su. COMMUNITY STRUCTURE AND FUNCTION. (5 cr; prereq ecology course, △; 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.

5815su. FIELD ETHOLOGY. (5 cr; prereq intro biol/ecol, △; statistics course recommended; limited to 20 students)
Field course emphasizing principles of animal behavior in its ecological context and methods of studying behavior of wild animals. Quantitative techniques; sound recordings and sound tape analysis, capturing and marking techniques. Individual research project and term paper on social behavior of one species required. Individual projects require considerable outside time.

5817su. VERTEBRATE ECOLOGY. (5 cr; limited to 15 students; prereq course in ecology, #)
Designed primarily for students with fisheries and wildlife management interests.

5820su. WETLAND ECOLOGY. (10 cr; limited to 15 students; prereq 15 cr in biology, introductory chemistry, course in plant identification, △; Biol 3041 recommended; offered when feasible)
Nature, origin, and development of lake, marsh, swamp, and bog ecosystems; environmental control and productivity.

5831su. NATURAL HISTORY OF INVERTEBRATES. (5 cr; prereq Biol 1106, △; offered when feasible; limited to 20 students)
Advanced taxonomic and ecological survey of local fauna and independent ecological studies of several taxonomic groups.

5832su. NATURAL HISTORY OF VERTEBRATES. (5 cr; prereq Biol 1106, △; offered when feasible; limited to 20 students)
Taxonomic survey of local vertebrates (excluding birds); study of morphological, physiological, and behavioral adaptations to different habitats.

5834su. FIELD ORNITHOLOGY. (5 cr; limited to 15 students; prereq Biol 1106, △; offered annually)
Designed primarily for students with fisheries and wildlife management interests.

8800su. ADVANCED FIELD ECOLOGY. (5 cr; limited to 24 students; prereq admission to a grad program and △) Staff
Formulation and testing of ecological theory under field conditions. Group and individual research projects, lectures, seminars, and student presentations on topics such as coevolution, life history strategies, behavioral strategies, resource allocation, and community structure.

Directed Studies

5970. DIRECTED STUDIES. (Cr ar; prereq #, △)

5990. DIRECTED RESEARCH. (Cr ar; prereq #, △)
Laboratory 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.

8500. WRITING RESEARCH PROPOSALS. (2 cr; prereq #)
Reading, reviewing, and writing proposals for support of research in ecology and behavior.

8990. GRADUATE RESEARCH. (Cr ar; prereq #) Staff

See other fields of instruction for descriptions of the following related courses:

Biol 5816. FIELD BIOLOGY PHOTOGRAPHY

Biol 5870. ITASCA SEMINAR

Biol 5890. RESEARCH PROBLEMS AT ITASCA

Geo 5602. CASE STUDIES IN LIMNOLOGY

Geo 8262. QUATERNARY PALEOECOLOGY AND CLIMATE

Geo 8602. ADVANCED LIMNOLOGY

Economics (Econ)

Regents' Professor: John S. Chipman; Leonid Hurwicz (emeritus); Vernon W. Ruttan

Professor: Norman J. Simler, *chair;* Neil Wallace, *director of graduate studies*; Edward Coen; Roger D. Feldman; Edward Foster; James P. Houck; James S. Jordan; John H. Kareken; Timothy J. Kehoe; Lung-Fei Lee; Herbert Mohring; Edward C. Prescott; Marcel K. Richter; Mark R. Rosenzweig; G. Edward Schuh; Christopher A. Sims; Craig E. Swan; Kenneth I. Wolpin

Associate Professor: George D. Green; Takatoshi Ito; Andrew McLennan; Mark M. Pitt

Assistant Professor: Sumru G. Altug; Hidehiko Ichimura; Patrick J. Kehoe; Ramon Marimon; Paul A. Richardson; T. Scott Thompson; Jan Werner

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; industrial organization; international economics; labor economics; mathematical economics; monetary economics; public finance and fiscal policy.

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 January 15.

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—Contact the director of graduate studies, Department of Economics, 937 Management and Economics, University of Minnesota, 271 19th Avenue South, Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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)
Alternative patterns for future world economy, implications for economic welfare of nations. World institutions, relation to growth and survival problems.

5970. READINGS IN ECONOMICS. (Cr ar; prereq consent of adviser, #, △, CLA approval; offered when feasible)
Areas useful to individual programs and objectives not available in regular course offerings.

8010. ADVANCED TOPICS IN GENERAL ECONOMICS. (Cr ar [may be repeated for cr]; prereq 8103; offered when feasible)
Topics announced in *Class Schedule*. Course may be offered in several sections at the same time and with different topics.

8990. INDIVIDUAL GRADUATE RESEARCH. (Cr ar)

Theory

5107H. HONORS COURSE: GAME THEORY AND ITS APPLICATIONS. (4-5 cr; prereq 3101, 3102, 3103 or equiv, Math 1221, Math 3142 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 3142, 3211 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.

5271-5272. BAYESIAN DECISION MAKING. (4 cr per qtr, §Stat 5271-5272, §AgEcon 5271-5272; prereq 3101 or equiv, Stat 5122 or equiv; offered when feasible)
5271: Rationale for expected utility representation of decision problems. Amount of a venture problem. Production decisions by firms. Combinations of ventures, portfolio problems. 5272: Sequential economic decisions. Dynamic programming. Multivariate utility.

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)
Basic macroeconomics course for graduate majors. 8104: Deterministic macroeconomic models solving for the interest rate, price level, output, employment, and distribution of income. 8105-8106: Dynamic and stochastic analysis. Recursive and classical optimal control applied to the construction of consumption, investment, and growth models; optimal search theory and matching models; overlapping generations models of public finance and fiat money; state-preference analyses; rational expectations theory, implications for econometric work.

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.

8114-8115-8116. DECISION MAKING AND OPERATIONS ANALYSIS. (3 cr per qtr; prereq 3101 or 5151, 2 qtrs calculus, 1 qtr linear algebra; offered when feasible)
8114: Linear models of economic activity, emphasizing linear programming and input-output analysis. 8115: Nonlinear models of economic activity, emphasizing nonlinear programming models. 8116: Special topics.

8121. APPLIED WELFARE ECONOMICS. (3 cr; prereq 8103 or #; offered when feasible)
Applications of welfare concepts for analysis of typical policy issues with emphasis on development of student's skills.

8124-8125. HISTORY OF ECONOMIC THOUGHT. (3 cr per qtr; prereq 8102, 8104; offered when feasible)
8124: Classical economists, Marx, and beginning of neoclassical economics. 8125: Development of neoclassical economics through the 1930s. Origins of macrotheory.

8131. INCOME DISTRIBUTION. (3 cr; prereq 5151, 5152 or equiv; offered when feasible)
Axiomatic treatments of measurement of inequality of income distribution. Lorenz curve, Gini coefficient and other inequality measures. Functional forms for description of income distributions and models generating them; Pareto, Amoroso, log-normal, and other distributions. Parametric and nonparametric methods of estimating income distributions.

8161-8162-8163. MATHEMATICAL ECONOMICS. (3 cr per qtr; prereq 5163 or 8113, Math 3211 or equiv, Math 3142, ¶Math 5612 for 8161, Math 5243 recommended)
Mathematical models underlying contemporary economic theory.

8181-8182-8183. ADVANCED TOPICS IN MICROECONOMICS. (3 cr per qtr; prereq 8103; offered when feasible)

8184-8185-8186. ADVANCED TOPICS IN MACROECONOMICS. (3 cr per qtr; prereq #; offered when feasible)

8191-8192-8193. WORKSHOP IN MATHEMATICAL ECONOMICS. (Cr ar; prereq #)
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; prereq 3101 or equiv, Stat 5121-5122 or Stat 5131-5132-5133, Math 1221, Math 3142 or equiv)
Advanced econometric models, including systems of simultaneous equations, structural models of qualitative economic behavior, and intrinsically nonlinear models. Asymptotic and small-sample properties of estimators. Applications of econometrics to household and firm behavior; forecasting and policy analysis with macroeconometric models.

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. Laboratory 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 Markor 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.

8214. ECONOMETRICS IN PRACTICE. (3 cr; prereq 8212)
Students complete a paper applying or developing econometric techniques. For students without substantial previous experience in applications of econometric technique.

8281-8282-8283. ADVANCED TOPICS IN ECONOMETRICS. (3 cr per qtr; prereq #; 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, §5337; not open to economics majors; prereq 1101, 1102, or equiv)
Functions of all economic systems—the market economy, liberal socialism, the centrally planned economy. American and Soviet economies.

5311. ECONOMY OF LATIN AMERICA. (4 cr, §5341; not open to economics majors; prereq 1001, 1002 or equiv; offered when feasible)
Current economic problems: exchange controls, land reform, inflation, and fluctuation in prices of basic commodities. Evaluation of foreign aid proposals.

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.

5313. ECONOMY OF THE U.S.S.R. (4 cr; prereq 3101 or equiv; offered when feasible)
Development of economic organization of the state, planning and control of use of resources, and distribution of product. Performance of the economy in agriculture and industry under 5-year plans. Internal and external economic policy. Public finance, income distribution, and economic incentives under Soviet system.

5315. THE JAPANESE ECONOMY. (4 cr, §3315; prereq 3101 or equiv; offered when feasible)
Economic development of Asia following contact with Western civilization. Some present problems: population growth, capital formation, international economic relations.

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. (4-5 cr, §5301; prereq 3101, 3102, or equiv, 1 qtr calculus; B avg recommended)
Economic growth in low-income countries. Theory of aggregate and per capita income growth. Population growth, productivity increases, and capital formation. Allocation of resources between consumption and investment and among sectors. International assistance and trade.

5337. COMPARATIVE ECONOMIC SYSTEMS. (4 cr, §5307; prereq 3101, 3102 or equiv)
Functions of all economic systems—the market economy, liberal socialism, the centrally planned economy. American and Soviet economies.

5341. ECONOMY OF LATIN AMERICA. (4 cr; prereq 3101, 3102 or #)
Analysis of current economic problems: exchange controls, land reform, inflation, and fluctuation in prices of basic commodities. Evaluation of foreign aid proposals.

5347, 5348. DEVELOPMENT OF THE AMERICAN ECONOMY. (4 cr per qtr; prereq 3101, 3102 or equiv or #)
Application of economic theory and empirical methods to topics in American economic development, particularly during the 19th-century period of accelerated growth and industrialization.

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)
Technical change and economic growth, sources of productivity change, economics of research and development, science and technology policy.

8313. HUMAN RESOURCES AND DEVELOPMENT. (3 cr; prereq 8103, 8105)
Labor markets, household economics, education, health, population growth, savings, income distribution, international migration.

8321. ADVANCED COMPARATIVE ECONOMIC SYSTEMS. (3 cr, §5307, §5337; prereq 5151, 5152 or equiv or #; offered when feasible)
Functions of all economic systems: market economy, liberal socialism, centrally planned economy. Analysis of American and Soviet economies.

8381-8382-8383. ADVANCED TOPICS IN ECONOMIC DEVELOPMENT. (3 cr per qtr; prereq #; offered when feasible)

International Economics

5401. INTERNATIONAL ECONOMICS. (4 cr, §5429, §5432; not open to economics majors; prereq 1001, 1002 or equiv)
Explanations of trade patterns. Commercial policy and international capital movements. Balancing international receipts and payments, role of exchange rate, international monetary reform.

5411. U.S. FOREIGN ECONOMIC POLICY. (4 cr; prereq 5401 or equiv)
Development of U.S. foreign economic policy in the 20th century and current issues of U.S. foreign economic policy.

5431. INTERNATIONAL TRADE. (4 cr, §5401, §5429; prereq 3101, 3102, 3103, or equiv)
Explanations of trade patterns; commercial policy and international capital movements.

5431H. HONORS COURSE: INTERNATIONAL TRADE. (4-5 cr, §5401, §5429; prereq 3101, 3102, 3103, or equiv, 1 qtr calculus; B avg recommended)
For description, see 5431.

5432. INTERNATIONAL FINANCE. (4 cr; prereq 3101, 3102, 3103, or equiv; 5431 or equiv recommended)
Balancing international receipts and payments; role of exchange rates; international monetary reform.

5432H. HONORS COURSE: INTERNATIONAL FINANCE. (4-5 cr; prereq 3101, 3102, 3103, or equiv, 1 qtr calc; B avg, 5431 or equiv recommended)
Balancing international receipts and payments; role of exchange rates; international monetary reform.

8401-8402-8403. INTERNATIONAL TRADE AND PAYMENTS THEORY. (3 cr per qtr; prereq 8102, 8104)
8401: The Heckscher-Ohlin-Samuelson model of international trade. 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. Effective protection. Customs unions. 8403: Balance of payments disequilibrium, exchange rates, capital movements, international liquidity.

8481-8482-8483. ADVANCED TOPICS IN INTERNATIONAL TRADE THEORY. (3 cr per qtr; prereq 8101, 8102, 8403 or equiv or #; offered when feasible)

8491-8492-8493. WORKSHOP IN TRADE AND DEVELOPMENT. (Cr ar; prereq #)
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.

5533. INCOME DISTRIBUTION: FACTS, THEORIES, ISSUES. (4 cr; prereq 3101; offered when feasible)
Measurement and interpretation of income inequalities. Alternative hypotheses to explain existing distribution of income. Alternative policies or methods for changing distribution of income.

5534. ECONOMIC SECURITY. (4 cr, §Ins 3210; prereq 1101, 1102, or equiv; offered when feasible)
Public and private approaches to problems of economic insecurity. Economic and social implications of private and public programs. Emphasis on economics of income and employment stabilization rather than upon legal or administrative aspects of policy.

5537. LABOR MARKET BEHAVIOR AND REGULATION. (4 cr; prereq 3501 or 5531 or #; offered when feasible)
Public and private rules and policies directed at regulation of employer-employee-union relations and labor market behavior. Settlement of disputes. Control of employer and union self-help techniques. Emphasis on economics of control rather than upon legal or administrative aspects of policy.

5541. CONTEMPORARY LABOR ISSUES. (4 cr; prereq 3501 or 5531 or #)
Analysis of important labor problem areas. Current issues examined in light of their broader economic, legal, political, and social implications.

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.

8581-8582-8583. ADVANCED TOPICS IN LABOR ECONOMICS. (3 cr per qtr; prereq #; 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. Will 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.

5621H. HONORS COURSE: URBAN ECONOMICS. (4-5 cr; prereq 3101 or equiv, 1 qtr calculus, 1 qtr Stat; B avg recommended)
For description, see 5621.

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)
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. (4-5 cr; prereq 3101, 3103, 1 qtr calculus; B avg recommended)
For description, see 5631.

8601-8602-8603. INDUSTRIAL ORGANIZATION AND GOVERNMENT REGULATION. (3 cr per qtr; prereq 8101)
Profit maximization and equilibrium theories of business behavior; profits, assets, and barriers to entry; concentration and other aspects of industry structure; scale economies and other determinants of industry structure; performance consequences of alternative industry structures; analysis of business pricing practices; determinants of invention and innovation; economic analysis of antitrust, conservation, and direct regulatory activities of federal, state, and local governments.

8681-8682-8683. ADVANCED TOPICS IN INDUSTRIAL ORGANIZATION. (3 cr per qtr; prereq #; offered when feasible)

8691-8692-8693. WORKSHOP IN APPLIED MICROECONOMICS. (Cr ar; prereq #)
Written and oral presentations by Ph.D. students engaged in or planning to engage in thesis research in applied microeconomics.

Money

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, §3701, §5701; prereq 3101, 3102, or equiv; offered when feasible)
Historical development, present characteristics, and economic role of financial institutions. Commercial banking, the Federal Reserve system, and monetary policy.

5721H. HONORS COURSE: MONEY AND BANKING. (4-5 cr; prereq 3101 [or preferably 3101H], 3102 [or preferably 3102H], 1 qtr calculus; B average recommended)
For description, see 5721.

5731. MACROECONOMIC POLICY. (4 cr; prereq 3101, 3102)
Evaluation of policy alternatives; rational expectations; rules versus discretion; control of inflation; natural rate of unemployment; targets and instruments.

5731H. HONORS COURSE: MACROECONOMIC POLICY. (4-5 cr; prereq 3101 [or preferably 3101H], 3102 [or preferably 3102H], 1 qtr calculus; B average recommended)
For description, see 5731.

5733-5734-5735. INTERTEMPORAL ECONOMICS. (4 cr per qtr; prereq 3101, 3103, Math 1231; offered when feasible)
5733: Real intertemporal economics: overlapping-generations models of interest rates; applications to social security and deficit finance. 5734: Monetary theory: theories of money applied to commodity and fiat systems and to systems with unregulated and regulated banking. 5735: Topics in monetary theory: selected historical episodes to be interpreted in light of theories studied in 5733 and 5734.

5741. BUSINESS CYCLES. (4 cr; prereq 3101, 3102, 5721 or equiv)
Fluctuations in economic activity; causes and statistical data; relationship of cycles to economic growth. Methods of forecasting. Proposals for stabilization.

5741H. HONORS COURSE: BUSINESS CYCLES. (4-5 cr; prereq 3101 [or preferably 3101H], 3102 [or preferably 3102H], 5721, 1 qtr calculus; B avg recommended)
For description, see 5741.

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.

8781-8782-8783. ADVANCED TOPICS IN MONETARY ECONOMICS. (3 cr per qtr; prereq #; offered when feasible)

8791-8792-8793. WORKSHOP IN MACROECONOMICS. (Cr ar; prereq #)
Written and oral presentations by Ph.D. students engaged in or planning to engage in thesis research in macroeconomics.

Public Finance

5811. STATE AND LOCAL FINANCE. (4 cr; prereq 3801 or 5821 or equiv)
Main problems of state and local finance and proposed solutions; interstate comparisons and coordination of practices and policies.

5821. ELEMENTS OF PUBLIC FINANCE. (4 cr, §3801; prereq 3101, 3103)
Survey of 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 outposts.

5821H. HONORS COURSE: ELEMENTS OF PUBLIC FINANCE. (4-5 cr; prereq 3101 [or preferably 3101H], 3103 [or preferably 3103H], 1 qtr calculus; B avg recommended)
For description, see 5821.

5831. COST-BENEFIT ANALYSIS. (4 cr; prereq 3101, 3103)
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. (4-5 cr; prereq 3101, 3103, or equiv, 1 qtr calculus; B avg recommended)
Principles for evaluation of benefits and costs of public projects or programs. Definition and measurement of benefits and costs. Rate of return and rate of discount. Treatment of market imperfections, risk, and uncertainty.

8801-8802-8803. PUBLIC FINANCE. (3 cr per qtr; prereq 8102, 8105)
Theory of economic policy. Economic effects of taxes, public debt, and public expenditure on resource allocation, employment, and income distribution (including techniques of cost-benefit analysis). Current problems of fiscal policy and taxation.

8831. COST-BENEFIT ANALYSIS. (4 cr, §5831; prereq 8102)
Measurement of benefits and costs to society arising from public projects and programs. Market prices and shadow prices; compensating variation, consumer's surplus and rents; problems of evaluating unmarketed effects; issues associated with distribution of income; investment criteria; uncertainty.

8881-8882-8883. ADVANCED TOPICS IN PUBLIC FINANCE. (3 cr per qtr; prereq #; offered when feasible)

Education[1]

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 higher education. The doctoral degree is offered with emphases in curriculum and instruction (see Curriculum and Instruction for description); higher education (see Educational Policy and Administration for description); recreation, park, and leisure studies (see Physical Education and Recreation for description); social and philosophical foundations of education (see Educational Policy and Administration 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.

Note—See also Child Psychology; Curriculum and Instruction; Educational Policy and Administration; Educational Psychology; Physical Education and Recreation; and Vocational and Technical Education for other education-related degrees.

Educational Administration

See Educational Policy and Administration.

Educational Policy and Administration

Graduate programs in this field are educational administration, higher education, and social and philosophical foundations of education. See program listings immediately below for specific degrees offered.

Department Core Courses (EdPA)

5201. FORMAL ORGANIZATIONS IN EDUCATION. (3 cr, §EdAd 5201, §EdAd 8201; S-N optional)
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.

5260. INTRODUCTION TO EDUCATIONAL PLANNING. (3 cr; S-N optional)
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.

5281. COST ANALYSIS IN EDUCATIONAL EVALUATION. (3 cr; S-N optional)
Use and application of cost-effectiveness, cost-benefit, cost-utility, and cost-feasibility in evaluation of educational problems and programs.

8340. POLICY SYSTEMS IN EDUCATION. (3 cr, §EdAd 8340; prereq EdAd 8220)
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.

[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 education; community education administration; curriculum and instructional systems; early childhood education; elementary education; home economics education; industrial education; marketing 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.*

8341. ANALYSIS OF EDUCATION POLICY SYSTEMS. (3 cr, §EdAd 8341; prereq 8340) 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.

Educational Administration

Professor: Tim L. Mazzoni, *acting chair;* Van D. Mueller, *director of graduate studies;* William M. Ammentorp; Larry K. Bright[1]; Shirley M. Clark; Vernon L. Hendrix; Clifford P. Hooker; Darrell R. Lewis; Neal C. Nickerson; Charles H. Sederberg; Richard F. Weatherman; W. Keith Wharton

Associate Professor: Gary F. Alkire; James C. Hearn, Jr.; Karen Seashore Louis; Barbara Pillinger

Adjunct Lecturer: Michael J. Lovett

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), Ed.D., Ph.D., and Certificate of Specialist in Education.

Curriculum—The program features research opportunities and coursework in administration and organization of educational and human service institutions, both public and private, at local, state, and federal levels. Emphases include study of elementary and secondary school systems at the local and state levels and of postsecondary institutions.

The master's degree ordinarily serves as a first step for students beginning a program of graduate study in the field. The Ph.D. program emphasizes intensive study in a particular area of educational administration. While the Ph.D. program is available to persons who may follow administrative careers, it is especially appropriate for those who plan to pursue research or teaching careers. The Ed.D. program is particularly suitable for individuals interested in leadership careers in the operation of educational institutions and capable of applying the findings of scholarly research in the school setting.

Prerequisites for Admission—There are no special prerequisites for admission.

Special Application Requirements—Beginning with winter 1989 admissions, scores from the Graduate Record Examination (GRE) General Test are required.

Master's Degree Requirements—In addition to coursework and research in the field of educational administration, the program includes work in curriculum and instruction, educational psychology, foundations of education, and a collateral or related field outside of education.

The Plan A major must include at least 21 credits in the student's area of emphasis as part of the minimum of 28 credits in the major. At least 8 credits are required from outside the major field. The Plan B major requires a minimum of 45 credits including the following: at least 21 credits in educational administration; at least 12 credits in two or more fields substantively related to educational administration with a minimum of 6 credits in each; and at least 9 credits of independent research work culminating in one 9-credit or three 3-credit paper(s). Students usually complete one of the following courses, depending on the chosen emphasis: for elementary school administration, EdAd 8270; for secondary school administration, EdAd 8271; and for school business administration and general administration, EdAd 8272.

A final oral examination is required for both master's programs. The examination covers the major and minor or related fields and the thesis or project(s).

For further details, see the program publication.

Doctoral Degree Requirements—For the Ph.D. degree, students take a major consisting of at least 9 credits in the common foundational area, 12 credits in the common core, 30 credits in the concentration, and 18 credits in a research methodology sequence; 21 credits are taken in the supporting field or minor. At least 15 credits (collateral field) must be in coursework taken outside the College of Education; these credits could be used to meet the research methodology or supporting field/minor requirements.

[1]*University of Minnesota, Duluth*

For the Ed.D. degree, students take a major consisting of at least 21 credits in the core, 12 credits in a research methodology sequence, 0-9 credits in an internship or clinical experience, and 12-21 credits in specializations (e.g., seminars, principalship courses, technical courses); 24 credits are taken in supporting areas. At least 15 credits (collateral field) are selected from courses outside the College of Education that are appropriate for the study of administration.

Specialist Certificate Requirements—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—This program is designed for superintendents and central office personnel. The second year includes seminars in educational administration; workshops on the improvement of instruction in the elementary and secondary schools, school building planning, and state-school administrative problems; advanced courses in educational psychology; field research; and graduate courses dealing with school-community problems and educational philosophy.

School Business Administration—This program is designed for the school business manager, assistant superintendent in charge of business affairs, and persons in similar positions. The program is similar to the general educational administration program, with special emphasis on those aspects of administration that relate to the business operation of the school.

Intermediate Unit in Educational Administration—The program is similar to other school administration programs with the addition of a differentiated group of courses designed to prepare students for service in the intermediate unit in educational administration. Persons who have completed master's level work in other areas of school administration may enter this program.

Secondary School Administration—This program is planned to prepare students to serve as school principals, assistant principals, directors, or supervisors of secondary education, or in related positions. The program emphasizes secondary school curriculum and instruction with supporting work in educational psychology and child psychology as well as educational administration. It is also possible to emphasize the junior high school level or curriculum development.

Elementary School Administration—Requirements are arranged by areas of study. Available emphases include curriculum and instruction as well as administration in the elementary school.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Educational Administration Program, 275 Peik Hall, University of Minnesota, 159 Pillsbury Drive S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Note—Educational administration course listings immediately follow the social and philosophical foundations of education program description below.

Higher Education

Professor: William M. Ammentorp; Russell W. Burris; Shirley M. Clark; Paul E. Johnson; Darrell R. Lewis; James R. Rest; Robert D. Tennyson

Associate Professor: James C. Hearn, Jr., *director of graduate studies;* Kathleen A. Dalgaard; Karen Seashore Louis

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 higher education) and Ph.D. in education (emphasis in higher education).

Curriculum—Areas of emphasis, which include theory and applications, are organization and administration (organization theory, administrative leadership, and organizational planning) and policy evaluation and research (policy analysis, program evaluation, institutional research, and system level planning). Master's program emphases are individualized according to student background and professional goals and may be designed around postsecondary professional specialties (e.g., the health sciences and student personnel work).

Prerequisites for Admission—Applicants must have completed appropriate undergraduate and graduate study. Of special relevance is previous study in sociology, psychology, economics, educational administration, educational psychology, management science, and measurement and statistics.

Special Application Requirements—Scores from the GRE are required. A special program application must be submitted directly to the director of graduate studies.

Master's Degree Requirements—There is considerable flexibility in designing programs to meet individual circumstances. A typical Plan B program includes 10 to 12 core credits, 10 to 12 credits in an area of concentration, 8 to 10 credits in a related field, 7 to 9 credits in related methodology preparation, and 9 to 12 credits in electives in the categories above or in an optional internship or practicum. The final examination for the Plan B program is an oral examination and a research paper.

Doctoral Degree Requirements—Students typically take at least 22 core credits, 18 methodology credits, 27 credits in a concentration focus, 3 credits related to thesis development, and 18 credits in a minor or supporting area. There is considerable flexibility in designing programs to meet individual circumstances.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Higher Education Program, 275 Peik Hall, University of Minnesota, 159 Pillsbury Drive S.E., Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Note—Higher education course listings immediately follow the educational administration course listings below.

Social and Philosophical Foundations of Education

Regents' Professor: Robert H. Beck[1]

Professor: Marion L. Dobbert[1], *director of graduate studies;* Josef L. Altholz; Ayers L. Bagley[1]; Shirley M. Clark[1]; Roland A. Delattre; Marion L. Dobbert[1]; Darrell R. Lewis; Robert B. Tapp

Associate Professor: Arthur M. Harkins[1]; James C. Hearn, Jr.; Glenn Hendricks[1]; Karen Seashore Louis; Patrick J. Starr

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 Social and Philosophical Foundations of Education; Ph.D. in Education (emphasis in social and philosophical foundations of education).

Curriculum—Fields of concentration are available in the history and philosophy of education, comparative and international education, sociology of education, anticipatory anthropology and education, or in combinations thereof.

Prerequisites for Admission—Applicants should have undergraduate or graduate education in a field related to the chosen area of concentration, and should be able to demonstrate how their program objectives can be accomplished. In some cases, necessary background courses may be taken after admission.

[1]*Also holds graduate faculty appointment in Education*

Special Application Requirements—Scores from the Miller Analogies Test, letters of recommendation from academic or professional sources, and a detailed statement of purpose are required.

Degree Requirements—Programs require coursework in general foundations or related disciplines as well as specific courses in the concentration and in research method. A final oral examination is required for both master's programs.

Language Requirement—None, except in anticipatory anthropology and education for which doctoral candidates are expected to gain a working knowledge of French and either Spanish or one computer language.

For Further Information—Contact the director of graduate studies, Social and Philosophical Foundations of Education, 275 Peik Hall, University of Minnesota, 159 Pillsbury Drive S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Note—Social and Philosophical Foundations of Education course listings immediately follow the Higher Education course listings below.

Educational Administration (EdAd)

5101. PUBLIC SCHOOL ADMINISTRATION. (3 cr; not open to majors in educational administration; prereq 9 cr in education; S-N optional)
Organization, administration, and general support of public schools in state and local school districts.

5103. SUPERVISION AND ADMINISTRATION OF SPECIAL EDUCATION. (3 cr, §EPsy 5660, §PsyS 5160; prereq #; S-N optional)
Procedures in establishing and improving educational programs for exceptional children.

5105. WORKSHOP: ADMINISTRATION AND SUPERVISION OF SPECIAL EDUCATION. (1-6 cr; S-N optional)
Laboratory approach to common administrative and supervisory problems for experienced administrators of special needs programs.

5110. PERSONAL TIME MANAGEMENT AND ADMINISTRATION. (2 cr; S-N optional)
Application of proven practical and pragmatic techniques to problems of personal and administrative scheduling, organizing, delegating, prioritizing; handling interruptions and meetings; doing the distasteful and difficult; increasing self- and staff productivity; developing new concepts and techniques of management.

5120. PRACTICUM: POSTSECONDARY ADMINISTRATION. (3-6 cr [max 6 cr])
Intensive group and individual examination of current and pertinent administrative problems in postsecondary but nonbaccalaureate institutions.

5125. PRINCIPAL-CONSTITUENT DECISION MAKING. (3 cr)
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.

5127. WORKSHOP: POLICY DEVELOPMENT FOR SCHOOL MANAGERS. (3 cr; S-N optional)
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; S-N optional)
Laboratory approach provides opportunities for experienced administrators to concentrate on common administrative and supervisory problems.

5130. ADMINISTRATOR DEVELOPMENT SEMINAR. (3-9 cr [max 9 cr]; S-N optional)
Assessment and development of skills required of the administrator in areas of planning, decision making, and human relations; introduction to contemporary issues in educational administration; initial course for students pursuing professional licensure programs.

5139. LABORATORY IN DECISION MAKING. (1-4 cr; S-N optional)
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; S-N optional)
Issues and skills relevant to an administrator who directs a preschool program or the student planning a leadership position in early education.

5167. THE AMERICAN MIDDLE SCHOOL. (3 cr; S-N optional)
Sources of the movement; purposes, functions, and limitations; fundamental problems, types, and curricular implications of reorganization.

5180, 5181. SEMINAR: ADMINISTRATION OF SPECIAL EDUCATION. (3 cr per qtr, §EPsy 8760, 8761; prereq 5103 or EPsy 5660 or #; S-N optional)
Problems of administration and organization of special education programs.

5200. DESIGN AND MANAGEMENT OF EDUCATION SERVICES. (3 cr; S-N optional)
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.

5202. POLITICS OF EDUCATION. (3 cr, §8202 or §SPFE 5202 or §SPFE 8202; S-N optional)
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.

5203. THE COMMUNITY SCHOOL. (3 cr, §8203; S-N optional)
Changing structure and process in school organization; evolving team model; multiple-skills process in socialization.

5210. FINANCING ELEMENTARY AND SECONDARY SCHOOLS. (3 cr, §8210; S-N optional)
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.

5212. SCHOOL BUDGETING. (3 cr, §8212)
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)
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, §8214)
Basic techniques required to generate, maintain, and make accessible computer-based management information system in education.

5224. LEGAL IMPLICATIONS OF ACTS BY SCHOOL BOARDS, ADMINISTRATORS, AND TEACHERS. (3 cr, §8224)
Constitutional, statutory, and common law bases of school administration; principles growing out of fundamental legal procedures.

5225. EDUCATIONAL POLICY AND THE LAW. (3 cr, §8225)
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, §8226; S-N optional)
Planning educational facilities for public and private school systems and institutions of higher education.

5227. PUBLIC SCHOOL PERSONNEL PROGRAMS. (3 cr, §8227; S-N optional)
Selection, assignment, evaluation, and development of school personnel; salary and conditions of service; policies of administrative, instructional, and noninstructional personnel.

5230. PUBLIC RELATIONS FOR SCHOOL ORGANIZATIONS. (3 cr, §8230; S-N optional)
Concepts central to public relations programs in education studied in selective theoretical contexts relevant to administrative leadership.

5231. PRACTICUM: PUBLIC RELATIONS FOR SCHOOL ORGANIZATIONS. (1-4 cr; S-N optional)
Practical experience in design and use of basic tools in a program such as conducting community analysis; preparing copy and news releases; meeting, working with material for the press, radio, and television; planning school publications; opinion polling and personal conferences.

5233. PRACTICUM: MIDDLE SCHOOL ADMINISTRATION. (1-4 cr; S-N optional)
Projects such as articulation with elementary and senior high schools; organizing to meet the needs of the preadolescent; activity programs; guidance functions.

5250. AMERICAN HIGHER EDUCATION. (4 cr, §Educ 5250, §HiEd 5250; S-N optional)
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.

5274. TWO-YEAR POSTSECONDARY INSTITUTIONS. (3 cr, §VoEd 5274; S-N optional)
Present status, development, functions, organization, curriculum, and trends in postsecondary but nonbaccalaureate institutions.

5275. TWO-YEAR COLLEGE ADMINISTRATION. (3 cr, §8275; prereq 5274 or VoEd 5274; S-N optional)
Selected topics and problems associated with administration, administrative positions, and organization of postsecondary but nonbaccalaureate institutions.

5280. INTRODUCTION TO THE ECONOMICS OF EDUCATION. (4 cr, §SPFE 5180; S-N optional)
Economic impact of education on educational markets, prices and production relationships, distribution of income, and investment and cost-benefit analysis in education.

5292. THE LAW AND POSTSECONDARY EDUCATIONAL INSTITUTIONS. (3 cr, §HiEd 5292)
Analysis of court opinions and Federal regulations affecting postsecondary educational institutions.

8215. THE ELEMENTARY SCHOOL PRINCIPALSHIP. (3 cr)
Problems in elementary school administration and the principal's role of leadership.

8216. RECENT RESEARCH IN ELEMENTARY SCHOOL ADMINISTRATION. (3 cr; prereq 8215)
Pertinent research literature.

8217. SEMINAR: ELEMENTARY SCHOOL ADMINISTRATION. (3 cr; prereq 8216 or #)
Problems of administration and organization of instruction.

8218. SEMINAR: THE SOCIAL ORGANIZATION OF SCHOOLS. (3 cr; prereq 5201 or #; offered when feasible)
Structural components of school organization examined within the framework of social system theory; classifications of system properties and observations in operational contexts investigated by means of empirical models.

8219. SEMINAR: APPLIED HUMANISM IN ADMINISTRATIVE BEHAVIOR: THE CLASSICAL PERSPECTIVE. (3 cr, §Clas 8219; prereq 5201 or #; offered when feasible)
Interdisciplinary methodologies used to synthesize reflective thought and aesthetic works of classical antiquity with theoretical literature of administration and leadership roles; focus on classical materials having applied value for preparation of school administrators.

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.

8221. QUANTITATIVE MODELS FOR PROGRAM ANALYSIS AND RESEARCH. (3 cr; prereq 8220)
Quantitative techniques for program analysis, research, and decision making in the administration of educational organizations; emphasis on general linear models and computer usage.

8223. QUANTITATIVE TECHNIQUES FOR DECISION MAKING. (3 cr; prereq 8220 or #)
Decision-making procedures and Bayesian statistical analysis for administration of educational organizations.

8228. PROBLEMS: HIGHER EDUCATION. (Cr ar, §HiEd 8228; prereq #)
Selected topics on college programs, instruction, organization, and administration.

8229. SEMINAR: HIGHER EDUCATION. (1-4 cr, §HiEd 8229; prereq #)
Intensive study of selected topics.

8234. SEMINAR: EDUCATIONAL FINANCE. (3 cr; prereq 5210 or #)
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.

8235. SEMINAR: APPLIED HUMANISM IN ADMINISTRATIVE BEHAVIOR: THE MODERN PERSPECTIVE. (3 cr; prereq 5201 or #; offered when feasible)
Administrative leadership and the human condition examined as an aspect of social exchange theory; includes concepts of power and influence and insights from the humanities.

8236. SEMINAR: EDUCATIONAL FACILITIES PLANNING. (3 cr; prereq 5226 or #)
Application of principles of educational facility planning to development of education and specifications.

8237. SEMINAR: THEORY AND RESEARCH IN EDUCATIONAL LAW. (1-3 cr; prereq 5224 or 5292 or 8225)
Legal theory as it applies to education.

8238. SEMINAR: THEORY AND RESEARCH. (3 cr; prereq educational administration major or #)
Research design involving thesis or field project; includes interrelatedness of formulation of conceptual framework and the analytical process; clinical and research problems.

8240. SEMINAR: CLINICAL EXPERIENCES IN EDUCATIONAL ADMINISTRATION. (1-9 cr)
For educational administration majors engaged in clinical experiences.

8241. SEMINAR: INTERNSHIP IN EDUCATIONAL ADMINISTRATION. (0-9 cr)
For interns in elementary, secondary, general, and postsecondary administration.

8242. SEMINAR: PUBLIC SCHOOL PERSONNEL PROGRAMS. (3 cr; prereq 5227 or #)
Analysis of selected school personnel topics for in-depth study.

8247. SEMINAR: SCHOOL DISTRICT POLITICS. (3 cr; prereq 5202)
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)
Impact of metropolitanization on policy issues confronting public schools in core cities; strategies proposed for restructuring educational governance emphasizing Twin Cities metropolitan area.

8253. ADMINISTRATION IN HIGHER EDUCATION. (3 cr, §HiEd 8255; prereq 5201, 5250 or HiEd 5250, EdPA 5201)
Higher education governance, management, and leadership from theoretical and applied perspectives; decision-making structures and processes, management of constrained resources, conflict management, information systems and planning.

8264. THE SECONDARY SCHOOL PRINCIPALSHIP. (3 cr)
Role of the principal: qualifications, duties, and problems, including current issues and factors of staff and student relationships.

8265. ADMINISTERING THE HIGH SCHOOL PROGRAM. (3 cr)
Practices and procedures used in building a master schedule; analysis and evaluation of the school program and services.

8270. PROBLEMS: ELEMENTARY SCHOOL ADMINISTRATION. (Cr ar; prereq #)

8271. PROBLEMS: SECONDARY SCHOOL ADMINISTRATION. (Cr ar; prereq #)

8272. PROBLEMS: EDUCATIONAL ADMINISTRATION. (1-3 cr per qtr)
For superintendents and principals qualified to make intensive studies of a school system.

8273. FIELD STUDY. (0-10 cr; prereq #)
Required for specialist in education certificate. The 10 credits will be based on a written report covering an approved field study. Students may register for the general planning and organization of their study without credit.

8276. SEMINAR: ADMINISTRATION OF CURRICULUM IN THE TWO-YEAR COLLEGE. (3 cr; prereq 5274)
Principles of curriculum management within postsecondary but nonbaccalaureate institutions emphasizing methods of assessing faculty, courses offered, and administrative designs.

8278. RECENT RESEARCH IN TWO-YEAR COLLEGE ADMINISTRATION. (1-3 cr [max 3 cr]; prereq #)
Examination of pertinent research topics in two-year college administration.

8290. FINANCING HIGHER EDUCATION. (3 cr, §HiEd 8290; prereq #)
Financing postsecondary systems at national and state levels; financing postsecondary students; budgeting and financial analysis in postsecondary institutions; cost-effectiveness analysis.

Higher Education (HiEd)

5250. AMERICAN HIGHER EDUCATION. (4 cr, §Educ 5250, §EdAd 5250; S-N optional)
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.

5292. THE LAW AND POSTSECONDARY EDUCATIONAL INSTITUTIONS. (3 cr, §EdAd 5292)
Analysis of court opinions and federal regulations affecting postsecondary educational institutions.

5540. SEMINAR: THE COLLEGE STUDENT. (3 cr, §EPsy 5451, §PsyS 5540; prereq 6 cr psychology or educational psychology; S-N optional)
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.

8228. PROBLEMS: HIGHER EDUCATION. (Cr ar, §EdAd 8228; prereq #)
Selected topics on college programs, instruction, organization, and administration.

8229. SEMINAR: HIGHER EDUCATION. (1-4 cr, §EdAd 8229; prereq #)
Intensive study of selected topics.

8230. SEMINAR: DISSERTATION RESEARCH IN HIGHER EDUCATION. (1 cr per quarter; prereq #)
Three-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.

8250. THE HIGHER EDUCATION INSTITUTION: ORGANIZATION AND ENVIRONMENT. (3 cr, §Educ 8250; prereq 5250 or EdAd 5250, EdPA 5201)
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, §Educ 8251; prereq 5250 or EdAd 5250)
Nature of academic programs; change processes; role of education.

8252. INSTRUCTION AND LEARNING IN HIGHER EDUCATION. (3 cr, §Educ 8252; prereq 5250 or EdAd 5250)
Teaching-learning relationship; study and appraisal of methods employed to encourage, guide, and appraise students' learning.

8253. SEMINAR: IMPROVEMENT OF COLLEGE INSTRUCTION. (Cr ar; prereq #; offered when feasible)
For instructors, teaching assistants, and graduate students from various departments of the University and other institutions; current problems, research, and trends; offered with cooperating staff of various teaching departments.

8254. DIRECTED EXPERIENCE IN COLLEGE INSTRUCTION. (Cr ar; prereq #; offered when feasible)
Individualized program under guidance of an instructor or department; understandings, procedures, and skills related to application of instructional theory, curriculum development, and evaluation practices. Offered with cooperating staff of various teaching departments.

8255. ADMINISTRATION IN HIGHER EDUCATION. (3 cr, §EdAd 8253; prereq 5250 or EdAd 5250, EdPA 5201)
Higher education governance, management, and leadership from theoretical and applied perspectives; decision-making structures and processes, management of constrained resources, conflict management, information systems and planning.

8290. FINANCING HIGHER EDUCATION. (3 cr, §EdAd 8290; prereq #)
Financing postsecondary systems at national and state levels; financing postsecondary students; budgeting and financial analysis in postsecondary institutions; cost-effectiveness analysis.

Social and Philosophical Foundations of Education (SPFE)

5090. SCHOOL AND SOCIETY. (3 cr, §3090; prereq ar or post-BA student in education)
Readings in social science and philosophy relevant to thinking about role of school in changing American society.

5099. DIRECTED STUDY. (Cr ar [max 9 cr]; S-N optional; prereq #)
Individual or group work on topics or problems in social and philosophical foundations of education.

5101. HISTORICAL FOUNDATIONS OF MODERN EDUCATION. (3 cr; S-N optional)
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; S-N optional)
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.

5120. HISTORY OF CHILDHOOD EDUCATION. (3 cr; S-N optional)
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; S-N optional)
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.

5131. COMPARATIVE EDUCATION. (3 cr; S-N optional)
European, Asiatic, and American systems and philosophies of education; possibilities of international education.

5141. CRITICAL ISSUES IN CONTEMPORARY EDUCATION. (3 cr; S-N optional)
Introduces graduate students to ideas involved in current theory and practice.

5155. HISTORY OF WESTERN EDUCATIONAL THOUGHT. (3 cr; S-N optional)
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; S-N optional)
Readings in American political, economic, and social development related to education; reference to the emerging system of public education. Recommended as background for SPFE 5170, but not a prerequisite.

5170. AMERICAN PRAGMATISM AND EDUCATION. (3 cr; S-N optional)
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; S-N optional)
Cross-cultural perspectives in examining educational patterns, the implicit and explicit cultural assumptions underlying them; methods and approaches to cross-cultural studies in education.

5172. ANTHROPOLOGY OF AMERICAN EDUCATION. (3 cr, §Anth 5144; prereq △; S-N optional)
Application of anthropological principles to study of socialization, schooling, and cultural transmission in the United States; utility of anthropological concepts for study of our own education systems and analysis of educational change.

5174. FIELD METHOD FOR THE STUDY OF EDUCATION. (4 cr; prereq 5171 or 5172 or Anth 5145 or Anth 5144 or Anth 1502; S-N optional)
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. INTRODUCTION TO SYSTEMS THEORY IN SOCIAL SCIENCE AND EDUCATION. (3 cr; S-N optional)
Fundamental aspects of general systems theory; readings; basic modeling techniques.

5176. ETHNOGRAPHIC RESEARCH SKILLS LABORATORY. (2 cr; prereq ¶5174; S-N only)
Introduction to processes of creating evaluative design; supervised practice in data analysis, use of theory, proposal writing, reporting.

5180. INTRODUCTION TO THE ECONOMICS OF EDUCATION. (4 cr, §EdAd 5280; S-N optional)
Economic impact of education on educational markets, prices and production relationships, distribution of income, and investment and cost-benefit analysis in education.

5182. COMPARATIVE PHILOSOPHIES OF EDUCATION. (3 cr; S-N optional)
Examination of competing philosophies of education.

5190. SOCIOLOGY OF EDUCATION. (4 cr, §Soc 5953; S-N optional)
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.

5191. PROFESSIONALIZATION AND TEACHING. (3 cr; offered when feasible; S-N optional)
Process, social history, and ideology; role of teacher organizations; forms of militancy; comparison with professionalism in other occupations.

5192. SOCIOLOGY OF HIGHER EDUCATION. (4 cr, §Soc 5958; prereq introductory statistics or #; S-N optional)
Advanced studies in social aspects of higher education; socialization of students, comparative institutional organization, role structure; emphasis on theory and empirical research.

5202. POLITICS OF EDUCATION. (3 cr, §8202, §EdAd 5202, §EdAd 8202; S-N optional)
Social science findings, concepts, and methods used to consider political context of education administration; emphasis on public school policymaking by local and state governments; role of administrators.

5209. EDUCATION IN FUTURE SOCIAL SYSTEMS. (3 cr, §5212; S-N optional)
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; S-N optional)
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; S-N optional)
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.

8170. SEMINAR: RESEARCH METHODS IN ANTHROPOLOGY AND EDUCATION. (1-3 cr [max 9 cr]; prereq 5174 or 5175 or Anth 8152 or #)
Anthropological research below dissertation level including designing and carrying out of a research project related to education, schools, or socialization; emphasizes relevant theory, reliability and validity, research ethics, and reporting.

8172. SEMINAR: TOPICS IN ANTHROPOLOGY AND EDUCATION. (3-9 cr; prereq 5171 or 5172 or grad student in anthropology)
Each quarter a selected aspect of the field is chosen: theory or history in anthropology and education, cases in minority education, the work of Margaret Mead.

8220. SEMINAR: SOCIAL AND EDUCATIONAL FUTURES. (1-6 cr [max 6 cr]; prereq 5209 or 5210 or 5211 or #)
Review and critique of outstanding theoretical contributions of leading social and educational futurists to delineate areas for additional inquiry and research.

8241. PROBLEMS: HISTORY AND PHILOSOPHY OF EDUCATION. (Cr ar; prereq #)
For graduate students interested in research and original work in these areas.

8242. SEMINAR: EDUCATIONAL PHILOSOPHY. (3 cr; prereq #; offered alt yrs)
For advanced students; critical study and discussion of special problems.

8255. SEMINAR: EUROPEAN AND AMERICAN EDUCATIONAL THOUGHT: 16TH AND 17TH CENTURIES. (3 cr; prereq 5155 or ¶5155 or #; offered when feasible)
Analysis and interpretation of primary source materials of 16th- and 17th-century educational thought and practice in Western Europe, principally England.

8256. SEMINAR: EUROPEAN AND AMERICAN EDUCATIONAL THOUGHT: 17TH CENTURY. (3 cr; prereq 5155 or 8255 or #; offered when feasible)
Analysis and interpretation of primary source materials of 17th-century educational thought and practice in Western Europe and the American colonies.

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.

8290. ADVANCED SOCIOLOGY OF EDUCATION. (3 cr; prereq 5190 or Soc 5953 or #; offered alt yrs)
Analysis of a contemporary critical socioeducational problem; choice of problem varies from quarter to quarter.

8991. PROBLEMS: SOCIOLOGY OF EDUCATION. (1-3 cr [max 9 cr]; prereq 5190 or Soc 5953 or #; offered when feasible)
Guided reading and development of research topics; formulation of appropriate research designs.

Educational Psychology (EPsy)

Professor: Jack C. Merwin, *chair;* Frank H. Wood, *director of graduate studies;* Bruce Balow; William M. Bart; Jerome Beker; Robert H. Bruininks; Russell W. Burris; Mark L. Davison; Stanley L. Deno; Byron Egeland; David L. Giese; Lorraine S. Hansen; Thomas J. Hummel; David W. Johnson; Paul E. Johnson; Roger T. Johnson; Dorothy R. Loeffler; Geoffrey R. Maruyama; James R. Rest; Maynard C. Reynolds; John E. Rynders; S. Jay Samuels; Thomas M. Skovholt; Marlowe H. Smaby; Martin L. Snoke (emeritus); John E. Stecklein; Robert D. Tennyson; W. Wesley Tennyson; James S. Terwilliger; James E. Turnure; Richard F. Weatherman; Richard A. Weinberg; Wayne W. Welch; Frank B. Wilderson, Jr.; James E. Ysseldyke

Associate Professor: Douglas H. Anderson; V. Lois Erickson; Susan C. Hupp; E. Gary Joselyn; Marie Knowlton; Donald G. MacEachern; Patricia R. McCarthy; John L. Romano; Susan Rose; Warren F. Shaffer; John M. Taborn

Assistant Professor: Annie Baldwin; Ernest C. Davenport; Lynne K. Edwards; Sherrie L. Lindborg; Scott R. McConnell; Elsa S. Shapiro; Paul W. van den Broek

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. 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 official transcripts from all colleges and universities attended. These test scores are required: Graduate Record Exam (GRE) and Miller Analogies Test (MAT) for M.A., and GRE, MAT, Minnesota Multiphasic Personality Inventory (MMPI), and Strong Campbell Interest Inventory (SCII) for Ph.D., *CSPP;* GRE and interview, *school psychology*; GRE, *special education*; and GRE, *psychological foundations.*

Applications to CSPP and school psychology are accepted for fall admission only; the deadline is February 1. Applications to psychological foundations and special education 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 is 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 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—The purpose of this program is to provide 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. One year of the 90-credit program is devoted to the general coursework leading to the M.A. degree in educational psychology. The second year allows for in-depth study in one or two areas of concentration related to the work of the counselor (e.g., career development and career education, family counseling, organizational and systems development, guidance administration). It is expected that the student will have completed coursework or can demonstrate competency in specified areas, with specialization in one or two. A year of full-time postbaccalaureate study at either the University of Minnesota or another institution before enrollment in the program is required to qualify for the specialist certificate.

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 as well as appropriate practicum experiences.

Special Education—This program is designed for students preparing for administrative, supervisory, and consultant positions in special education. Flexibility allows concentration in a particular field (e.g., education of the gifted, the mentally retarded, or the hearing impaired). Generally students will be 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.

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—Contact the director of graduate studies, Educational Psychology, 204 Burton Hall, University of Minnesota, 178 Pillsbury Drive S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5110. INTELLIGENCE. (3 cr, §PsyF 5147)
Theories of intelligence; its development; implications for educational practices and psychological research.

5111. PSYCHOLOGY AND PEDAGOGY OF READING. (3 cr, §PsyF 5148)
Physiological, psychological, and linguistic factors influencing beginning and fluent reading, implications for instruction.

5112. KNOWING, LEARNING, AND THINKING. (4 cr, §PsyF 5152)
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, §PsyF 5153)
Survey of psychological factors in design of instruction; performance criteria, strategy, and sequence in contexts 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, §PsyF 5182)
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. ADULT LEARNING AND EDUCATIONAL PRACTICE. (4 cr, §PsyF 5183)
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, §PsyF 5149)
Practical applications of reinforcement theory; behavior analysis, precision teaching, programmed instruction.

5117. PROBLEM ANALYSIS AND DECISION MAKING. (4 cr, §PsyF 5570)
Literature from decision research contrasted with literature in problem solving from cognitive psychology and psychology of information processing; improvement in decision making through consideration of training, allocation of work, and decision aids.

5118. INDIVIDUAL DIFFERENCES AND EDUCATIONAL PRACTICE. (4 cr, §PsyF 5581; prereq 5221 or PsyF 5121 or #)
Student characteristics (age, sex, personality, ethnicity, cognitive styles) as they relate to differences in performance. Methods and models for utilizing student characteristics to improve learning and development.

5130. PERSONALITY AND SOCIAL DEVELOPMENT. (3 cr, §PsyF 5162; prereq 5 cr introductory psychology)
Major concepts and research findings in adjustment and development, with special emphasis on educational implications.

5135. WORKSHOP IN HUMAN RELATIONS. (6 cr, §PsyF 5305; 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.

5150. SOCIAL PSYCHOLOGY OF EDUCATION. (4 cr, §PsyF 5170)
Concepts and theories applied to educational problems and settings; laboratory sessions to make applications and develop skills in group behavior.

5151. STRUCTURING LEARNING: SOCIAL PSYCHOLOGICAL APPROACHES. (3 cr, §PsyF 5172)
How to use cooperation, competition, and individualization to affect learning climate and cognitive and affective outcomes of instruction.

5152. ISSUES IN SCHOOL DESEGREGATION. (4 cr, §PsyF 5173; prereq survey course in social psychology or #)
Policy, methods, theory, research; emphasis on outcomes for children.

5153. WORKSHOP: IMPROVEMENT OF SCHOOL SUPPORT SERVICES. (1-12 cr [max 12 cr]; prereq #)
Topics appropriate to activities and interest of participants; each offering to focus on current problems.

5217. EDUCATIONAL RESEARCH COLLOQUIUM. (1 cr [max 6 cr]; S-N only)
Planned presentations for faculty and students of contemporary educational research by researchers.

5220. EDUCATIONAL MEASUREMENT IN THE CLASSROOM. (4 cr, §PsyF 5120; S-N optional)
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, §PsyF 5121; prereq 5260 or 8260 or PsyF 5110 or 8110; S-N optional)
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.

5240. PRINCIPLES AND METHODS OF EVALUATION. (3 cr, §PsyF 5125; S-N optional)
Introductory course in program evaluation; theory; practical examples; purpose, roles, program descriptions, and evaluation strategies.

5243. PRACTICUM: INSTRUMENTS AND PROCEDURES FOR EVALUATION. (3 cr, §PsyF 5621; prereq 5221, 5240 or PsyF 5121 or PsyF 5125 or equiv; S-N optional)
Development of curriculum evaluation instruments and procedures; introduction to methods and theories; focus on identification of evaluation problems; development and implementation of techniques for their solution.

5246. EVALUATION COLLOQUIUM. (1 cr [max 6 cr]; S-N only)
Informal seminar of faculty and students interested in the problems of evaluation.

5260. INTRODUCTORY STATISTICAL METHODS. (4 cr, §PsyF 5110; S-N optional)
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, §PsyF 5111; S-N only)
Introduction to concepts and operations; applications in multiple regression, factor analysis of variance.

5262. STATISTICAL METHODS COMPUTER LABORATORY. (2 cr, §PsyF 5112; prereq 5260 or PsyF 5110 or equiv; S-N only)
Practical experience using time-sharing computer language MINITAB; applications of introductory statistical methods and concepts to data files.

5280. COMPUTER PROGRAMMING: PASCAL. (3 cr, §PsyF 5330; prereq sr; S-N optional)
Computer as tool for research in behavioral sciences; Pascal is taught for both micro and mainframe; laboratory experience.

5281. INTRODUCTION TO COMPUTER OPERATIONS: U OF M SYSTEMS, SPSS. (1 cr, §PsyF 5333; S-N only)
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, §PsyS 5110)
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.

5402. COUNSELING PROCEDURES II. (3 cr, §PsyS 5111; prereq 5401 or PsyS 5110)
Analysis of type of client and stage of counseling; isolation of chain of interactions between client and counselor described and practiced; appropriate techniques.

5410. INTRODUCTION TO GUIDANCE. (3 cr, §PsyS 5130)
Philosophy, principles, and practices in development and operation of pupil personnel services; role of counselor, teacher, principal, and specialized personnel; guidance techniques and case studies.

5411. GROUP PROCEDURES IN GUIDANCE. (3 cr, §PsyS 5131; prereq 9 cr education, 5410 or PsyS 5130 or #)
Content and materials for home room groups, occupation units, and other guidance courses in junior and senior high school.

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 #)
Psychological theories related to test interpretation and counseling process; critical review and selection of standardized tests.

5422. GROUP COUNSELING: PRINCIPLES AND PROCEDURES. (3 cr, §PsyS 5320)
Basic principles of group dynamics related to group counseling process; emphasis on development of concepts, attitudes, and skills; includes theory and laboratory experiences.

5430. FOUNDATIONS OF CAREER DEVELOPMENT. (3 cr, §PsyS 5210)
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, §PsyS 5331)
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, §PsyS 5332; prereq 5430 or 5431 or PsyS 5210 or PsyS 5331 or equiv or #)
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, §PsyS 5310; S-N optional)
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)
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, §HiEd 5540, §PsyS 5540; prereq 6 cr psychology or educational psychology)
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, §PsyS 5505; prereq #)
Effect of cross-cultural and cross-national differences in counseling process.

5471. SEMINAR: PSYCHOLOGICAL EDUCATION. (3 cr [max 9 cr]; prereq #)
Review of curriculum programs in psychological/affective education including achievement training, sensitivity groups, psychological and moral education. Not intended to meet licensure requirements in school psychology.

5542. PRACTICUM IN GROUP COUNSELING. (1-6 cr [max 6 cr]; prereq 5422 or PsyS 5320 or equiv, #)
Supervised practice in counseling several groups, preferably in setting student intends to work; emphasis on systematic evaluation of progress through direct observations and tapes and on development of skills in interpersonal perception, communication, and research.

5571. PRACTICUM: PSYCHOLOGICAL EDUCATION. (1-3 cr [max 9 cr]; prereq #)
Practice designing and implementing programs in psychological/affective education. Not intended to meet licensure requirements in school psychology.

5600. CHILDHOOD LANGUAGE DEVELOPMENT: CLASSROOM IMPLICATIONS. (3 cr, §PsyS 5100)
Recent trends and findings in study of language acquisition; classroom implications for education of exceptional children.

5601. EDUCATION OF EXCEPTIONAL CHILDREN. (4 cr, §PsyS 5101)
Introduction to field of special education for classroom teachers and other school personnel.

5604. SOCIAL AND VOCATIONAL DEVELOPMENT OF HANDICAPPED STUDENTS. (4 cr, §PsyS 5104)
Organization and design of training programs to promote independent living, vocational and community adjustment of handicapped persons; curriculum materials and methods at adolescent and adult levels.

5605. LAW AND THE HANDICAPPED: IMPLICATIONS FOR EDUCATION. (2-4 cr, §PsyS 5105)
Analysis of recent litigation and legislation; emphasis on implementation of right to education, right to treatment, labeling, due process, and related issues.

5606. EXCEPTIONAL STUDENTS IN REGULAR CLASSES. (2 cr, §3606, §PsyS 3106, §PsyS 5106)
Policies and procedures for teaching handicapped and gifted students in regular school settings; exposure to special curriculum adaptations; collaborative roles of regular and special education teachers, parents, pupil personnel workers, and other educators.

5607. MAINSTREAMING: ISSUES IN INDIVIDUALIZING INSTRUCTION. (3-5 cr, §PsyS 5107)
Mandate for, implications of, and problems in implementation of systems models and practical classroom practices facilitating education of handicapped within regular classroom settings.

5608. PARENT AND PROFESSIONAL PLANNING FOR HANDICAPPED STUDENTS. (3 cr, §PsyS 5108)
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)
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, §PsyS 5112)
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. (4 cr)
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, §PsyS 5120; prereq 5601 or PsyS 5101 or #)
Issues relating to educational practices; community planning; educational philosophy, administration and organization, and programming.

5621. METHODS AND MATERIALS FOR ELEMENTARY AND SECONDARY MENTALLY RETARDED PUPILS. (4 cr, §PsyS 5121; prereq 5601 or PsyS 5101 or equiv)
Curriculum content, materials and methods of instruction for educable mentally retarded children; preparation of units and development of teaching aids.

5622. PROGRAMS AND CURRICULA FOR LEARNERS WITH SEVERE HANDICAPS. (3 cr)
Elementary and secondary school program design and curricula for learners with severe disabilities, including moderate to profound developmental delay, autism, and severe multi-handicapping conditions. Emphasis on preparing children and youth for integrated, normalized community environments in domestic living, leisure, and vocational domains.

5624. BIOMEDICAL ASPECTS OF DEVELOPMENTAL DISABILITIES. (Cr ar [max 4 cr], §PsyS 5124)
Selected information in genetics, anatomy and physiology, central nervous system, biochemistry of the body, and prenatal development; causative factors and clinical features, particularly mental retardation and its clinical manifestations.

5625. EDUCATION OF HANDICAPPED INFANTS AND PRESCHOOL CHILDREN. (4 cr, §PsyS 5125; prereq 5601 or 5620 or PsyS 5101 or PsyS 5120 or #)
Issues, problems, and practical applications in designing strong programs for young children with all types of handicapping conditions.

5626. INSTRUCTION FOR LEARNERS WITH SEVERE HANDICAPS. (3 cr; prereq 5622, 5700 or ¶5700)
Data-based strategies for school and non-school instruction; assessment, design, implementation, and evaluation of instruction related to specific disability, curriculum, and environmental learning; concept and task analysis; natural and instructional cures, corrections, consequences.

5635. EDUCATION OF STUDENTS WITH PHYSICAL DISABILITIES. (3 cr, §PsyS 5135; 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 PHYSICAL AND SENSORY IMPAIRMENTS. (4 cr; prereq 5601)
Characteristics; design of instructional programs to remedy or circumvent disabilities; use of prosthetic devices; related areas of performance affected by physical and sensory impairments.

5640. PSYCHOSOCIAL AND EDUCATIONAL ASPECTS OF DEAFNESS. (3 cr, §PsyS 5140)
Historical and current societal perceptions of the deaf; analysis of effects and patterns of auditory impairment on children and adults; intelligence, personal and social adjustment, effect of psychological processes on acquisition of language, speech, and speechreading skills.

5641. METHODS OF TEACHING SCHOOL SUBJECTS TO THE HEARING IMPAIRED. (3 cr, §PsyS 5141)
Adaptation of materials and teaching methods for hearing-impaired children in reading, mathematics, social studies, and science.

5643. LANGUAGE FOR HEARING-IMPAIRED CHILDREN. (4 cr, §PsyS 5143; prereq 5640 or PsyS 5140)
Functional language development in communicatively handicapped persons; overview of language curricula and programming strategies, pertinent research and models of instruction for use in educational environment.

5644. TEACHING LANGUAGE TO THE HEARING IMPAIRED II. (3 cr, §PsyS 5144)
Devising language curricula and teaching techniques in primary, intermediate, and advanced programs for the deaf; comparative study of the language development of the deaf and hearing.

5645. TEACHING SPEECH TO THE HEARING IMPAIRED I. (3 cr, §PsyS 5145)
Survey of speech methodologies in teaching auditorily impaired children; major emphasis on techniques for teaching specific sounds, articulation, voice, and sentence rhythm, stressing intelligibility of speech. Demonstration and practice with individuals and groups of auditorily impaired children.

5647. AURAL REHABILITATION OF HEARING-IMPAIRED CHILDREN. (3 cr, §PsyS 5147)
Recent trends in training hearing-impaired (deaf and hard-of-hearing) children in utilization of residual hearing; consideration of present alternative approaches to auditory training and aural rehabilitation.

5648. MODES OF COMMUNICATION FOR THE HANDICAPPED. (3 cr, §PsyS 5148)
Theoretical and applied study of selection and application of alternative communication modalities; assessment and development of modes including gestures, speech reading, cued speech, sign systems, form boards, and Bliss-symbolics.

5649. CLINICAL AND EDUCATIONAL PROCEDURES FOR PRESCHOOL AND PRIMARY HEARING-IMPAIRED CHILDREN. (6 cr, §PsyS 5340; prereq teacher of hearing impaired or #)
Overview of education of the deaf; practical application to guided clinical experience with hearing-impaired children ages 1-6. For professionals working with the hearing-impaired.

5651. MANAGING PROBLEM BEHAVIOR IN THE CLASSROOM. (3 cr, §PsyS 5151)
Typical patterns of problem behavior in classroom settings; relationships to teacher mental health; simulation of methods for prevention and management.

5654. EDUCATIONAL INTERVENTIONS FOR EMOTIONAL DISTURBANCE/ BEHAVIORAL DISORDERS. (4 cr)
Preparation for specialists: theoretical background; assessment procedures; strategies and interventions appropriate for school settings; teaching social behavior; team procedures.

5660. SUPERVISION AND ADMINISTRATION OF SPECIAL EDUCATION. (3 cr, §EdAd 5103, §PsyS 5160)
Procedures in establishing and improving educational programs for exceptional children.

5670. INTRODUCTION TO EDUCATION OF VISUALLY HANDICAPPED CHILDREN. (3 cr, §PsyS 5170)
Educational programs, services, and resources for blind and partially seeing children; historical background; philosophy; sociological and psychological problems.

5671. BRAILLE I. (3 cr, §PsyS 5171; prereq 5670 or PsyS 5170 or #)
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. BRAILLE II. (3 cr, §PsyS 5172; prereq 5671 or PsyS 5171, educ or grad student)
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 VISUALLY HANDICAPPED CHILDREN. (4 cr, §PsyS 5173; prereq 5670 or PsyS 5170)
Principles of preparation, selection, and effective use of instructional materials; adaptation of school environment; utilization of family, school, and community resources.

5674. ORIENTATION AND MOBILITY TECHNIQUES FOR VISUALLY IMPAIRED STUDENTS. (3 cr, §PsyS 5174)
Introduction to basic techniques to gain skills in precane 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, §PsyS 5175)
Ophthalmological and educational considerations of anatomy and physiology of the eye and visual tract, visual screening and visual efficiency.

5676. MANAGEMENT OF LOW VISION. (3 cr; prereq 5675 or #)
Advanced course requiring competence in evaluation and use of low vision aids; evaluating and managing cognitive, psychosocial, and physical needs of students; consideration of parent, teacher, and student counseling.

5680. EDUCATION OF THE DISADVANTAGED. (3 cr, §PsyS 5180; prereq 12 cr psychology or educational psychology 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 HANDICAPPED INFANTS AND PRESCHOOL CHILDREN. (3 cr, §PsyS 5181; prereq 12 cr education or #)
Methods, materials, conceptual models for maximizing educational development of young children with all types of handicapping conditions.

5690. EDUCATION OF THE GIFTED AND TALENTED. (3 cr, §PsyS 5190)
Origin and development of terms such as giftedness, creativity, genius, talent, and intelligence; implications for educational practice; current issues and trends.

5695. INTRODUCTION TO RESEARCH IN SPECIAL EDUCATION. (2 cr, §PsyS 5501; S-N only)
Issues in special education; critique of research with exceptional children.

5700. ASSESSMENT AND DECISION MAKING IN SPECIAL EDUCATION. (3 cr, §PsyS 5200)
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 optional)
Supervised experience in teaching or related work in schools or other agencies serving exceptional children.

5702. WORKSHOP: SPECIAL EDUCATION. (Cr ar; prereq #)
Laboratory approach. Provides opportunities for school personnel to study specific problems related to special education.

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 PROCEDURES WITH MILDLY AND MODERATELY HANDICAPPED PEOPLE. (4 cr, §PsyS 5305; 5116, PsyF 5149, or Psy 5017 recommended)
Behavioral approaches to improving academic and personal-social behavior of mildly and moderately handicapped people 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)
Normal functioning within these domains; nature of deficits and developmental delays and differences; associated deficits in related curriculum areas; design of instruction to enhance performance in functional instructional domains.

5710. CONTEMPORARY SERVICES FOR PERSONS WITH DEVELOPMENTAL DISABILITIES. (3 cr)
Survey of characteristics and service needs of persons with substantial developmental disabilities using multidisciplinary approaches. Changing concepts, models of services, issues related to promoting independence, productivity, and integration into the community.

5711. PRACTICUM: BEHAVIOR ANALYSIS CERTIFICATE PROGRAM. (Cr ar; prereq #)
Practical experience applying behavioral intervention techniques and principles in applied settings.

5713. ASSESSMENT IN INFANCY AND EARLY CHILDHOOD. (3 cr, §PsyS 5313; S-N optional)
Issues related to psychological assessment of neonates, infants, and toddlers to age two; basic theory, knowledge, current research in relationship to current practices.

5801. WORKSHOP IN SCHOOL PSYCHOLOGY. (3-6 cr [max 6 cr])
Concepts and techniques of psychological and developmental education applied to needs of specific groups of educators, emphasizing classroom applications. Improving effectiveness of educational programming for conceptual, moral, or ego development. Positive self identity. Interpersonal and affective growth.

5814. METHODS OF DEVELOPMENTAL INTERVENTION IN THE CLASSROOM: GROUP. (3 cr, §PsyS 5514; prereq #; S-N optional)
Developmental approach to use of group techniques to promote psychological growth in the classroom.

5815. METHODS OF DEVELOPMENTAL ASSESSMENT: THE PUPIL AND CURRICULUM CONTENT. (3-6 cr [max 6 cr]; S-N optional)
Practical approaches matching individual development with curriculum materials; developmental psychology applied to assessment of individual pupils and instructional programs.

5849. ASSESSMENT OF THE PRESCHOOL CHILD. (3 cr, §PsyS 5549; prereq statistics or measurement or grad course in assessment; S-N optional)
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.

5900. INDEPENDENT STUDY. (Cr ar [max 12 cr]; prereq #)
Independent study in areas of special interest to students.

8111. KNOWLEDGE AND SKILL. (3 cr, §PsyF 8541 or §PsyF 8544)
Analysis of expertise in human problem solving; representation of knowledge and skill; issues in artificial intelligence; semantic memory, process of acquisition, design of training environments.

8112. SEMINAR: COGNITIVE PROCESSES OF THE ADOLESCENT AND EDUCATIONAL IMPLICATIONS. (3 cr, §PsyF 8547)
Critical issues in relationship between development of cognitive processes in adolescent and curriculum structure, pedagogy, measurement practices, and evaluation procedures; discussion of research literature.

8113. PSYCHOLOGICAL ANALYSIS OF VERBAL LEARNING AND READING. (3 cr, §PsyF 8548; prereq 5111 or intro course in learning or #)
Discriminatory, decoding, semantic, and syntactic aspects; designs and procedures used to investigate psychological problems.

8114. ETHOLOGICAL ISSUES IN EDUCATION. (3 cr, §PsyF 8553; prereq CPsy 5329 or #)
Analysis and interpretation of selected educational issues; planning of ethological studies in education; examination of methodological issues in naturalistic observational research.

8115. INSTRUCTIONAL PSYCHOLOGY. (3 cr, §PsyF 8554; prereq course in learning and/or instructional psychology)
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.

8116. THEORETICAL DEVELOPMENTS IN INSTRUCTIONAL DESIGN. (3 cr, §PsyF 8682; prereq 5112 or PsyF 5152 or #)
Instructional theories as related to models of design; historical developments in reference to examination of current theoretical models.

8128. RESEARCH PROBLEMS: INSTRUCTIONAL PSYCHOLOGY. (Cr ar [max 9 cr]; prereq #)
Guided reading and research consultation; formulation of research designs.

8129. RESEARCH PROBLEMS: LEARNING AND COGNITION. (Cr ar; prereq #)
Formulation of research designs.

8130. PERSONALITY DEVELOPMENT AND SOCIALIZATION. (3 cr, §PsyF 8562; prereq 1 grad course in personality or child psychology; concurrent regis in 8149 recommended)
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, §PsyF 8565; 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. (4 cr, §PsyF 8571; prereq 5150 or PsyF 5170 or equiv)
Review of research and theory, application to practical settings.

8151. ORGANIZATIONAL DEVELOPMENT AND CHANGE. (4 cr, §PsyF 8572; prereq 5150 or PsyF 5170 or equiv)
Review of theory and research procedures and methods for changing organizations; special reference to educational organizations.

8152. SMALL GROUP PROCEDURES USED FOR PERSONAL AND ORGANIZATIONAL CHANGE. (4 cr, §PsyF 8573; prereq 5150 or PsyF 5170 or equiv)
Review of theory, research, and procedures for using small group techniques for changing individuals and organizations. Laboratory experiences to make applications and develop skills in leading small groups.

8153. SOCIAL AND PSYCHOLOGICAL INFLUENCES ON INDIVIDUAL BEHAVIORS. (3 cr, §PsyF 8574; prereq intro course in social psych or #)
Social and situational influences on individual behavior, focusing on effects of norms, peers, and others; situational characteristics affecting evaluation by self or others.

8154. PRACTICUM IN GROUP LEADERSHIP. (3 cr, §PsyF 8670; prereq #)
Supervised practice in leading a discussion or activity group.

8169. RESEARCH PROBLEMS: SOCIAL PSYCHOLOGY. (Cr ar; prereq #)
Formulation of research topics and designs.

8210. METHODS IN EDUCATIONAL RESEARCH. (3 cr, §PsyF 8120; prereq spring qtr PhD students only)
Methods and techniques employed in investigation and report of educational problems. Suggested for all candidates for graduate degrees.

8211 SEMINAR: RESEARCH PLANNING. (1 cr [max 3 cr])
Functional approach to planning empirical research projects appropriate for basis of Ph.D. thesis. Students develop outlines of projects and present them for critical review by seminar members.

8220. ADVANCED THEORY OF MEASUREMENT. (3 cr, §PsyF 8522; prereq 5221, 8261, PsyF 5121, PsyF 8111 or #)
Principles underlying constructionand use of psychological and educational measuring instruments, limitations of tests for purposes of measurement and evaluation. Students may register concurrently or subsequently for 8239 of individual extensions and applications.

8221. THEORY OF PSYCHOLOGICAL SCALING. (3 cr, §PsyF 8523; prereq 5221 and 8261 or PsyF 5121 and 8111 or #)
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 #)
Special topics in development and use of evaluation procedures in education.

8247. INTERNSHIP: EVALUATION. (3 cr [max 12 cr]; prereq #)
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)
Designing, implementing, analyzing strategies. Students work on their own problems, on evaluation problems of school in area, or on problems associated with national curriculum projects.

8260, 8261, 8262. STATISTICAL METHODS. (3 cr per qtr, §PsyF 8110, 8111, 8112; 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, §PsyF 8113; 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, §PsyF 8114; prereq 5261 and 8261 or ¶5261 or PsyF 5111, PsyF 8111 or #)
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, §PsyF 8117; prereq 5261, 8261 or ¶5261 or PsyF 5111, 8111 or #)
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, §PsyF 8510; prereq 8261 or PsyF 8511 or equiv or #)
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. COMPUTER APPLICATION TO STATISTICAL ANALYSES. (3 cr, §PsyF 8130; prereq 8262 or PsyF 8112 or equiv)
Use of computer to analyze data from behavioral sciences; interpretation of results; attention to large-scale problems.

8281. SEMINAR: DEVELOPING COMPUTER APPLICATIONS. (3 cr, §PsyF 8530; prereq 5280 or PsyF 5330 and #)
Specific problems of computer utilization in research and development activities in behavioral sciences. Laboratory experience.

8289. RESEARCH PROBLEMS: COMPUTER APPLICATIONS. (Cr ar; prereq #)
Recent developments in computer applications to educational and psychological problems.

8402-8403-8404. COUNSELING THEORY AND PROCEDURES I, II, III. (3 cr each, §PsyS 8302-8303-8304; prereq ¶8502 and # for 8402, 8402 and ¶8503 and # for 8403, 8403 and ¶8504 and # for 8404)
Introduction to theory and practice of individual and group counseling; theoretical approaches to counseling and vocational choice theories; utilization of diagnostic principles, dynamics of interviewing; small group dynamics.

8410. SEMINAR: ADVANCED COUNSELING THEORY. (4 cr, §PsyS 8510; prereq PhD student, #)
Theoretical positions in learning and personality development relating to emerging theory of counseling.

8411. SEMINAR: ADVANCED COUNSELING RESEARCH. (4 cr, §PsyS 8511; prereq PhD student, #)
Seminar for doctoral students interested in designing and executing small scale research projects.

8412. SEMINAR: ADVANCED COUNSELING RESEARCH. (4 cr, §PsyS 8512; prereq PhD student, #)
Seminar for doctoral students interested in professional development issues and in designing and executing small scale research projects.

8420. COLLEGE STUDENT PERSONNEL WORK—FOUNDATIONS AND SCOPE. (3 cr, §PsyS 8140; prereq course in higher education or concurrent registration or #)
For potential personnel workers in college or university; scope, administration, coordination, and evaluation of program.

8421. COLLEGE STUDENT PERSONNEL WORK—HOUSING. (2 cr, §PsyS 8541; prereq 8420 or PsyS 8140)
Weekly seminar discussion of college student personnel work.

8422. COLLEGE STUDENT PERSONNEL WORK—STUDENT ACTIVITIES. (2 cr, §PsyS 8542; prereq 8420 or PsyS 8140)
Weekly seminar discussion of college student personnel work.

8423. COLLEGE STUDENT PERSONNEL WORK—DISCIPLINE AND ADMINISTRATION. (2 cr, §PsyS 8543; prereq 8140 or PsyS 8140)
Weekly seminar discussion of college student personnel work.

8424. DIAGNOSIS AND TREATMENT OF COLLEGE LEARNING DIFFICULTIES. (3 cr, §PsyS 8341; prereq reading course, #)
Introduction to principles and practice; readings in research literature with emphasis on reading and study skills.

8431. MASTERS SEMINAR: CSPP. (Cr ar [max 6 cr]; prereq MA student, #)
Discussion of significant issues in the field.

8432. DOCTORAL SEMINAR: CSPP. (Cr ar [max 6 cr]; prereq doctoral student in CSPP, #)
Issues in the field.

8433. PROFESSIONAL SEMINAR: CSPP. (Cr ar [max 10 cr]; prereq specialist student, #)
Continuous enrollment required of all part-time students enrolled in specialist program.

8434. SEMINAR: RESEARCH IN GROUP COUNSELING. (1-6 cr [max 6 cr]; prereq 8404, 8604, or 5422, 5542, or PsyS 8304, 8604, or PsyS 5320, 5620, or #)
Designed to develop interest and skill; focus on identification of significant issues and development of innovative ideas. Individual and group research projects.

8441. PSYCHOLOGICAL CONSULTATION: THEORY AND PRACTICE. (3 cr, §PsyS 8605)
Process of psychological consultation; various modes; review and relevant issues. Students will manage a consultation experience.

8450. PSYCHOLOGICAL ASPECTS OF COUNSELING SUPERVISION. (3 cr, §PsyS 8150; prereq 8410, 8504, or PsyS 8604 and #)
Consideration of theories; review of relevant research; experience in development, management, and supervision of counseling practicum.

8502-8503-8504. COUNSELING PRACTICUM I, II, III. (3 cr each, §PsyS 8602-8603-8604; prereq ¶8402 and # for 8502, ¶8403 and 8502 and # for 8503, ¶8404 and 8503 and # for 8504)
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.

8510. INTERNSHIP: CSPP. (0-6 cr [max 9 cr for MA and specialist students, 18 cr for PhD students])
Supervised employment at department-approved sites.

8513-8514-8515. COUNSELING PRACTICUM: UNIVERSITY COUNSELING SERVICES. (3 cr per qtr [max 9 cr], §PsyS 8613-8614-8615; prereq #)
Supervised experience in counseling at college and adult levels; 3 consecutive quarters beginning fall.

8520. COUNSELING PRACTICUM: ADVANCED. (1-3 cr [max 6 cr]; prereq #)
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.

8524. CLINICAL PRACTICE IN DIAGNOSIS AND TREATMENT OF COLLEGE LEARNING DIFFICULTIES. (3 cr, §PsyS 8641; prereq 8424 or PsyS 8341)
Supervised practice in group and individual work.

8603. SERVICES FOR PERSONS WITH DEVELOPMENTAL DISABILITIES: RESEARCH AND POLICY ANALYSIS. (3 cr) Bruininks
Interdisciplinary seminar examining research and conceptual literature on policies and management practices in providing services and social support for persons with substantial, life-long disabilities; emphasis on research, problems in education, prevention, health care, employment, rehabilitation, and related services.

8612. CURRENT ISSUES IN LEARNING DISABILITIES. (4 cr, §PsyS 8112)
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)
Review of research and theories in context of relevant developmental theories; important contributions in primary sources concerning principles of behavior and applied problems.

8621. FUNCTIONAL ANALYSIS OF BEHAVIOR IN THE MENTALLY RETARDED. (4 cr, §PsyS 8121; prereq 8620 or PsyS 8120 or #)
Empirical approach to study of development in mentally retarded, emphasizing psychological research; procedures for deriving appropriate field applications; generating and implementing researchable questions.

8651. THEORIES OF EDUCATING DISTURBED CHILDREN. (3 cr, §PsyS 8151; prereq #)
Applications of major personality theories to education of children with behavioral disorders.

8652. RESEARCH IN EDUCATION OF DISTURBED CHILDREN. (3 cr, §PsyS 8152; prereq #)
Review; critical analysis of specific designs and procedures; critique of current status of research.

8695. RESEARCH IN SPECIAL EDUCATION. (1 cr [max 3 cr])
Preparation for M.A. colloquium paper research; critique of research with handicapped children; review of research in special education.

8701. ADVANCED PRACTICUM. (Cr ar; prereq #)
Experience planned with supervising professor in college teaching, supervision of student teachers or other forms of advanced professional practice. Usually taken by advanced graduate students.

8702. SEMINAR: SPECIAL EDUCATION. (Cr ar; prereq #)
Special topics and schedules announced by department.

8706. BEHAVIORAL RESEARCH WITH HANDICAPPED STUDENTS. (Cr ar [max 4 cr]; prereq 5601 or PsyS 5101 or Psy 5017 or #)
Analysis and synthesis of recent research applying operant principles and methodology to academic and personal-social development of exceptional individuals.

8720. LANGUAGE ACQUISITION AND LEARNING THEORY. (3 cr, §PsyS 8540; prereq #)
Recent trends in developmental psycholinguistics; consideration of behavioristic, neobehavioristic, and biological theories.

8725. SOCIOCULTURAL THEORY AND RESEARCH ON HANDICAPPING CONDITIONS. (4 cr, §PsyS 8525)
Service arrangement, 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, §PsyS 8560, 8561 or §EdAd 5180, 5181; prereq 5660 or PsyS 5160, EdAd 5103 or #)
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 or human servs grad program or #) Bruininks, McConnell
Introduction to principles and procedures.

8780. SEMINAR: THE DISADVANTAGED. (3 cr, §PsyS 8580)
Psychological theory and research with implications for educational planning and procedures.

8810. TECHNIQUES OF PSYCHOEDUCATIONAL ASSESSMENT. (5 cr, §PsyS 8310; prereq #)
Current approaches to evaluation of individual child in context of educational setting; behavioral observations; interviewing procedures; administration and interpretation of standardized intelligence tests including Stanford-Binet and Wechsler scales. Field experiences require full day or two mornings a week.

8811. TECHNIQUES OF PSYCHOEDUCATIONAL ASSESSMENT: SPECIAL POPULATIONS. (5 cr, §PsyS 8311; prereq 8810 or PsyS 8310, #)
Individual assessment procedures appropriate for evaluating children with cerebral dysfunction, learning disabilities, physical handicaps. Field experiences in specialized educational settings require full day or two mornings per week for practicum.

8812. PERSONALITY APPRAISAL IN CHILDREN AND ADOLESCENTS. (5 cr, §PsyS 8312; prereq #)
Individual assessment of personality functioning in school-age children and adolescents; administration, scoring, and interpretation of objective and projective instruments. Full day or two mornings per week required for practicum.

8813. THEORIES AND METHODS OF INTERVENTION: INDIVIDUALS. (3 cr, §PsyS 8513)
Psychological intervention appropriate for disorders found in school-age populations. Provides basic knowledge of various intervention methods: individual verbal psychotherapy, plan therapy, milieu therapy, family intervention, conditioning techniques.

8814. THEORIES AND METHODS OF INTERVENTION: GROUPS. (3 cr, §PsyS 8514)
Training in use of group techniques in schools: use of T-group method. Designed to increase skills in problem solving, decision making, communication, and conflict resolution.

8815. THEORIES AND METHODS OF INSTRUCTIONAL INTERVENTION. (3 cr, §PsyS 8515; prereq 8810, 8811, or PsyS 8310, 8311 or #)
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.

8820. SEMINAR: RESEARCH IN SCHOOL PSYCHOLOGY. (2 cr [max 6 cr], §PsyS 8520; prereq #)
Seminar for doctoral candidates planning dissertation research in school psychology.

8821. SEMINAR: SCHOOL PSYCHOLOGY. (Cr ar; prereq #)
Intensive study of significant topics from behavioral sciences as they apply to contemporary educational problems.

8831. PRACTICUM: SCHOOL PSYCHOLOGICAL SERVICES. (1-5 cr; prereq #)
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)
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 8831 or PsyS 8610, #)
Advanced field experience for doctoral candidates in school psychology.

8841. INTERNSHIP: INSTRUCTION AND SUPERVISION IN SCHOOL PSYCHOLOGY. (1-9 cr; prereq 8840 or PsyS 8700 or # and doctoral candidate in school psychology)
Experience and tutorial for doctoral candidates preparing to train school psychologists in higher education settings.

8850. DEVELOPMENTAL NEUROPSYCHOLOGY. (3 cr; prereq 8810, 8811, 8812, or #)
Neuroanatomy; development of nervous system; theories of higher cortical functioning; assessment techniques; neuropsychology of learning disabilities, attentional disorders, language dysfunction, medical disorders; neuropsychological effects of medication and medical treatment; intervention approaches.

8853. NEW APPROACHES TO PSYCHOPATHOLOGY IN CHILDREN AND ADOLESCENTS. (3 cr, §PsyS 8153, §CPsy 8606)
Alternative formulation of childhood disorders, emphasizing competency training rather than medical nosology.

8900. RESEARCH PROBLEMS. (Cr ar; prereq #)
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 first yr EPsy doctoral student or #)
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 #)
Reading and analysis of research on selected problems.

Electrical Engineering (EE)

Regents' Professor: Lawrence Markus

Professor: Robert J. Collins, *head;* Vernon D. Albertson, *associate head;* Richard Y. Kain, *director of graduate studies;* James A. Carruthers (emeritus); Steven K. Case; Keith S. Champlin; Lorne M. Chanin; Philip I. Cohen; Anand Gopinath; Bernard V. Haxby (emeritus); Jack H. Judy; Mostafa Kaveh; Pramod P. Khargonekar; John C. Kieffer; Larry L. Kinney; K.S. P. Kumar; Robert F. Lambert; E. Bruce Lee; Marshall I. Nathan; Allen Nussbaum (emeritus); Hendrik J. Oskam; Robert P. Patterson; William T. Peria; Mahmoud Riaz; Rolf Schaumann; Otto H. Schmitt (emeritus); Michael Shur; Allen R. Tannenbaum; Alfons A. Tuszynski (emeritus); Aldert van der Ziel (emeritus); Raymond M. Warner, Jr.; Gottfried K. Wehner (emeritus)

Adjunct Professor: David Lamb; David S. Lo; Rolf Mueller (emeritus); Frederick M. Waltz

Associate Professor: Fredric N. Bailey; Douglas W. Ernie; James E. Holte; Thomas S. Lee; Ned Mohan; William A. Plice; Dennis L. Polla; William P. Robbins; Gerald E. Sobelman; Harry Wechsler

Assistant Professor: Kevin M. Buckley; Stephen A. Campbell; Vladimir S. Cherkassy; Naikuan Huang; Andrzej Peczalski; Ahmed H. Tewfik; Anthony J. Valois; Arthur D. Van Rheenen; Sudhakar Yalamanchili

Adjunct Assistant Professor: P. Paul Ruden

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., 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, acoustics, holography, 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, hydro-acoustics, 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—Foreign students applying from overseas are expected to score at least 550 on the TOEFL. Foreign 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.

Master's Degree Requirements—For the M.S.E.E. degree, full-time students follow a Plan A program unless permission is received from the adviser and the Graduate Advisory Committee to complete a Plan B program. Only the Plan B program is available to part-time students. For the M.E.E. degree, see Professional Master's Degree in Engineering in the General Information section of this bulletin. The final examination for the master's degree is oral.

Doctoral Degree Requirements—The written preliminary examination is conducted by the department twice each year. Students who enter the program with the M.S. degree or who obtain department permission to bypass the M.S. degree *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

Language Requirement—For the master's degree, none. For the Ph.D. degree, reading knowledge of one foreign language acceptable to the Electrical Engineering Graduate Committee, satisfactory completion of the department's program in oral paper presentation, or a collateral skill is required.

For Further Information—Contact the director of graduate studies, Department of Electrical Engineering, University of Minnesota, 201 Union Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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, 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 and their use to predict system performance. Comparison of performance and topology of various logic families including TTL, MOS, CMOS, I^2L, 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 and their applications; linear and switching voltage regulators.

5056. ELECTRONICS CIRCUITS LABORATORY. (1 cr; prereq IT student or grad IT major, 3401, ¶5055)

5062. COMMUNICATION CIRCUITS. (3 cr; prereq upper div EE student or grad IT major, 3012, 5055 or #)
Design and analysis of electronic circuits common to communication systems and instrumentation incorporating the latest IC technology. Typical circuits include tuned amplifiers, mixers, modulators, and phase-locked loops.

5090. DIGITAL CIRCUIT DESIGN LABORATORY. (1 cr; prereq ¶5053)

5091. COMMUNICATION CIRCUITS LABORATORY. (1 cr; prereq ¶5062)

5112. ELECTROMAGNETIC BOUNDARY VALUE PROBLEMS. (4 cr; prereq IT student or grad IT major, 3111 or #)
Review of static field theory with applications. Boundary value problems. Quasi-statics. Reflection and refraction of plane waves. Properties of guided waves. Rectangular and circular wave guides. Resonant cavities.

5113. PROPAGATION OF ELECTROMAGNETIC FIELDS. (4 cr; prereq IT student or grad IT major, 3111 or #)
Review of transients on transmission lines. Pulses on lossy transmission lines. Coupled transmission lines. Superconducting transmission lines. Microwave networks and S-parameter design. Radiation and antenna arrays. Wave propagation in anisotropic media. Microwave electronics.

5120. ACOUSTICS FOR ARCHITECTS AND PLANNERS. (3 cr; prereq Math 1231, Phys 1122 or 1052 or #, some background in statistical methods desirable; not for electrical engineering majors)
Sound, both indoors and out-of-doors, with special reference to noise and its abatement. Building and community noise sources, their properties and response measures. Design procedures for noise control in building technology and urban planning. Room acoustics.

5150. ELECTRICAL ENGINEERING MATERIALS. (4 cr; prereq IT student or grad IT major, 3060, 3111, Phys 3501 or #)
Electric, magnetic, and dielectric properties of materials as related to devices used in electrical engineering.

5160. PHYSICAL ELECTRONICS. (4 cr; prereq IT student or grad IT major, 3060, 3111, Phys 3501 or #)
Physics of solid state electronic devices important to electrical engineering: p-n junctions, Schottky barriers, BJTs, MOSFETs, semiconductor laser, and topics of current interest.

5162. SOLID-STATE TRANSDUCERS. (3 cr; prereq IT student or grad IT major, 3060, 3111, Phys 3501 or #)
Design and operations of solid state devices used for transducing physical and chemical signals.

5202. ANALOG COMMUNICATION. (3 cr; prereq upper div EE student 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. DATA COMMUNICATION. (3 cr; prereq upper div EE student or grad IT major, 3012, 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 ¶5202)

5241. DATA COMMUNICATIONS LABORATORY. (1 cr; prereq ¶5203)

5252. DIGITAL CONTROL SYSTEMS. (3 cr; prereq upper div EE student or grad IT major, 3351 and 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.

5253. LINEAR CONTROL SYSTEMS. (3 cr; prereq upper div EE student or grad IT major, 3012 or #)
Modeling, characteristics, and performance of feedback control systems. Stability, root-locus, and frequency-response methods. Compensator design.

5290. DIGITAL CONTROL SYSTEMS LABORATORY. (1 cr; prereq ¶5252)

5291. LINEAR CONTROL SYSTEMS LABORATORY. (1 cr; prereq ¶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, 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, 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.

5332, 5333. ENERGY CONVERSION METHODS. (4 cr per qtr; prereq 3060, 3111, ME 3301, Phys 3501 or #)
Principles of energy conversion systems: thermodynamic considerations; various nonconventional energy conversion systems with emphasis on technical, environmental, and economic problems; special topics of current interest.

5355. MICROPROCESSOR INTERFACING AND SYSTEM DESIGN. (4 cr, §5352; prereq upper div EE major or grad IT major, 3351, 3352, or #)
Microprocessor interfacing. Memory devices. Parallel and serial input/output: techniques and devices. Analog device interfacing. Direct memory access. Design of microprocessor-based systems. Integral laboratory.

5470. DIRECTED STUDY. (Cr ar [may be repeated for cr]; prereq △)
Studies of approved topics, theoretical or experimental in nature.

Courses Acceptable for Satisfaction of Either Major or Minor Requirements

5500-5501-5502. DESIGN OF ACTIVE AND PASSIVE ANALOG FILTERS. (3 cr per qtr; prereq grad student or #)
5500: Review of some network analysis concepts; system equations; poles and zeros; one-port (impedance) and two-port (transfer) functions; two-port parameters; LC impedance synthesis; approximation theory (Butterworth, Chebyshev, elliptic, general, Thompson functions); computer aids; frequency transformation; computer-aided design of passive filters (LC ladders, lattice networks). 5501: Theory of sensitivity and tolerances; elements of active network design; design of optimized second-order active filters (biquads); methods for design of higher-order active filters. 5502: Fully integrated (monolithic) analog filters; design and performance problem, need for automatic tuning; methods for automatic tuning; realization procedures for continuous-time IC filters; principles of sampled-data switched-capacitor filters; design methods of switched-capacitor filters.

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.

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.

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 grad student in EE or CSci or Phys 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 circuits 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).

5605. MICROWAVE CIRCUITS. (3 cr; prereq 3111, 3062 or #)
Design of microwave semiconductor amplifiers and oscillators using s-parameter techniques. Realization of circuits with microwave transistors and microstrip line. Broad band, high-power and low-noise considerations.

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.

5607. GUIDED WAVE STRUCTURES. (3 cr; prereq upper div EE major or grad IT major, 3111)
Guided wave structures for high frequency, microwave millimeterwave, and optical frequencies, including planar structures, hollow cylindrical guides, optical fibres, and dielectric planar guides.

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.

5650. DYNAMICAL METHODS IN ELECTRICAL ENGINEERING. (3 cr; prereq #)
Lagrange and Hamilton formulations of dynamics, with applications to electromagnetic systems. Lagrange's equations; dissipative forces; normal coordinates and small oscillations; Hamilton equations; variational principles for discrete and continuous systems.

5651. THERMODYNAMIC METHODS IN ELECTRICAL ENGINEERING. (3 cr; prereq grad student or #)
Basic thermodynamic concepts and laws, with special application to electromagnetic systems. Energy, entropy, and thermodynamic potentials; application to electrically and magnetically polarizable materials, rigid or elastic, piezoelectricity, magnetostriction, thermoelectricity, reciprocal relations in reversible and irreversible processes.

5652. STATISTICAL-MECHANICAL METHODS IN ELECTRICAL ENGINEERING. (3 cr; prereq 5650, 5651 or #)
Classical and quantum-statistical mechanics, with application to materials and problems of electrical engineering. Statistical ensembles, phase space, Liouville theorem, the canonical ensemble, the partition function. Classical and quantum statistics. Relation between statistical mechanics and thermodynamics. Classical and quantum calculations of susceptibilities.

5654-5655-5656. HIGH-SPEED, COMPOUND SEMICONDUCTOR DEVICES I-II-III. (3 cr per qtr; prereq ¶5660 or #)
5654: Group III-V materials for devices; electron transport in GaAs; materials, requirements, and technology. 5655: Digital GaAs integrated circuits; monolithic GaAs microwave circuits; FET fabrication technology; other microwave devices; modulation-doped FETs. 5656: Metal-semiconductor contacts for III-V semiconductors; transferred electron devices; GaAs FETs.

5660-5661-5662.SEMICONDUCTOR PROPERTIES AND DEVICES. (3 cr per qtr; prereq EE sr or grad student or adult special, 3111)
Principles and properties of semiconductor devices. Selected topics in quantum and statistical mechanics, crystal structures, semiconductor properties; transistor action and other device phenomena; influence of surfaces. Treatment of actual devices. Large-scale integrated-circuit principles.

5666-5667-5668. 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. 5668: Properties of soft and hard magnetic materials with applications such as thin film memories, permanent magnets, magnetic recording, and magnetooptics.

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. (4 cr; prereq #)
Experimental and theoretical studies of the basic physical processes used in microelectronic device fabrication. Transistor and integrated-circuit layout, fabrication, and evaluation.

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, kielectric, magnetic, optical, and piezoelectric properties of thin films. Laboratory.

5700. INFORMATION THEORY AND CODING. (3 cr; prereq Stat 3091 or #, IT sr or grad or EE adult special 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.

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 extension.

5750. TOPICS IN LINEAR SYSTEMS. (3 cr; prereq grad IT major, Math 5242 or ¶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 or #)
Time and frequency domain models of multiple-input-multiple-output systems. Linear-quadratic and linear-quadratic-Gaussian optimization problems. Properties of linear-quadratic and linear-quadratic-Gaussian regulators. Output feedback and the 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. Biofeedback.

5802. ELECTRIC POWER SYSTEM ANALYSIS. (3 cr; prereq #)
Formulation of describing equations and advanced computer methods of analysis of large-scale electric power systems. Applications to the load-flow problem, faulted system calculations, stability studies, and economic environmental dispatch.

5805. ELECTRIC POWER SYSTEM ENGINEERING. (3 cr; prereq #)
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.

5808. DIRECT-CURRENT POWER CONVERSION AND TRANSMISSION. (3 cr; prereq #)
General aspects of DC power transmission and comparison with AC transmission. Theory of operation and control of solid state AC/DC power converters. Transients due to long DC transmission lines. System protection and harmonic filtering. Environmental impact. Current research topics.

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. Stage 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.

5851. APPLIED SWITCHING THEORY. (3 cr; prereq 3351, 3352 or #)
Review of traditional logic design methods; algorithmic state machine methods; 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. DIGITAL COMPUTER SYSTEMS. (3 cr per qtr; prereq 5851 or #)
Digital computer organization; register-level simulation; control unit design; microprogramming; memory organization. Input/output techniques; arithmetic unit design; features of larger computers.

5854. ADVANCED COMPUTER NETWORKS. (3 cr; prereq grad IT major or EE adult special student, CSci 5211 or #)
International Standards Organization (ISO) network architecture; topology analysis; data communication; satellite and packet radio networks; distributed systems and case studies.

5860. MICROCOMPUTER ARCHITECTURE. (4 cr; prereq IT grad and 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 laboratory.

5952. SPECIAL TOPICS IN ELECTRICAL ENGINEERING. (3 cr [may be repeated for cr]; prereq IT grad student or adult special or #)
Topics vary according to needs and staff.

5960-5961. ENGINEERING DESIGN. (3 cr per qtr; prereq #)
Application of mathematical and computational techniques to design problems chosen from a wide range of engineering disciplines. Frequent use of interdisciplinary problems. Topics include classical control theory, discrete-time systems, state-space analysis, distributed systems, microprocessors, and appropriate mathematical and statistical techniques. Weekly written reports required.

8000. ADVANCED TOPICS IN NETWORK THEORY. (Cr ar [may be repeated for cr]; prereq #)
Advanced topics selected from current or recently published literature.

8051-8052-8053. LARGE-SCALE INTEGRATED CIRCUITS. (3 cr per qtr; prereq #)
Standard LSI components including monolithic semiconductor memories and microprocessors, with emphasis on design of large arrays; popular technologies, circuit architecture, device design, and dynamic response of MOS and bipolar arrays; design rules of principal technologies, layout topology, and interactive graphics.

8060. BIPOLAR TRANSISTOR THEORY. (3 cr; prereq 5660 or #)
Recent developments in device modeling with emphasis on bipolar junction transistor. High-level effects in base and collector regions and their interrelationship.

8062. HETEROJUNCTION MICROWAVE DEVICES. (3 cr; prereq grad student or #)
Ultrafast novel heterojunction devices, including modulation doped transistor, permeable base transistor, and heterojunction bipolar junction transistor. Ultrafast ICs.

8090. ELECTRONICS SEMINAR. (Cr ar [may be repeated for cr]; prereq #)
Current literature; individual assignments.

8110-8111-8112. 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.

8120-8121-8122. 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.

8153-8154-8155. 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. Utilization of semiconductor properties in devices, especially devices of current importance.

8156-8157-8158. FERROMAGNETISM AND RELATED PHENOMENA. (3 cr per qtr; prereq 5652 or #)
Basic magnetic concepts, classical and quantum mechanical. Statistical mechanics of magnetization; spontaneous magnetization; types of ordered magnetic structure. Behavior of fine particles. Magnetic microstructures; micromagnetics and domain theory; thin films. Magnetoelastic interactions. Dynamic phenomena.

8160-8161-8162. QUANTUM ELECTRONICS. (3 cr per qtr; 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.

8170-8171-8172. FLUCTUATION PHENOMENA. (3 cr per qtr; prereq #)
Theory with applications to electrical engineering. Circuit noise, vacuum-tube noise and semiconductor noise, influence upon performance of amplifiers, mixes, solid-state devices, detectors, and sensitive measuring equipment.

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.

8206. IMAGE UNDERSTANDING AND APPLICATIONS. (3 cr; prereq 8205 or #)
Computer vision, invariant image interpretation, expert systems for image understanding, texture and motion analysis, robotic applications, hardware implementation.

8211. CODING THEORY. (3 cr, §5701; prereq 5700 or #)
Error correcting codes; cyclic codes, finite fields, and BCH codes; majority logic decoding; burst error correction, convolutional codes.

8212. CODING THEORY II. (3 cr; prereq 5700, 8211 or #)
Continuation of 8211. Theory of error-correction codes, including modulation codes and soft decoding.

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.

8253. TOPICS IN LARGE-SCALE SYSTEMS. (3 cr; prereq #)
Modelling, control, and optimization problems in large-scale systems. Partitioning aggregation, decision theory, team theory, and hierarchical control concepts as used in analysis and control of complex interconnected systems. Current topics.

8256. TOPICS IN STOCHASTIC FILTERING AND CONTROL. (3 cr; prereq #)
Stochastic processes, mean square calculus, stochastic difference and differential equations, filtering via innovations theory, Kalman-Bucy theory, engineering applications, suboptimum control of stochastic systems.

8257, 8258. ADVANCED SYSTEMS THEORY I, II. (3 cr per qtr; prereq IT grad student, #)
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.

8300-8301-8302. 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.

8340. SEMINAR: ELECTRIC POWER. (Cr ar [may be repeated for cr]; prereq #)
Current literature, individual assignments in the areas of power systems and electromechanics.

8341. SEMINAR: ENERGY CONVERSION. (Cr ar [may be repeated for cr]; prereq #)
Topics relating to physical processes involved in conversion of energy in its several forms to electrical energy and to devices that exploit these processes.

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.

8355. COMPUTER ARCHITECTURE I. (3 cr; prereq 5853, CSci 5101 or #)
Systems requirements: trade-offs in meeting the requirements. Von Neumann systems structure. Control of single streams; specification, sequencing, algorithm structures. Memory systems; items, names, data structures, segmentation, paging, cache memories. Paged systems. Examples selected from current systems.

8356. COMPUTER ARCHITECTURE II. (3 cr; prereq 8355)
(Continuation of 8355) Input/output systems; devices, controllers, and channels. Data manipulation schemes; registers, stack and instruction sets. Controlling related processes; multiprogramming, multiprocessing, overlap, pipelines, parallel machines. Examples selected from current systems.

8360. LOCAL AREA NETWORKS. (3 cr; prereq 5854 or CSci 5211) Cherkassky
Computer networks classification; Local Area Networks (LAN) technology; LAN topology, protocols, and standards; performance evaluation.

8370. DESIGN OF INTELLIGENT SYSTEMS. (3 cr; prereq #)
Basic elements and application areas of artificial intelligence (AI) as related to design and implementation of expert systems (ES). Knowledge representation; reasoning under uncertainty; ES and their environment; planning; natural language processing; intelligent computer-aided instruction; AI tools (software and hardware).

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: Peter J. Reed, *chair;* Chester G. Anderson; Nancy B. Armstrong; Kent Bales; Michael Dennis Browne; Alan Burns; Thomas S. Clayton; Peter E. Firchow; Norman Fruman; Philip G. Furia; Shirley N. Garner; Edward M. Griffin; Michael Hancher; Calvin B. Kendall; Andrew MacLeish; Toni A. H. McNaron; J. Lawrence Mitchell; Donald Ross, Jr.; Marty Roth; Edward B. Savage; Madelon Sprengnether; Ellen J. Stekert; Joel C. Weinsheimer; George T. Wright

Associate Professor: Robert L. Brown, Jr., *director of graduate studies;* Charles J. Sugnet, *director of creative and professional writing program;* Lillian Bridwell Bowles; Margery S. Durham; Geneviève J. Escure; Arthur I. Geffen; David B. Haley; Patricia Hampl; Gordon D. Hirsch; Archibald I. Leyasmeyer; Donna Przybylowicz; Robert Solotaroff; John S. Wright

Assistant Professor: Christopher Anson; Maria Damon; Lonnie J. Durham; David B. Luke; Ellen Messer-Davidow; John W. Mowitt; Paula Rabinowitz; M. Charlotte Ward

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—Course requirements for the Ph.D. program are broadly defined, allowing the student to shape a program of study responsive to special needs and interests. Four emphases are available in the master's program: language and literature; literary genre; English language and linguistics; and writing. The M.A. program 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. Applicants to the Ph.D. program who show promise but whose qualifications do not warrant direct admission to that program may be invited to enter the M.A. program. 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, preferably including satisfactory courses in Chaucer, Shakespeare, and Milton. Except for students in the writing program and English language and linguistics emphasis, students who have not completed courses in Chaucer, Shakespeare, or Milton are required to take them after admission.

Special Application Requirements—Three letters of recommendation, scores from the General Test of the Graduate Record Examination, and a writing sample, such as a course paper, are required.

Most Ph.D. candidates begin their studies in the fall quarter; the relevant application deadline is *January 15*. Applicants for the M.A. program are admitted quarterly; deadlines for each quarter are as follows: *April 15* for either of the two summer sessions or fall quarter; *October 25* for winter; *December 15* for spring. Some of these deadlines are earlier than Graduate School deadlines and supersede them.

Master's Degree Requirements—The minimum requirement is 44 credits (normally, eleven courses).

For the *master's degree with an emphasis on language and literature,* 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,* 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, 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 qualifying examination for the master's program (all emphases except English language and linguistics) is administered 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 books that the student constructs in consultation with his or her examining committee. This list of primary and secondary works defines a broad area of doctoral study. 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, including a course in Shakespeare, 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 En-

glish is required. Students should consult the director of graduate studies for advice in selecting courses.

For Further Information—Contact the director of graduate studies, Department of English, 205 Lind Hall, University of Minnesota, 207 Church Street S.E., Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

English (Engl)

5131. RENAISSANCE POETRY. (4 cr)
Historical and intellectual background; poetic theory; major figures, including Wyatt, Sidney, Spenser, Donne, Herbert, and Jonson.

5132. 17TH- AND 18TH-CENTURY BRITISH POETRY. (4 cr)
Historical and intellectual background; poetic theory; major figures, including Dryden, Pope, Finch, C. Smith, Thomson, Gray, and Cowper.

5133. 19TH-CENTURY BRITISH POETRY. (4 cr)
Historical and intellectual background; poetic theory; major figures, including Wordsworth, Coleridge, Keats, R. Browning, E. B. Browning, Tennyson, and Arnold.

5134. 20TH-CENTURY BRITISH POETRY. (4 cr)
Historical and intellectual background; poetic theory; major figures, including Hardy, Housman, Hopkins, Yeats, Eliot, S. Smith, Thomas, Larkin, and Hughes.

5151. 18TH-CENTURY ENGLISH NOVEL. (4 cr)
Novels by such authors as Defoe, Richardson, Fielding, Smollett, Sterne, and Austen.

5152. 19TH-CENTURY ENGLISH NOVEL. (4 cr)
Novels by such authors as Scott, Dickens, the Brontës, Thackeray, Eliot, and Hardy.

5153. 20TH-CENTURY ENGLISH NOVEL. (4 cr)
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)
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)
Selected plays of Jonson, Tourneur, Webster, Middleton, Ford, and others.

5173. RESTORATION AND 18TH-CENTURY DRAMA. (4 cr; prereq 3241 or 3242)
The heroic play, tragedy, comedy of manners, and sentimental comedy.

5174. MODERN DRAMA, 1880-1920. (4 cr)
Beginnings of modern realism, naturalism, and expressionism in English and Continental drama.

5175. MODERN DRAMA SINCE 1920. (4 cr)
Survey of chief dramatists, English, American, and Continental.

5211. OLD ENGLISH (ANGLO-SAXON). (5 cr)
An 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)
Critical reading of texts, introduction to versification.

5213. BEOWULF. (4 cr; prereq 5211)
Introduction to the Old English poem, with reading of considerable portions of text.

5215. MAJOR TYPES OF MIDDLE ENGLISH LITERATURE. (4 cr; prereq 5221)
Readings in Middle English, in romance, lyric, allegory, and devotional prose.

5221. CHAUCER: THE CANTERBURY TALES. (5 cr)
Reading of *The Canterbury Tales* and introduction to Chaucer's language. Prerequisite for all courses in Middle English literature (5215-5222).

5240. ADVANCED SHAKESPEARE. (4 cr per qtr; prereq 3241 and 3242 or 3243 or #)
Intensive study of a few works, extensive readings on particular topics. Course content varies with the term and instructor.

5261. MILTON. (4 cr)
Paradise Lost, Samson Agonistes, minor poems, *Areopagitica*, and often, although not always, *Paradise Regained.*

5363, 5364. JAMES JOYCE. (4 cr per qtr)
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.*

5431, 5432. AMERICAN POETRY. (4 cr per qtr)
Critical survey; major figures; historical and intellectual background; poetic theory. 5431: Beginnings to 1890. Typical authors: Taylor, Poe, Whitman, Bryant, Dickinson. 5432: Since 1890. Typical authors: Frost, Stevens, Pound, Eliot, Moore, Williams.

5451. 19TH-CENTURY AMERICAN NOVEL. (4 cr)
Typical authors: Hawthorne, Melville, Stowe, Twain, James.

5452. 20TH-CENTURY AMERICAN NOVEL. (4 cr)
Typical authors: Dreiser, Cather, Hemingway, Fitzgerald, Faulkner.

5471. AMERICAN DRAMA. (4 cr)
Critical survey of American drama; emphasis on 1914 to present; some representative American plays of the 18th, 19th, and early 20th centuries.

5481, 5482, 5483. FOLKLORE. (4 cr per qtr; prereq 5481 or 5482 or # for 5483)
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. FOLKSONG. (4 cr per qtr; prereq 5486 or # for 5487)
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)
Contextual readings of 19th- and 20th-century black novelists such as Charles Chesnutt, James Weldon Johnson, Zora Neale Hurston, Richard Wright, Chester Himes, Ann Petry, James Baldwin, John Williams, Toni Morrison, and Ishmael Reed.

5595. AFRO-AMERICAN POETRY. (4 cr, §Afro 5595)
Selected Afro-American poets from 18th to 20th century, including Phillis Wheatley, Paul Laurence Dunbar, Langston Hughes, Sterling Brown, Gwendolyn Brooks, Melvin Tolson, Robert Hayden, and Amiri Baraka.

5596. AFRO-AMERICAN AUTOBIOGRAPHY. (4 cr, §Afro 5596)
Literary and intellectual traditions of black autobiography beginning with 18th-century slave narrative. Equiano, Douglass, DuBois, Hurston, Wright, Malcolm X, Angelou, and others.

5597. THE HARLEM RENAISSANCE. (4 cr, §Afro 5597)
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)
Readings of one or more women writers, perhaps working at various times within various forms. Writers specified in the *Class Schedule.*

5651, 5652. TECHNIQUES OF POETRY. (4 cr per qtr)
Analysis of poetry. 5651: Form and sound; meter, stanza, euphony, free verse. 5652: Figurative language, diction, syntax, imagery, metaphor.

5671. THEORY OF THE NOVEL. (4 cr)
Readings in theoretical criticism of the novel with application to selected British and American fiction.

5711. CLASSICS OF LITERARY CRITICISM. (4 cr)
An intensive study of selected major works in the classic critical tradition, with emphasis on Aristotle and Coleridge and attention to such authors as Plato, Horace, Longinus, Sidney, Dryden, Johnson, Hume, and Eliot.

5712. LITERARY CRITICISM: PLATO TO DRYDEN. (4 cr)
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 #)
Major texts of English and American criticism from 1700 to the modern period.

5714. MODERN AND CONTEMPORARY CRITICAL THEORY. (4 cr)
Readings in modern and postmodern literary criticism, with attention to contemporary movements, theory, and practice.

5811. CELTIC WORLD. (4 cr)
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)
The development of the English language from Old to Early Modern English: phonology, morphology, and syntax.

5821. OLD AND MIDDLE ENGLISH DIALECTS. (4 cr; prereq 5851 or #)
Dialect differentiation in Old and/or Middle English, based on phonemic-graphemic theory with some attention to generative theory; close textual analysis of dialect examples.

5831. AMERICAN ENGLISH. (4 cr)
History of the English language in the United States; significant regional variation.

5843. AMERICAN SOCIAL DIALECTS. (4 cr)
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)
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)
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 #)
Topic (English phonology, syntax, or semantics) specified in the *Class Schedule*.

5871. THE LANGUAGE OF LITERATURE. (4 cr)
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 or 5920. TOPICS IN ENGLISH AND AMERICAN LITERATURE. (1-4 cr per qtr)
Topics specified in the *Class Schedule*.

5940 or 5950. FIGURES IN ENGLISH AND AMERICAN LITERATURE. (1-4 cr per qtr)
Figures specified in the *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. (4 cr)
Approaches to practical and theoretical problems of literary history and genre.

8050. STUDIES IN SPECIAL SUBJECTS. (2-4 cr [12 cr max])
Topics specified in the *Class Schedule*.

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

8112. PROSEMINAR IN RENAISSANCE STUDIES

8113. PROSEMINAR IN 17TH-CENTURY STUDIES

8114. PROSEMINAR IN 18TH-CENTURY STUDIES

8115. PROSEMINAR IN THE ENGLISH ROMANTIC MOVEMENT

8116. PROSEMINAR IN VICTORIAN STUDIES

8117. PROSEMINAR IN EARLY AMERICAN LITERATURE

8118. PROSEMINAR IN 19TH-CENTURY AMERICAN LITERATURE

8119. PROSEMINAR IN 20TH-CENTURY BRITISH AND AMERICAN LITERATURE

8210 through 8810. SEMINARS. (4 cr each)
Descriptive title specified in the *Class Schedule*.

8210. MEDIEVAL STUDIES

8220. CHAUCER

8230. RENAISSANCE STUDIES

8240. SHAKESPEARE

8250. 17TH-CENTURY STUDIES

8270. 18TH-CENTURY STUDIES

8310. STUDIES IN THE ENGLISH ROMANTIC MOVEMENT

8330. VICTORIAN STUDIES

8480. STUDIES IN FOLKLORE

8510. STUDIES IN EARLY AMERICAN LITERATURE

8530. STUDIES IN 19TH-CENTURY AMERICAN LITERATURE

8590. STUDIES IN AFRO-AMERICAN LITERATURE

8610. STUDIES IN 20TH-CENTURY BRITISH AND AMERICAN LITERATURE

8650. STUDIES IN POETRY

8670. STUDIES IN PROSE FICTION

8690. STUDIES IN DRAMA

8710. STUDIES IN CRITICISM

8720. STUDIES IN FEMINIST CRITICISM

8750. STUDIES IN AESTHETICS

8810. STUDIES IN THE ENGLISH LANGUAGE

8970. INDEPENDENT READING. (1-15 cr; prereq #, △)

English Creative and Professional Writing (EngW)

5101, 5102, 5103. ADVANCED FICTION WRITING. (4 cr per qtr, §Engl 5101, 5102, 5103; prereq △)
Advanced workshop for students with considerable experience in writing fiction.

5105, 5106, 5107. ADVANCED POETRY WRITING. (4 cr, §Engl 5104, 5105, 5106; prereq △)
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 #)
Workshops by Edelstein-Keller visiting writers. See *Class Schedule* for particular topics.

5120. TOPICS IN ADVANCED POETRY WRITING. (4 cr; prereq #)
Special workshops by Edelstein-Keller visiting writers. See *Class Schedule* for particular topics.

5201, 5202. MEMOIR WRITING. (4 cr per qtr, §Engl 5108, 5109; prereq △)
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; prereq △)
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 #)
Special topics in essay writing, such as arts reviewing, writing about public affairs, and writing in personal voice. See *Class Schedule* for particular topics.

5310, 5320. READING AS WRITERS. (4 cr; prereq #)
Special topics. Open to graduate and advanced undergraduate students in literature, as well as to creative writing students. See *Class Schedule* for particular topics.

5401. INTRODUCTION TO PROFESSIONAL EDITING. (4 cr)
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.

5970. DIRECTED STUDY IN WRITING. (1-4 cr; prereq #)
Projects in writing poetry, fiction, drama, and nonfiction, or study of ways to improve writing.

8410. WRITING OF NONFICTION PROSE. (4 cr, §Engl 8410; prereq #)
Writing, editing, and criticism of nonfiction prose in various genres. Some common assignments, but each student works on individual assignments.

8420. WRITING OF FICTION. (4 cr, §Engl 8420; prereq #)
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.

8430. WRITING OF POETRY. (4 cr, §Engl 8430; prereq #)
Writing of poetry with focus on the exploration and practice of various styles. Some common assignments, but each student works on individual project.

English as a Second Language

Associate Professor: Elaine E. Tarone, *director of graduate studies*; Bruce T. Downing; Jeanette Gundal; 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. The major emphasis is on preparation in the field of linguistics. Elective coursework allows students to specialize in language acquisition, English for special purposes, 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 TOEFL scores (minimum 550). 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—Ling 5001, 5002, 5003, 5701, 5721, 5722, 5741, 5742, and additional elective coursework are required. See the English as a Second Language Program publication 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.

Minor Requirements for Students Majoring in Other Fields—Ling 5001,

5003, 5721, 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—Contact the Program in English as a Second Language, 152 Klaeber Court, University of Minnesota, 320 16th Avenue S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Program Requirements

Ling 5001—Introduction to Linguistics
Ling 5002—Linguistic Analysis
Ling 5003—Applied Phonetics
Ling 5701—Contrastive Linguistics
Ling 5721—English as a Second Language: Methods
Ling 5722—English as a Second Language: Practicum
Ling 5741-5742—Linguistic Description of Modern English

Suggested Electives

Structure of a foreign language (not English)—See language department listings.
Ling 5101—Language Types and Linguistic Universals
Ling 5201-5202—Introduction to Syntax
Ling 5503—Introduction to Applied Linguistics
Ling 5702—Second Language Acquisition
Ling 5723—English as a Second Language: Materials
Ling 5805—Psycholinguistics
Ling 5821—Sociolinguistics
Ling 8731—Research Methods in Language Acquisition
Ling 8751—English for Special Purposes
SeEd 5385—Planning and Assessing Second Language Instruction
Spch 5451—Intercultural Speech-Communication
Engl 5815—History of the English Language
Engl 5831—American English
Engl 5843—American Social Dialects

Entomology (Ent)

Professor: Richard L. Jones, *head*; Mark E. Ascerno; Basil Furgala; Phillip K. Harein; Herbert M. Kulman; William E. Miller; Roger D. Price; Edward B. Radcliffe; Richard J. Sauer

Associate Professor: Roger D. Moon, *director of graduate studies;* Ann M. Fallon; David W. Ragsdale

Assistant Professor: David A. Andow; Ralph W. Holzenthal; Timothy J. Kurtti; Karen A. Mesce; Kenneth R. Ostlie; Robert D. Sjogren

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, embryology, genetics, microbiology, physiology, taxonomy, and toxicology 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.

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—A reading knowledge of one or more foreign languages is advised but not required for either the master's or the doctoral degree. A reading knowledge of one or more foreign languages, however, must be acquired as part of the major program when such a skill is needed to support the student's research objectives.

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—Contact the director of graduate studies, Department of Entomology, 219 Hodson Hall, University of Minnesota, 1980 Folwell Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5010. INSECT MORPHOLOGY. (5 cr; prereq 3005 or #)
Comparative studies of external and internal anatomy and histology of insects; phylogeny and function.

5020. INSECT TAXONOMY. (5 cr; prereq 3005 or equiv) Price
Identification of adults and immatures of taxa within insect orders.

5030. INSECT PHYSIOLOGY. (5 cr; prereq #, BioC 5001 and 5002 or MdBc 5100 recommended) Kurtti
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.

5040. INSECT ECOLOGY. (3 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.

5200. APICULTURE. (4 cr; prereq 9 cr entomology or biology) Furgala
Characteristics and social behavior of honey bees; colony development and management; diseases and their control; hive products; pollination. Lectures and laboratory demonstrations.

5215. INSECTS IN RELATION TO PLANT DISEASES. (4 cr; prereq 5 cr entomology, 5 cr plant pathology or equiv or #) Ragsdale
(Same as PlPa 5215) Insect transmission and dissemination of plant pathogens; development of plant-insect relationships; habits of principal insect vectors and practical methods of control.

5220. STORED PRODUCT PEST MANAGEMENT. (4 cr; prereq 1005 or 3005 or #; offered alt yrs) Harein
Principles of management to protect stored food and fiber; pest identification, damage assessment, and prevention and control procedures based on interrelationships within storage ecosystems.

5250. FOREST ENTOMOLOGY. (4 cr; prereq any 2 courses among the forestry, zoological, botanical, biological and/or agricultural sciences) Kulman
Lectures and laboratory concerning ecology and population management of forest insects, with emphasis on tree factors and biological control.

5275. MEDICAL ENTOMOLOGY. (4 cr; prereq 3005 or #) Price
Principal arthropods noxious to humans and animals. Emphasis on those that serve as vectors of pathogenic organisms of humans and animals.

5280. LIVESTOCK ENTOMOLOGY. (3 cr) Moon
Biology and management of arthropods that affect livestock production systems.

5300. CHEMICALS AND INSECT BEHAVIOR. (2 cr; prereq 3005 or EBB 5112, 12 cr organic chemistry; offered alt yrs) Jones
Survey of nature and behavioral role of chemicals affecting insect behavior, with emphasis on mating and host location. Research techniques.

5310. SAMPLING BIOLOGICAL POPULATIONS. (4 cr; prereq Stat 5021 or equiv) Moon
Design of sampling plans for study of field and laboratory populations of living organisms.

5320. ECOLOGY OF AGRICULTURE. (4 cr; prereq 1 course in Agro or Hort or AnSc at 3xxx-level or above, 1 course in Ent or PlPa or Soil at 3xxx-level or above, or #) Andow
Origins of agriculture and comparison of functions and ecology of contemporary and extinct agricultural systems, with emphasis on social function and biology of agriculture. Ecology of postindustrial agriculture; soil ecology, plant growth and development, pest ecology, biological and cultural control, forage quality, animal production, and food quality as interactive network.

5340. BIOLOGICAL CONTROL OF INSECTS. (2 cr; prereq 5210, intro entomology and course in ecology; offered when feasible)
History, ecological basis, classical biological control, augmentation, analysis of selected projects.

5350. INSECT PATHOLOGY. (3 cr; prereq 5030) Kurtti
Survey of major pathogenic microorganisms that cause diseases in insects; routes of infection of insects; factors to be considered in the utilization of infectious disease to control pest insects.

5360. AQUATIC ENTOMOLOGY. (2 cr; prereq 3005 or equiv or #; offered alt yrs) Holzenthal
Identification and biology of aquatic and littoral insects in all stages.

5370. PRINCIPLES OF SYSTEMATICS. (5 cr; prereq 3005 or equiv, 5020; offered alt yrs)
Procedures of systematic entomology, systematic literature, zoological nomenclature, use and construction of keys, and presentation of results of systematic research.

5380. LEPIDOPTEROLOGY. (2 or 3 cr; prereq course in entomology or #, course each in ecology and genetics recommended) Miller
Overview of Lepidoptera, with emphasis on processes and phenomena demonstrated by this insect order, such as polymorphism, mimicry, individual quality.

5600su. FIELD ENTOMOLOGY AT ITASCA. (5 cr; limited to 15 students; prereq introductory biology; offered at Itasca)
Insect fauna in various natural habitats of the park and surrounding areas. Field trips, collection and identification of insects, as well as studies of general morphology, life histories, and habitats of local species.

5610. AQUATIC ENTOMOLOGY AT ITASCA. (5 cr; prereq 3005 or 5600 or equiv or #; offered at Itasca)
Identification and biology of aquatic and littoral insects in all stages.

5620su. RESEARCH PROBLEMS AT ITASCA IN ENTOMOLOGY. (Cr ar; prereq #) Staff

5650. HOUSE AND GARDEN INSECTS. (3 cr; 3 lect and 6 lab hrs per wk)
Identification and life history of commonly encountered Minnesota insects. Short field trips and lectures by selected faculty.

5900. BASIC ENTOMOLOGY. (Cr ar; prereq #) Staff
Opportunity to make up certain deficiencies in biological background.

5910. SPECIAL PROBLEMS IN ENTOMOLOGY. (Cr ar; prereq #)
Individual field, laboratory, or library studies in various aspects of entomology.

5920. SPECIAL LECTURES IN ENTOMOLOGY. (Cr ar)
Lectures and/or laboratories in special fields of entomological research given by a visiting scholar or regular staff member.

8030. ADVANCED INSECT PHYSIOLOGY. (3 cr; prereq 5030 or equiv; offered alt yrs) Jones
Intensive study of the most current theories and mechanisms in insect physiology. Emphasis on uniqueness of insects and homeostasis.

8050. INSECTICIDES AND THEIR ACTION. (3 cr; prereq 15 cr incl 1005 or equiv or #, inorganic and organic chemistry; offered alt yrs) Fallon
Chemistry, physiological action, toxicology of insecticides.

8055. INSECTICIDES LABORATORY. (2 cr; prereq 8050 or equiv or ¶8050; offered alt yrs) Fallon
Research training in field of study discussed in Ent 8050.

8200. COLLOQUIUM IN APICULTURE. (1-3 cr; prereq 3005, 5200 or #) Furgala
Lectures by instructor; lectures, research reports, and critiques by students on pheromones, pollination, nutrition, diseases, communication, foraging behavior, honey, caste determination.

8230. COLLOQUIUM IN INSECT PHYSIOLOGY. (Cr ar; prereq #) Jones
Lectures, discussions, and individual laboratory problems.

8240. COLLOQUIUM IN INSECT ECOLOGY. (1-2 cr; prereq 5040 or #) Andow
Advanced topics.

8300. GRADUATE SEMINAR. 1 cr; prereq #) Ragsdale
Oral and written reports on and discussion by students of selected topics from current literature in entomology.

8310. CURRENT TOPICS IN FOREST ENTOMOLOGY. (1-3 cr) Kulman
Seminars on current problems and research by visiting specialists, faculty, and advanced students. Students not giving talks write brief term papers.

8500. RESEARCH IN ENTOMOLOGY. (Cr ar; prereq #) Staff

Environmental Health (PubH)

Professor: Donald E. Barber, *head;* Irving J. Pflug; Sheldon B. Sparber; Donald Vesley; W. Dixon Ward

Adjunct Professor: Paul W. Willard

Associate Professor: Rexford D. Singer, *director of graduate studies*; Jack S. Mandel; Lee D. Stauffer

Clinical Associate Professor: Alan P. Bender

Assistant Professor: Susan G. Gerberich; Charles E. McJilton; Orlando R. Ruschmeyer; Jeffrey B. Stevens; Deborah L. Swackhamer; Fay M. Thompson

Clinical Assistant Professor: Marian C. Marbury

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, hazardous waste management, industrial hygiene, institutional environmental health, occupational epidemiology, occupational medicine, public health biology, and radiation protection.

Two-year courses of study in environmental health providing advanced study in biometry and epidemiology plus additional coursework in the major also are available.

Prerequisites for Admission—A bachelor's degree, including coursework in biology, chemistry, mathematics, physics, and/or engineering is required. Additional coursework may be required for students admitted without the appropriate preparation.

Special Application Requirements—Graduate Record Examination scores are required. A letter describing the applicant's professional objectives and the names and addresses of three persons who may be contacted for recommendations are required. Ph.D. applicants must also submit a research prospectus. First-year master's students may begin graduate study during fall or summer terms only.

Master's Degree Requirements—The program requires a minimum of 11 months of study. Students are required to complete PubH 5152, 5153, 5154, 5159, and other core courses from the area of emphasis in the major and are expected to include courses in administration, biometry, epidemiology, and toxicology either in the major or as one of the related fields. A written and an oral final examination are 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—Contact the director of graduate studies, Environmental Health, School of Public Health, Box 197 UMHC, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Note—Courses in environmental health are listed and described under Public Health later in this bulletin. See PubH 5150 to 5271 and 8150 to 8269.

Epidemiology (PubH)

Professor: Henry Blackburn, *head, director of graduate studies;* Robert K. Anderson (emeritus); Stanley L. Diesch; Laël Gatewood; Frederick C. Goetz; Robert L. Kane; Arthur S. Leon; Russell V. Luepker; R. Ashley Robinson; Leonard M. Schuman (emeritus); David G. Thawley

Associate Professor: Alan P. Bender; Richard S. Crow; Robert W. Gibson; Richard H. Grimm; David R. Jacobs, Jr.; Robert W. Jeffery; Jack Mandel; David M. Murray; Michael T. Osterholm; Cheryl L. Perry; John D. Potter; James M. Schaefer

Assistant Professor: John D. Belcher; Gregory L. Burke; John R. Finnegan, Jr.; Aaron R. Folsom; Orlando Gomez-Marin; Stephen R. Mascioli; Rebecca M. Mullis; Phyllis L. Pirie; Frank S. Rhame; Leslie L. Robison; David A. Snowdon; J. Michael Sprafka; Carolyn L. Williams

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 department 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.

Prerequisites for Admission—For the master's program, a strong undergraduate background in biological and physical sciences and high scholastic achievement (i.e., a grade point average of at least 3.00) are desirable.

For the doctoral program, applicants must have received either the M.S. or the M.P.H. degree from an accredited school of public health. 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. Since 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 Plan A program may be approved subject to the availability of research material and the feasibility of completing the research in the time available. 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—Contact the director of graduate studies, Division of Epidemiology, School of Public Health, Stadium Gate 27, University of Minnesota, 611 Beacon Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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 Practice and Community Health (FPCH)

Professor: Edward W. Ciriacy, *head;* John T. Kelly, *director of graduate studies;* Carole J. Bland; Douglas A. Fenderson; John B. O'Leary (on leave); John E. Verby; Vernon E. Weckwerth

Associate Professor: Donald S. Asp; Edmond J. Coleman; Harold R. Ireton; Sharon B. Satterfield; Leif I. Solberg

Assistant Professor: Dwenda K. Gjerdingen; Christopher L. Krogh; Michael E. Metz; Leon J. Nesvacil; Harold C. Seim

Lecturer: Faruk Abuzzahab

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.

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-N 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—Contact the director of graduate studies, Department of Family Practice and Community Health, Box 381 UMHC, University of Minnesota, 516 Delaware Street S.E., Minneapolis, MN 55455.

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 #) Krogh, 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.

5504. MEDICAL ETHICS. (2 cr) Ciriacy and staff
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.

5563. CLINICAL NEUROPSYCHOPHARMACOLOGY. (2 cr; prereq FPCH residency) Abuzzahab
Identification, diagnosis, treatment, and follow-up of major psychiatric disorders. Emphasis on the neuropsychopharmacological approach, identification of psychoactive drugs, contraindications, side effects, and long-term management of patients.

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 and staff
Practical counsel and information on day-to-day management of medical clinics including architectural, 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 INTERNATIONAL/ INTERCULTURAL MEDICINE. (1 cr; prereq med fellow registration; register at least 3 wks before) Krogh, staff
Didactic and field experience program during three-week period. Generally applicable to those interested in the field. Tailored to students' individual interests and needs.

5598. INTRODUCTION TO PHYSICIAN'S ROLE IN NURSING HOMES. (2 cr) Ciriacy and staff
Roles of nursing home staff. Helps medical fellows become comfortable in nursing homes.

5843. DISEASE PREVENTION AND HEALTH PROMOTION: AN APPRAISAL OF GOALS AND TECHNIQUES IN FAMILY PRACTICE. (2 cr; prereq MD) Solberg
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 #) Krogh, staff
Practical experience in delivery of health care in urban or rural communities.

5904. COMMUNITY HEALTH. (2 cr; prereq 2nd-yr residency or #) Krogh
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
Supervised experience in sex-related counseling of individuals, couples, and groups. Work with problems of sexual adjustment, dysfunction, and couple conflict.

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) Fenderson
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 #) Fenderson
Machine-readable data bases and decision support systems relevant to community health.

8201. CLINICAL FAMILY MEDICINE. (Cr ar) Ciriacy and 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 stress 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) Fenderson
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) Staff
Psychological principles and techniques for primary physician. Psychological evaluation through interview and testing; illness and emotional distress; patient and family in crisis; resources for coping with psychological aspects of illness.

8207. SEMINAR: COMMON DISEASES SEEN IN FAMILY PRACTICE. (1 cr) Ciriacy and staff

8208. FAMILY MEDICINE CONFERENCES. (1 cr) Ciriacy and 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 and staff

8210. FAMILY MEDICINE GRAND ROUNDS. (1 cr) Krogh, staff
Monthly conference with each institution presenting topics.

8211. PRACTICE MANAGEMENT. (2 cr)
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) Staff
Diagnosis and management of psychological disorders in children; evaluation in context of normal development, family dynamics, and impact of illness; physician's coping through interdisciplinary cooperation with nursing, psychologists, social workers, and other allied health professionals.

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 #) Ciriacy and staff
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
Critical review of sociological research in medical areas, illness behavior, sick role, sociological aspects of doctor-patient relationship, problem of delay in seeking treatment, and differential reactions to pain.

8226. MEDICAL SOCIOLOGY SEMINAR. (2 cr; prereq physician or sociology grad student; offered when feasible) Staff
Problems in delivery of comprehensive health care.

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
Economic aspects of health care delivery. Economic impact of illness to total cost and cost effectiveness of various delivery systems.

8243. FAMILY MEDICINE IN THE RURAL AREA. (Cr ar; prereq #) Ciriacy and staff
Problems specific to rural areas such as physician distribution, use of allied health personnel, initial emergency treatment, referral patterns.

8245. ANALYSIS OF INSTRUCTION AND EDUCATIONAL EVALUATION. (Cr ar; prereq #) Bland, Houge
Psychology of learning, preparation of instructional objectives, educational evaluation, uses of instructional media, and educational methodology.

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) Staff
Management concepts and their application. Issues such as unionism and consumerism that affect both nonprofit and for-profit businesses in last quarter of 20th century; how these issues are managed or not managed by organizations and the results. Economic/financial concepts and analysis that help in reaching management decisions. Overview of health services sector of economy and trends. Criteria affecting residents' choice of practice location after graduation.

8253. RESEARCH PROBLEMS. (Cr ar; prereq #) Kelly
Under supervision of faculty member.

Family Social Science (FSoS)

Regents' Professor: Ellen Berscheid

Professor: M. Janice Hogan, *head;* Pauline Boss, *director of graduate studies;* Geraldine Gage; Mary E. Heltsley; David H. Olson; Paul C. Rosenblatt; Shirley Zimmerman

Associate Professor: Jean Bauer; Daniel F. Detzner; William J. Doherty; Sander M. Latts; James W. Maddock; Richard H. Needle; Kathryn D. Rettig

Assistant Professor: Sharon M. Danes

Research Associate: Kenneth O. Doyle

Other: 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 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 breadth and depth of knowledge, sophistication and skill in research, teaching, counseling, and interpersonal sensitivity.

A dual master of arts in family social science/master of social work is offered for students interested in specializing in marriage and family therapy or family financial counseling. Students are required to apply to both programs, and typically spend their first year in social work, their second year in family social science, and their third year in an internship in marriage and family therapy or family financial counseling.

The marriage and family therapy training is AAMFT approved at the doctoral level only.

Prerequisites for Admission—Minimum requirements for admission to the master's program include two family courses, four courses in social and behavioral sciences (two family courses can be counted toward this requirement), and one statistics course.

Minimum requirements for admission to the doctoral program include two family courses, eight courses in social and behavioral sciences (two family courses can be counted toward this requirement), one statistics course, and two additional research and/or quantitative courses. Admission to the doctoral program is contingent on completion of a master's degree.

Experience in working with families through paid employment or volunteer work is expected.

Special Application Requirements—Consult the director of graduate studies and the *Family Social Science Graduate Handbook*. The application deadline is December 15.

Degree Requirements—Consult the director of graduate studies and the *Family Social Science Graduate Handbook*.

Language Requirements—None.

For Further Information—Contact the chair of admissions, Family Social Science, 290 McNeal Hall, University of Minnesota, 1985 Buford Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5001. HUMAN SEXUAL BEHAVIOR. (5 cr; prereq 15 cr in social or behavioral or health sciences, or grad student 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.

5002. ADOLESCENT SEXUALITY. (3 cr; prereq 5001 or #)
Review of adolescent development. Patterns of sexual behavior during adolescence. Contraceptive use and nonuse. Adolescent pregnancy and parenthood. Parental and institutional sex instruction.

5025. PARENTING. (4 cr; prereq 5200 or 5202, CPsy 1301)
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 RELATIONSHIPS. (5 cr; prereq Psy 1001 or equiv, Soc 1001 or equiv) Doherty
Family as an institution and system of relationships. Survey of current developments in study of family. Changes in American society and their influence on family life.

5201. FAMILY IN AMERICAN SOCIAL STRUCTURE. (4 cr; prereq 5200, 25 cr social science courses exclusive of economics or #)
The family as a social institution interrelated with the economic, political, and other social institutions of society. Sources of change in the family and effects of other subsystems or social structures on the family viewed within the framework of sociological theories useful in understanding the process of change.

5202. SOCIAL PSYCHOLOGY OF CLOSE RELATIONSHIPS. (5 cr; prereq Psy 1001 and intro sociology or #) Rosenblatt
Introduction to social psychology theory and research on marriage, families, and other close relationships, with emphasis on symbolic interaction, family systems, exchange, conflict, and communication theory and social cognition.

5205. INTRODUCTION TO FAMILY RESEARCH METHODS. (3 cr; prereq 3260 and 5200) Needle
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.

5206. DEVELOPING AND EVALUATING FAMILY RESEARCH PROJECTS. (3 cr; prereq 5205) Needle
Practice in proposal writing, use of various family research techniques, and interpreting and reporting research results; includes use of microcomputer.

5210. THE FAMILY IN WORLD PERSPECTIVE. (5 cr; prereq 5200 and Anth 1102 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.

5218. FAMILY FINANCIAL MANAGEMENT. (4 cr; prereq 3260 or equiv) 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.

5219. FAMILY FINANCIAL MANAGEMENT COUNSELING. (4 cr; prereq 3260 or 5260, 3001 or #) Gage
Financial management processes of families, emphasizing dysfunctional management; modification of managerial behavior by application of cognitive and behavioral techniques.

5220. FAMILY ECONOMICS. (3 cr; prereq 3260 or #) Gage
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; prereq #)
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 *Class Schedule* for topics.

5241. ECONOMIC EFFECTS OF DIVORCE ON FAMILIES. (4 cr; prereq 5200, 5202, and 5218 or equiv) Rettig
Interdisciplinary seminar with readings and research findings in family economics, finance, and law applied to the economic well-being of families and resulting policy issues where divorce is a factor.

5242. DEATH, OTHER LOSSES AND THE FAMILY. (3 cr; prereq 5202 or equiv) Rosenblatt
Individual and family reactions to dying, death, and other losses or potential losses from perspective of theories of grief work, family systems, others.

5249. FIELDWORK. (5 cr [max 15 cr]; prereq 3 family courses, #) Zimmerman
Directed community work experience.

5255. APPROACHES TO FAMILY POLICY. (4 cr; prereq SW 3101 or Pol 3321 or #) Zimmerman
Interrelationship between families and social policy in welfare, housing, health care, family law, education, and social services.

5260. DYNAMICS OF FAMILY DECISION MAKING. (3 cr; prereq 3260 or #) Hogan
Conceptual models of decision making and resource management. Review and critique of current research and literature.

8200. SEMINAR: RESEARCH AND INTERPRETATION. (3 cr) Rosenblatt
Designed to help 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. (3 cr, §SW 8203) Boss, Needle
Theories related to family development, structure, and behavior in response to social and psychological stress. Normal and dysfunctional family behavior. Emphasis on application to crisis intervention in family systems.

8206. FAMILY POLICY: INTERNATIONAL PERSPECTIVE. (3 cr; prereq 5255 or #) Zimmerman
Comparison of different countries' policy choices that affect families: education, social services, housing, health, income maintenance, employment, taxation, and family law. Emphasis on explicit and implicit nature of family policy and its effect on families.

8214. THEORIES OF MARITAL AND FAMILY THERAPY. (4 cr; prereq 8255) 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) 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, 5001, or #) 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 8222, 8223. INTERNSHIP IN TEACHING COLLEGE-LEVEL FAMILY COURSES: I, II, III. (3-6 cr per qtr; prereq 12 cr in FSoS; offered alt yrs) Detzner, Maddock, Rettig
Overview of functional, substantive, affective, and experiential philosophies of education. Focus on content, procedure, and evaluation of a course. Syllabus preparation, critique of textbooks, and development of course objectives. Observation of various teaching styles. Supervised teaching experience.

8230. DIRECTED STUDY IN FAMILY SOCIAL SCIENCE. (1-5 cr; prereq #)

8231. SEMINAR IN GENDER ROLES. (3 cr) Hogan
Discussion and research focused on selected problems in the area of gender roles, similarities, and differences; review of scholarly literature in the area.

8242. VALUE THEORIES AND RESEARCH IN FAMILY SOCIAL SCIENCE. (4 cr; prereq 5200, 5260, or equiv or #) Rettig
Review and critique of theories and research on values and valuing processes in families.

8251. PROBLEMS: FAMILY SOCIAL SCIENCE. (1-5 cr; prereq #)

8252. PROBLEMS: FAMILY SOCIAL SCIENCE. (4 cr; prereq #)

8255. CONCEPTUAL FRAMEWORKS IN THE FAMILY. (4 cr; prereq 5200 or equiv, #) Boss, Rettig, Zimmerman
Required of all first-year graduate students in family social science. Overview and theoretical orientation to family field.

8260. FAMILY DECISION MAKING. (4 cr; prereq 5260 or #)
Theory and research in family/household decision processes; methodological issues and development of measures.

8261, 8262, 8263. PROCESS SEMINAR FOR FAMILY: I, II, III. (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) 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) 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) Boss
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 #) 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. FAMILY THERAPY PRACTICUM: I, II. (4 cr per qtr; prereq 8255, official acceptance into AAMFT-accredited training program, #) Boss, Doherty, Goodman, Maddock
On-campus live family therapy experience; 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; prereq 8214, 8215, family therapy intern)
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); Clarke Chambers (history, American studies); Patricia Faunce (women's studies, psychology); 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); Barbara Laslett (sociology); Toni McNaron (English, women's studies); Jeylan Mortimer (sociology); Martin Roth (English); Madelon Sprengnether (English)

Associate Professor: Amy Katz Kaminsky (women's studies), *director of graduate studies;* Ronald Aminzade (sociology); Maria Minich Brewer (French); Lillian S. Bridwell-Bowles (English); Mary Dietz (political science); Lois Erickson (educational psychology); Sara Evans (history); Susan Geiger (women's studies); Andrea Hinding (Humanities/Social Sciences Libraries); Diane Kjervik (nursing); George R. Lipsitz (American studies); Dorothy Loeffler (University Counseling Services); Elaine Tyler May (American studies); M. J. Maynes (history); Susan McClary (music); Barbara Nelson (Humphrey Institute); Riv-Ellen Prell (anthropology); Jean Quam (social work); Julia Robinson (architecture); Naomi Scheman (philosophy, women's studies); Amy Sheldon (linguistics); Eileen B. Sivert (French and Italian); Janet Spector (anthropology); Constance Sullivan (Spanish and Portuguese); Gayle Graham Yates (American studies)

Assistant Professor: Lisa Albrecht (General College); Rose M. Brewer (sociology, Afro-American and African studies); Rey Chow (comparative literature); Linda Jones (social work); Ellen R. Messer-Davidow (English); Paula Rabinowitz (English); Ann B. Waltner (history); Jacquelyn Zita (women's studies)

Course of Study—Minor in feminist studies, applicable to either master's or doctoral programs.

Curriculum—The Center for Advanced Feminist Studies (CAFS) offers a structured interdisciplinary graduate curriculum for students specializing in feminist studies. 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 Program is contingent upon prior admission to the Graduate School and to a master's or doctoral program in a degree-granting department.

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 will be 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 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 minor program.

For Further Information—Contact the director of graduate studies, Center for Advanced Feminist Studies, 496 Ford Hall, University of Minnesota, 224 Church Street S.E., Minneapolis, MN 55455.

Women's Studies (WoSt)

5011. IMAGES OF WOMEN WITHIN THE COURTLY LOVE TRADITION. (4 cr)
Conventional behaviors and images of women within courtship patterns as expressed in literature, art, and music of the 12th through 17th centuries in France, Italy, and England.

5100, 5200, 5300, 5400, 5500, 5600. TOPICS IN WOMEN'S STUDIES. (4 cr per qtr [12 cr max])
Topics specified in *Class Schedule*.

5101. HISTORY OF FEMINISM. (4 cr)
Feminist thought, movements, and acts since 1790, especially in the United States and Great Britain; other international references.

5102. CURRENT FEMINIST SCHOLARSHIP. (4 cr; prereq 1005, 1006 or grad student or #)
Current scholarship dealing with the feminist intellectual revolution.

5103. FEMINIST PEDAGOGY. (4 cr; prereq 8 cr in WoSt or #)
Theory and practice of feminist teaching and learning as system of inquiry, emphasizing challenges raised by diversity of women's experiences and perspectives.

5107. FEMINIST CRITICISM OF CONCEPTS OF THE SELF. (4 cr; prereq 12 cr in WoSt courses or substantial work in philosophy, religious studies, social sciences or psychology or #)
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.

5108. THE ANTHROPOLOGY OF CONTEMPORARY FEMINIST ISSUES. (4 cr; prereq 1001 or 1002, Anth 1102; Anth 3303 recommended)
Cross-cultural and evolutionary approaches to study of contemporary feminist issues.

5201. THE OLDER WOMAN: A FEMINIST PERSPECTIVE. (4 cr; prereq Soc 3937, 12 cr in women's studies or substantial work in social sciences or psychology or #)
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)
Exploration of sexism in theoretical views of women and in therapy; alternative views and therapeutic approaches for women.

5205. WOMEN: A SENSE OF IDENTITY. (4 cr, §3205)
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 potential of women.

5304. WORKING CLASS WOMEN'S LIVES. (4 cr; prereq 12 cr in WoSt or Engl or #)
Written work reflecting class background as significant variable. Novels, poems, essays, and short stories by women of various racial and ethnic identities.

5308. WOMEN WRITERS OF AFRICA AND LATIN AMERICA. (4 cr, §3308; prereq 8 cr in WoSt and/or Latin American or African Studies or #)
Analysis of literature written by 20th-century African and Latin American women.

5401. WOMEN, COLONIALISM, AND UNDERDEVELOPMENT. (4 cr)
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 #)
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)
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 #)
Survey of social problems and public policy issues of special significance to women in U.S. Macro-political, social, and economic forces shaping women's experiences as policy makers, administrators, citizens, and clients.

5601. GENDER AND CLASS. (4 cr; prereq 12 cr WoSt incl 1001 or 1002 for undergrad or grad, #)
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.

5920. TOPICS IN WOMEN'S STUDIES. (2 cr)
Topics specified in *Class Schedule*.

5970. DIRECTED STUDY. (1-5 cr per qtr [max 12 cr]; prereq # and △, CLA approval)

8510. FEMINIST THEORY AND METHOD. (4 cr; prereq #)
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 and #)
Continuation of 8510.

8710. FEMINIST RESEARCH. (4 cr; prereq 8511, #)
Examination and comparison of feminist research methods in several disciplinary and interdisciplinary contexts. Students will 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, #)
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: Thomas F. Waters, *director of graduate studies;* Ira R. Adelman; Robert Naiman; Daniel A. Panshin; George R. Spangler; James C. Underhill

Associate Professor: Yosef Cohen

Assistant Professor: Anne Kapuscinski

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. Areas of emphasis include fish ecology and physiology, fish population dynamics, fish behavior, computer modeling, stream ecology, aquaculture, and fish genetics.

Prerequisites for Admission—Prospective students are expected to have a basic background in the biological sciences, preferably with some experience in fisheries or aquatic science. Proficiency in mathematics and statistics is recommended. For admission to the Ph.D., a master's degree (with thesis) 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, since the faculty reviews most applications in early February for admission the following fall, it is recommended that complete applications be received by February 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. Also required are 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 examina-

tion 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—Contact the director of graduate studies (fisheries), Department of Fisheries and Wildlife, 200 Hodson Hall, University of Minnesota, 1980 Folwell Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5279. SPECIAL LECTURES IN FISHERIES. (Cr ar; offered when feasible)
Lectures and/or laboratories in special fields of fishery biology given by a visiting scholar or regular staff member.

5393. SPECIAL PROBLEMS IN FISHERY BIOLOGY. (Cr ar; prereq #)
Individual field, library, and laboratory research in various areas of fishery biology.

5455. AQUACULTURE. (4 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.

5456. FIELD ECOLOGY OF FISHES. (5 cr; prereq intro ecology course; offered at Itasca)
Ecological studies, observation and identification of fish in their natural habitat including life histories, reproduction, behavior, food habits, interrelationships with other fish, and general habitat requirements. Collection methods in streams and lakes.

5459. ENVIRONMENTAL PHYSIOLOGY OF FISHES. (3 cr; prereq Biol 5041 and EBB 5136 or equiv) Adelman
Effects of environmental factors such as temperature, oxygen, salinity, toxic substances, and food ration on fish physiology.

5601. ASSESSMENT AND MANAGEMENT OF VERTEBRATE POPULATIONS. (5 cr; prereq 1101, 3052, FR 1201)
Conceptual models of populations, description of population characteristics, and computer-assisted estimation of population parameters for purpose of management. Students select fisheries or wildlife laboratory.

5602. FISHERIES AND WILDLIFE PLANNING AND POLICY. (4 cr; prereq 3052)
Quantitative management methods such as linear programming; other decision-making methods. Extensive use of computer exercises. Policy and structure of management agencies.

5604. FISHERY MANAGEMENT IN INLAND WATERS. (3 cr; prereq Biol 5041 or #)
Fundamental concepts and applications of fisheries management; pond and reservoir fisheries; lake and stream investigations; rehabilitation; lake fisheries management; warm-water and trout stream management.

5701f, 5702w, 5703s. SENIOR PROBLEM. (1 cr per qtr; prereq FW sr or grad student, or #)
Problem-solving training. Management problem identification and analysis design (fall), information and data gathering and analysis (winter), and oral and written problem reporting (spring). Problem selection influenced by guest speakers, resource agency contacts, and group discussions; topic is contemporary fisheries and wildlife management issue.

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) Staff

8448. FISHERY SCIENCE. (4 cr; prereq fisheries grad 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.

8451. PRODUCTION BIOLOGY OF FISHERY ENVIRONMENTS. (4 cr; prereq Ent 5400 or Biol 5041, Stat 5021 or #; offered alt yrs) Waters
Structure and function of freshwater ecosystems; energetics of primary and secondary producers leading to fish production, theory, and techniques; effect of habitat parameters on fish production biology.

8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES. (3 cr; prereq intro genetics course or #)
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. (3 cr; prereq EBB 5601 or equiv or #; offered alt yrs) Naiman
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, biogeochemical processes involved in decomposition dynamics, ecosystem experiments and natural alterations, stability and succession, and ecosystem dynamics in a watershed perspective. One field trip.

Fluid Mechanics

Regents' Professor: Rutherford Aris (chemical engineering); 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); Perry L. Blackshear (mechanical engineering); Roger L. Fosdick (aerospace engineering and mechanics); Richard J. Goldstein (mechanical engineering); Daniel D. Joseph (aerospace engineering and mechanics); Thomas S. Lundgren (aerospace engineering and mechanics); Christopher W. Macosko (chemical engineering); Homer T. Mantis (physics); Gary Parker (civil engineering); Suhas V. Patankar (mechanical engineering); William E. Ranz (chemical engineering); L. Edward Scriven (chemical engineering); Charles C. S. Song (civil engineering); Ephraim M. Sparrow (mechanical engineering); Matthew Tirrell (chemical engineering); Hans F. Weinberger (mathematics); Theodore A. Wilson (aerospace engineering and mechanics)

Associate Professor: Charles J. Scott (mechanical engineering); Terry W. Simon (mechanical engineering)

Assistant Professor: Hiroshi Higuchi (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, 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 will 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 will consider any applicant whose scientific and engineering training is adequate to prepare them to pursue the program.

Special Application Requirements—None.

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 of study. 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—Contact the director of graduate studies, Fluid Mechanics, St. Anthony Falls Hydraulic Laboratory, Mississippi River at Third Avenue S.E., Minneapolis, MN 55414.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

AEM 5200. KINEMATICS AND DYNAMICS OF FLUID FLOW. (4 cr, §CE 3400; prereq mathematics incl differential equations and linear algebra)

AEM 5201. SHOCK WAVES AND COMPRESSIBLE FLUID FLOW. (4 cr; prereq 5200)

AEM 5202. INCOMPRESSIBLE BOUNDARY LAYER THEORY. (4 cr; prereq 5200)

AEM 5206. AERODYNAMICS OF LIFTING SURFACES. (4 cr; prereq 5200)

AEM 5240. RAREFIED GAS DYNAMICS. (4 cr; prereq 5201 or #)

AEM 8201-8202-8203. FLUID MECHANICS I-III. (4 cr per qtr; prereq undergrad fluid mechanics and vector analysis)

AEM 8207. HYDRODYNAMIC STABILITY AND BIFURCATION I. (4 cr; prereq 8201 or #)

AEM 8208. HYDRODYNAMIC STABILITY AND BIFURCATION II. (4 cr; prereq 8207 or #)

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 8230. ADVANCED GAS DYNAMICS. (3 cr; prereq 8203 or #)

AEM 8240. PERTURBATION METHODS IN FLUID MECHANICS. (3 cr; prereq 8202 or #)

AEM 8285. SELECTED TOPICS IN RAREFIED GAS DYNAMICS. (3 cr; prereq 5240, 8201 or #)

CE 5401. WATER RESOURCES ENGINEERING. (4 cr; prereq 3400 or #, IT student or grad)

CE 5402. COMPUTATIONAL HYDRAULICS. (4 cr; prereq 5401, CSci 3101 or #, IT student or grad)

CE 5405. HYDROLOGY AND HYDROLOGIC DESIGN. (4 cr; prereq 5401 or #, IT student or grad)

CE 5410. OPEN CHANNEL HYDRAULICS. (4 cr; prereq 3400, 5401 or #, IT student or grad)

CE 5420. INTRODUCTION TO WATER RESOURCES MANAGEMENT. (4 cr)

CE 5435. INTERMEDIATE FLUID MECHANICS WITH APPLICATIONS. (4 cr; prereq 3400, IT student or grad)

CE 5505. WATER QUALITY ENGINEERING. (4 cr; prereq Chem 1005, #, IT upper div student)

CE 8423. HYDRAULIC TRANSIENTS. (3 cr; prereq 5401 or #)

CE 8410.* FLUID TURBULENCE. (3 cr; prereq 5435; offered when demand warrants)

CE 8413.* MECHANICS OF SEDIMENT TRANSPORT. (3 cr; prereq 5410 or #)

CE 8415. HYDROPOWER DEVELOPMENT. (3 cr; prereq 5405)

CE 8416. HYDRAULIC MEASUREMENTS. (3 cr; prereq 3400 or #)

CE 8417. HYDRAULIC PUMPS AND TURBINES. (3 cr; prereq 5435 or #)

CE 8425.* ADVANCED GROUNDWATER MECHANICS. (4 cr; prereq 5425 or #)

CE 8430. LAKE AND RESERVOIR HYDRODYNAMICS. (3 cr; prereq #)

CE 8435, 8436, 8437. SPECIAL TOPICS IN HYDRODYNAMIC THEORY. (3 cr per qtr; prereq #)

CE 8440. FLOW EFFECTS ON STRUCTURES. (4 cr; prereq 5435 or #)

CE 8497-8498-8499.* ADVANCED HYDRAULIC LABORATORY. (2 cr per qtr; prereq #)

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 8106. ADVANCED TOPICS IN FLUID MECHANICS AND TRANSPORT PROCESSES. (3 cr; prereq 8101, 8103)

ChEn 8601-8602-8603. MOLECULAR THEORY OF EQUILIBRIUM AND NONEQUILIBRIUM PROCESSES. (3 cr per qtr)

Math 5441. MATHEMATICAL THEORY OF FLUID FLOW. (4 cr; prereq 5568 or 5572 or equiv or #)

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; 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 8333.* ADVANCED THEORY OF HEAT TRANSFER. (3 cr; prereq 5342)

ME 8350.* ADVANCED THERMODYNAMICS OF FLUID FLOW. (3 cr; prereq 5344, 8310 or #)

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 5441. INTRODUCTORY DYNAMIC METEOROLOGY I. (5 cr; prereq 1291 or 1341 or 1441, Math 3213 or 5602 or #)

Phys 5442.* INTRODUCTORY DYNAMIC METEOROLOGY II. (4 cr; prereq 5441 or #)

Phys 8163-8164.* PLASMA PHYSICS. (3 cr per qtr; prereq 5162)

Phys 8445.* ADVANCED TOPICS IN ATMOSPHERIC PHYSICS. (Cr ar)

Food Science (FScN)

Professor: Francis F. Busta, *head;* Theodore P. Labuza, *director of graduate studies;* Paul B. Addis; William M. Breene; Elwood F. Caldwell; Agnes S. Csallany; Eugenia A. Davis; Richard J. Epley; Joan Gordon; Larry L. McKay; Howard A. Morris; Vernal S. Packard, Jr.; Irving J. Pflug; Gary A. Reineccius; Sita R. Tatini; Joseph J. Warthesen; Edmund A. Zottola

Associate Professor: Elaine H. Asp; Dennis A. Savaiano; Joanne L. Slavin; David E. Smith; Zata M. Vickers

Assistant Professor: Mrinal Bhattacharya; Susan K. Harlander; H. William Schafer

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. 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 strongly recommended whether or not the prospective student is applying for financial assistance.

Master's Degree Requirements—Coursework in each of five program areas is required so that students develop a depth and breadth of knowledge in the field. The five program areas and the appropriate courses (equivalents may be substituted) are: (1) Chemistry—a minimum of 5 credits from among FScN 5310, 5312, 5412, 5413, 8311, 8312, 8313, 8315; (2) Engineering—a minimum of 5 credits from among FScN 5135, 5136, 5555, 8322, AgEn 5130, AgEn 5140; (3) Technology—a minimum of 4 credits from among FScN 5320, 5360, 5512, 5522, 5523, 5530, 5540; (4) Microbiology—a minimum of 5 credits from among FScN 5120, 5122, 5320, 5523, 8322, 8323, 8324; and (5) Consumer Issues—a minimum of 3 credits from among

FScN 5360, 5390, 5403, 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 percent 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.

For Further Information—Contact the director of graduate studies, Program in Food Science, 225 Food Science and Nutrition, University of Minnesota, 1334 Eckles Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5111. INDEPENDENT STUDY IN FOOD SCIENCE AND NUTRITION. (1-5 cr [may be repeated for cr]; prereq △) Staff
Individual laboratory or library research in some area related to food science or nutrition.

5120. FOOD MICROBIOLOGY. (5 cr; prereq MicB 5105 or VPB 3103) Tatini, Zottola
Relationship of environment to growth and survival of microorganisms in foods; characteristics of microorganisms in foods; recognition and control of food-borne pathogens.

5122. CONTROL OF MICROORGANISMS IN FOOD PROCESSING. (2 cr; prereq 5120 or #, ¶5123 recommended, especially for food science and technology majors) Zottola
Factors that influence the control and destruction of microorganisms; chemical, physical, and microbiological principles in cleaning and sanitizing food processing equipment; inactivation of microorganisms and thermal process evaluation; microbiological preservation methods; development of sanitation programs; microbiological criteria; hazard analysis and critical control point concept.

5123. MICROBIOLOGY OF FOOD FERMENTATIONS. (2 cr; prereq 5120 or #, ¶5122 recommended, especially for food science and technology majors; 2 lect hrs with 1 lect and 3 lab hrs alt wks) McKay
Characteristics of bacteria, yeasts, and molds involved in dairy and food fermentation; properties of lactic bacteriophages and methods of control in dairy fermentations; composition and factors that influence activity of dairy and food starter cultures; microbiology of natural and controlled fermentations; use of microorganisms in production of single cell protein and other products consumed as food, and in waste utilization.

5135. FOOD ENGINEERING UNIT OPERATIONS. (5 cr; prereq 1102 or ¶1102, Math 1142, Phys 1042, Phys 1046)
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).

5136. UNIT OPERATIONS LABORATORY. (2 cr; prereq 5135)
Applications of food engineering unit operations; experiments involving fluid flow, heat, and mass transfer.

5310. ADVANCED FOOD CHEMISTRY. (3 cr; prereq 3110) Csallany, Reineccius
Changes in chemical structure and functional properties of foods as modified by processing. Additional topics in areas such as flavor, color, safety, nutritive value, sweeteners, and irradiation of food.

5312. CHEMICAL AND INSTRUMENTAL ANALYSIS OF FOODS. (5 cr; prereq 3112, BioC 5025 or #) Davis, Reineccius
Application of quantitative physical, chemical, and instrumental methods of analysis to the examination of food products; evaluation of methods and interpretation of results.

5320. FOOD BIOTECHNOLOGY. (3 cr; prereq 5123, Biol 5001)
Impact of biotechnology in agriculture, nutrition, and food processing. Recombinant DNA and related technologies, bioprocess engineering, fermentation technology.

5350. APPLICATION OF EXPERIMENTAL DESIGN IN THE FOOD INDUSTRY. (4 cr; prereq course in statistics; lab hrs ar) May
Application of concepts and techniques of experimental design to the solution of food science problems. Case studies, computer programming and use emphasized.

5360. SENSORY EVALUATION OF FOOD QUALITY. (4 cr; prereq 3110 and Stat 3081 or 5021 or equiv) Vickers
Fundamentals of sensory perception. Test designs and methods used in studying the sensory quality of foods.

5380. FOOD PACKAGING. (3 cr; prereq 3110 and Phys 1042 or equiv)
Lecture and demonstration of the principles of packaging as applied to foods and the food industry.

5390. INTRODUCTION TO FOOD LAW. (4 cr; prereq 1102 or #; offered when feasible) Labuza
Analysis of federal and state legal requirements and case law history affecting production, processing, packaging, marketing, and distribution of food and food products.

5402. MODERN FOOD PREPARATION PRINCIPLES AND PRACTICES. (2-4 cr; prereq organic chemistry and 15 cr in food science and nutrition; offered when feasible)
Experimental bases of principles underlying present-day food preparation practices; development of experiences illustrative of such principles in high school teaching, dietetics, and foods in business.

5403. EXPERIMENTAL STUDY OF FOODS. (5 cr; prereq 3112, 3403, 5360) Davis
Individual laboratory experimentation and comprehensive literature search on a problem in foods. Statistics and computers as a research tool. Data analysis and interpretation for a scientific paper.

5404. CURRENT ISSUES IN FOOD AND NUTRITION. (2-4 cr; prereq 15 cr in 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.

5406. CURRENT LITERATURE IN FOODS. (2-4 cr [may be repeated for max 6 cr]; prereq 5413, △) Gordon
Assigned readings, reports, and discussions of topics in the experimental study of foods.

5412. PHYSICOCHEMISTRY OF FOODS. (3 cr; prereq 3110) Gordon
Characterization of crystalline systems, gels, emulsions, foams, and rheological systems; functionality of food macromolecules in these systems.

5413. STRUCTURAL-FUNCTIONAL RELATIONS IN FOOD SYSTEMS. (3 cr; prereq 3110) Gordon
Food as a complex biochemical system. Functionality of various biological entities and chemical constituents of food systems.

5462. ADVANCED TOPICS IN SENSORY EVALUATION OF FOOD. (2-4 cr; prereq 5360; offered alt yrs) Vickers
Review of current literature pertinent to specific topics under active investigation.

5472. FOOD PURCHASING. (4 cr; prereq principles of economics and 15 cr in food science and nutrition; offered when feasible) Staff
Cost-quality relationships of diverse food products as affected by technological changes. Composition and nutritive value of processed and formulated food products. Functional role of food additives. Recent legislation pertinent to labeling and grading of food products.

5473. ADVANCES IN THE MANAGEMENT AND PREPARATION OF FOOD. (2-4 cr; prereq 3403, 3472 or equiv; offered when feasible)
Recent developments in food materials and methods of preparation; their implications in management of time, money, and energy expenditures.

5474. FOOD MARKETING ECONOMICS. (3-4 cr, §AgEc 5550; prereq AgEc 3101 or #)
Economics of food marketing in U.S. 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 3110)
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 3110, 5120, 5135 or #) 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 3112, 5123) Morris
An integration of chemical, microbiological, and physical principles involved in the manufacture and storage of cheeses and fermented milks.

5524. SENSORY EVALUATION OF DAIRY PRODUCTS. (1 cr; prereq 3110 or #) Smith
Laboratory 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 3110, 5120 and 5135 or #) 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 3112 or #; 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.

5555. FREEZING AND DEHYDRATION OF FOODS. (5 cr; prereq 3110, 5120, 5135 or #) 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.

5562. FLAVOR TECHNOLOGY. (4 cr; prereq 1102 and 3110 or #; offered alt yrs) Reineccius
Flavor and off-flavor development in foods. Industrial production of food flavorings and their proper application to food systems.

5622. MACRONUTRIENT METABOLISM. (5 cr; prereq 3600, Biol 5001, Phsl 3051 or #) 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 3600, Biol 5001, Phsl 3051 or #) Thenen
Nutritional/biochemical and physiological function of essential vitamins and minerals in humans and experimental animal models.

5624. A METABOLIC APPROACH TO CLINICAL NUTRITION. (4 cr; prereq 5622, 5623)
Focus on individual human in clinical setting. Interaction of calorie deprivation, metabolic demands of illness, and nutritional implications of medical treatment.

5643. SEMINAR: WORLD FOOD SUPPLY PROBLEMS. (3 cr, §AgEc 5790, §Agro 5200, §Soc 5675, §LACS 5280; prereq sr or grad student; limited enrollment) Savaiano
A multidisciplinary approach to the social, economic, and technical problems of feeding the world's growing population.

8101. RESEARCH SEMINAR. (1 cr; S-N only; prereq #) 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; S-N only; prereq #) 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.

8313. TOPICS IN LIPID CHEMISTRY. (2 cr; prereq BioC 5002 or #; offered alt yrs) Csallany
Current evaluation of research and other topics relevant to lipid chemistry in food, animal and plant tissues, biological fluids, and microorganisms with emphasis on free radicals, autoxidation, oxidative deterioration, and antioxidant reactions.

8315. FOOD PROTEINS. (3 cr; prereq 5310, 5312 and BioC 5025; offered alt yrs) Davis
Symposium examining principles involved in isolation, handling, and processing of proteins from conventional as well as new protein sources. Emphasis on structural, functional, and interactive properties of proteins and how these relate in a practical way to developing or maintaining nutritional and aesthetic properties of products. Specific protein sources discussed dependent on research expertise of instructors and interests of students.

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 △) 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.

8412. INTERRELATIONSHIPS AND FUNCTIONS OF FOOD COMPONENTS. (4 cr; prereq 20 cr in food science and nutrition, #; offered when feasible) Gordon
Integration of recent findings from the physical, chemical, and biological disciplines with the body of knowledge of food structure and function.

Nutr 8745. SEMINAR. (1 cr [may be repeated for cr]; prereq #) Staff

Nutr 8990. GRADUATE RESEARCH. (2-5 cr; prereq #) Staff

Forestry

Professor: Richard A. Skok, *dean;* Kenneth N. Brooks, *director of graduate studies;* James L. Bowyer, *head, forest products;* Alan R. Ek, *head, forest resources;* Alvin A. Alm; Marvin E. Bauer; Robert A. Blanchette; Paul V. Ellefson; Robert W. Erickson; David W. French; Roland O. Gertjejansen; Hans M. Gregersen; David F. Grigal; Lewis T. Hendricks; Timothy B. Knopp; Herbert M. Kulman; Carl A. Mohn; Dietmar W. Rose; Robert H. Rouda; Harold Scholten; Edward I. Sucoff

Associate Professor: Thomas E. Burk; Vilis Kurmis; James A. Perry

Assistant Professor: Melvin J. Baughman; Charles R. Blinn; Bruno M. Franck; Glenn R. Furnier; Arthur S. Reed; Simo Sarkanen; Elmer L. Schmidt

Other: David N. Bengston; Erwin R. Berglund; Judson G. Isebrands; Rolfe A. Leary; David W. Lime; David C. Lothner; Allen L. Lundgren; John Schomaker; 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: ecology and silviculture; forest economics and management; forest protection; forest soils; policy and administration; genetics and tree improvement; hydrology and water quality management; measurements and biometrics; tree physiology and tissue culture; quantitative forest management; recreation land management; remote sensing; urban forestry; wood and wood fiber science; forest products production management; processing technology; and wood chemistry.

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—Graduate Record Examination scores and 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 of study 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 sci-

ence courses and introductory forestry courses if not included in their undergraduate program.

The final examination is oral.

Doctoral Degree Requirements—The program of study 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 will be influenced by the student's background and educational objective. Minor field competence is evaluated in the oral examination.

For Further Information—Contact the director of graduate studies, College of Forestry, 235 Natural Resources Administration Building, University of Minnesota, 2003 Upper Buford Circle, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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 #)
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. (3 cr; prereq 1301 or #)
Deterioration of wood and wood products by bacteria, fungi, insects, marine organisms, fire, and weathering; methods of preservation and preservatives used. Lecture and laboratory.

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, laboratory exercises, and plant tours.

5305. PULP AND PAPER TECHNOLOGY. (4 cr; prereq 5300 or #) Gertjejansen
Pulping processes; fiber refining and processing; manufacture of paper; fiber and paper properties; recycling of paper; water requirements and effluent treatment. Lecture and laboratory.

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 #) Gertjejansen
Design, manufacture, properties, and applications of structural and nonstructural wood-base panels. Adhesives and their application in the panel industry. Lecture and laboratory.

5310. PULP AND PAPER PROCESS LABORATORY. (3 cr; prereq 5305 or #) Gertjejansen
Chemical and mechanical pulping, pulp preparation, secondary fiber, wet end additives. Laboratory problems and exercises supplemented by lectures.

5312. PULP AND PAPER PROCESS CALCULATIONS. (4 cr; prereq ME 3301 or #; CE 3400, ChEn 5101, CSci 3101 or AgET 3030 recommended)
Chemical and physical process calculations; steady and unsteady state material and energy balances applied to pulping and papermaking processes; system calculations; introduction to computer-aided material balances.

5313. PULP AND PAPER PROCESS OPERATIONS. (5 cr; prereq 5305, 5312, 5353, CE 3400, ME 3301, or #; ChEn 5102 or ME 5342 recommended)
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.

5315. PAPER ENGINEERING LABORATORY. (2 cr; prereq 5305, 5310 or ¶5310, 5312, or #; 5306 recommended)
Experiments designed to 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)
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.

5317. INSTRUMENTATION AND PROCESS CONTROL. (2 cr; prereq 5312 or #; offered when feasible)
Measurements, analog and digital control systems, instrumentation, computers, computer control, system maintenance, fluidics, special applications.

5350. WOODY TISSUE MICROTECHNIQUE. (2 cr; offered when feasible)
Use of sliding and rotary microtomes, maceration, differential staining, and special techniques in preparation of woody tissue for microscopic study. Laboratory.

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)
Mechanical behavior of lumber, plywood, and particleboard applied to structural considerations in building construction. Lecture and laboratory.

5356. ADVANCED FOREST PRODUCTS MARKETING. (3 cr; prereq 3303 or #)
Marketing and market analysis, sales, and retail and wholesale distribution of forest products. Lectures and case studies.

5359. SURFACE AND COLLOID CHEMISTRY OF PAPERMAKING. (3 cr; prereq 5361 or #, Chem 3302, Chem 5520)
Principles of surface and colloid chemistry applied to basic problems in pulp and paper manufacturing operations and product uses.

5360. STRUCTURE AND PROPERTIES OF IMPORTANT TROPICAL WOODS. (2 cr; prereq 1303) Bowyer
Structure and methods of identification of commercially important tropical woods. Properties of these woods; relation of these properties to favored uses for the woods.

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)
Primarily to enable elementary and secondary school teachers to prepare unit on pulp and paper for elementary through senior high school science classes. Lectures, laboratories, 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)

8302.* RESEARCH PROBLEMS. (Cr ar)

8303. ADVANCED TOPICS IN PANEL PRODUCTS TECHNOLOGY. (2 cr; prereq 5307) Gertjejansen
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 laboratory.

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.

8307. ADVANCES AND METHODS IN FOREST PATHOLOGY AND PRESERVATION. (3 cr; prereq 5303, and 5304 or #)
Principles in wood protection and methods of evaluating preservatives with emphasis on international developments.

8310. MECHANICS OF WOOD AND WOOD COMPOSITES. (4 cr; prereq 5355 or #)
Fundamental mechanics of wood and wood composites, such as orthotropic elasticity, rheological systems, dynamic behavior, theories of failure, mechanical properties, environmental modifiers, and assignment of design stresses.

Forest Resources (FR)

5100. SILVICULTURE. (3 cr; prereq Itasca Session, 1100, 3104, or #) Alm
Introduction to silvics, forest regeneration and site preparation techniques, intermediate silvicultural practices, silvicultural systems.

5101. FIELD SILVICULTURE. (4 cr; prereq 5100, △, offered at Cloquet)
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.

5103.* ADVANCED FOREST TREE BIOLOGY. (3 cr; prereq 3104) Sucoff
Treatment of current applications and research.

5110. FORESTRY APPLICATIONS OF MICROCOMPUTERS. (3 cr; prereq Stat 3011, AgET 3030 or equiv)
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. (3 cr; prereq Itasca Session, Geo 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.

5126. SILVICULTURE: SOIL-SITE RELATIONSHIPS. (2 cr; prereq 1122, 5100, △; offered at Cloquet)
Field examination of forest soils and their relationship to site productivity and forest management.

5130. GEOGRAPHIC INFORMATION SYSTEMS IN NATURAL RESOURCE PLANNING. (3 cr; prereq senior or grad student or #)
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.

5140. APPLICATION OF SILVICULTURE IN NORTH AMERICAN FOREST TYPES. (3 cr; prereq 5100 or #)
Current regeneration methods and intermediate stand treatments. Economic and biological principles. Primarily lectures; student presentations, discussion of current literature, and field trips may also be included, depending on enrollment.

5150.* FOREST ECOLOGY SEMINAR. (3 cr; prereq sr, 3101, 5100 or #)
Survey of classical concepts and contemporary developments in ecology as related to forestry. Discussion group format.

5152.* FOREST GENETICS. (3 cr; prereq #) 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)
Plant identification, plant dynamics, land survey, tree measurement.

5200. AERIAL PHOTO INTERPRETATION. (3 cr)
Types, characteristics, procurement, preparation, viewing, and interpretation of aerial photographs; introduction to mapping; applications to resource surveys and management.

5212. NATURAL RESOURCES INVENTORY. (3 cr; prereq Itasca Session, 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 laboratory.

5215. FOREST FIRE MANAGEMENT. (2 cr; prereq 1100, Itasca session, 3103, 5100 or #)
Concepts, principles, and techniques of fire control and use in wild land management.

5216. SPECIAL TOPICS IN FOREST FIRE MANAGEMENT. (Cr ar; prereq 5215 or #)
Independent study of a selected aspect of forest fire management.

5217. FIELD TECHNIQUES FOR PRESCRIBED BURNING. (1 cr; prereq 5215 or #)
Field exercises in prescribed burn planning and execution.

5218. FIELD TECHNIQUES FOR FOREST FIRE CONTROL. (1 cr; prereq 5215 or #)
Supervised experience in presuppression and suppression activities.

5220. REMOTE SENSING, FOREST RESOURCES INVENTORY. (4 cr; prereq 5200, 5212, △; offered at Cloquet) Ek, Meyer, Rose
Use of aerial photographs in property boundary location; interpretation and classification of forest vegetation types. Application of sampling methods in estimating natural resources and resource use for management decision making.

5226. FOREST ECONOMICS AND PLANNING. (5 cr; prereq 5212, Ag Econ 1030 or #)
Conduct and interpretation of economic analysis, forest planning concepts, and principles and techniques of forest regulation.

5231. RANGE MANAGEMENT. (3 cr; prereq Biol 1103 or #)
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 DESIGN AND PLANNING. (4 cr; prereq 5232 or #) Knopp
(Same as LA 5010) For advanced students associated with design, management, and planning of recreational facilities. Planning and design principles related to recreational land use and development; parks; campsites, water areas, highways, summer and winter recreational facilities.

5236. FOREST RECREATION PLANNING. (1 cr; prereq 5232, △; offered at Cloquet)
Recreation area and site planning, examples and managerial concerns. Fieldwork and presentation.

5240. NATURAL RESOURCE POLICY AND ADMINISTRATION. (3 cr; prereq FR jr or sr or #)
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 #)
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, △; 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)
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.

5253.* FOREST BIOMETRY. (3 cr; prereq 5212, Stat 5021 or #; offered alt yrs) Ek
Topics in forest measurements and the modeling and analysis of forest characteristics with emphasis on growth and change estimation

5255. FOREST RESOURCE SURVEY DESIGN. (3 cr; prereq 5212, Stat 5021 or #; offered alt yrs) Ek
Advanced forest measurements, sampling, and survey design concepts and practices.

5257.* RECREATION LAND POLICY. (3 cr; prereq 3232 or #)
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 #) Knopp
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.

5269. INTERDISCIPLINARY SEMINAR I. (4 cr) Staff
Resource and community development analysis, implications for resource allocation. Selected speakers, readings, and discussion topics. Diverse disciplinary contributions reflected.

5270. INTERDISCIPLINARY SEMINAR II. (4 cr) Staff
Development of ability to identify and analyze resource development problems. Student participation as team members; guest speakers. Diverse disciplinary contributions reflected.

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.

5406. FORESTRY WORKSHOP FOR TEACHERS. (3 cr; offered at Cloquet)
Forest ecosystems and forest management; lecture and laboratory in forest environment. Techniques and materials for teaching principles of forestry in indoor and outdoor classrooms. Tours to forest and wildlife research and management units and utilization locations; guest lecturers on contemporary forestry issues.

5408. FORESTRY IN THE URBAN ENVIRONMENT. (3 cr; prereq student teacher, teacher or #) Staff
Study of forest ecosystems and forest management in lecture and laboratory sessions. Field exercises emphasize techniques and materials useful for teaching principles of forestry in indoor and outdoor classrooms; forest areas in the Twin Cities used for field exercises. Special uses and problems of the urban forest. Discussions and presentations by guest lecturers on contemporary forestry issues.

5412. ADVANCED REMOTE SENSING. (4 cr; prereq 5262 or #)
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.

5458. WATER QUALITY MANAGEMENT: ECOSYSTEM APPROACHES. (4 cr; prereq Chem 3101, Biol 5041 or equiv or #) Perry
Anthropogenic influences on aquatic ecosystems, including forest management, point and non-point pollution, and acid rain. Designed to supplement discussion of fishery impacts in FW/FR 5457.

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.

5501. URBAN FOREST ADMINISTRATION. (3 cr; prereq 5100, 5500 or #) Staff
Discussion and development of basic concepts; introduction to public relations, program building; staffing and labor relations; effect of legal restraints on ordinances and contracts; budget monitoring.

8100.* RESEARCH PROBLEMS: SILVICULTURE. (Cr ar) Alm, Kurmis, Scholten

8101.* RESEARCH PROBLEMS: FOREST-TREE PHYSIOLOGY. (Cr ar) Sucoff

8102.* RESEARCH PROBLEMS: FOREST-TREE GENETICS. (Cr ar) Mohn

8103.* RESEARCH PROBLEMS: FOREST HYDROLOGY. (Cr ar) Brooks, Perry

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 laboratory.

8106. TOPICS IN SILVICULTURE—FOREST SOILS. (Cr ar; prereq 5100 and 5 cr in 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 #) Leary
Process of scientific research, problem statements, hypothesis formation, test procedures, measurement, role of scientific concepts in research, hypothetic-deductive method, induction, strong inference, explanation, prediction.

8200.* RESEARCH PROBLEMS: FOREST MANAGEMENT. (Cr ar) Hallgren, Rose

8201.* RESEARCH PROBLEMS: FOREST ECONOMICS. (Cr ar) Ellefson, Gregersen, Rose, Skok

8202.* RESEARCH PROBLEMS: FOREST MEASUREMENTS. (Cr ar) Burk, Ek, Rose

8203.* RESEARCH PROBLEMS: FOREST RECREATION. (Cr ar) Knopp

8204.* RESEARCH PROBLEMS: FOREST POLICY. (Cr ar) Ellefson, Gregersen, Skok

8205.* RESEARCH PROBLEMS: REMOTE SENSING. (Cr ar) Bauer

8206. ADVANCED MANAGEMENT OF RECREATIONAL LANDS. (3 cr; prereq 5233, EBB 3004 or #; offered when feasible) Knopp
Relationship of people as recreationists to the natural environment. Principles of manipulation of plant and animal communities for outdoor recreation objectives. Lectures, readings, discussions, reports, field trips.

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.

8209. SEMINAR: FORESTRY AND ECONOMIC DEVELOPMENT. (3 cr; prereq 5261 or #) Gregersen
National, regional, and local development planning in forestry; approaches to forest-based sector analysis; demand and supply forecasting; political and institutional considerations. Review of literature; case studies.

8210. RESEARCH METHODS IN FORESTRY. (1 cr) Sucoff
Procedures for writing study plans and grant proposals. Each student will prepare study plan or grant proposal.

8211. SEMINAR: NATURAL RESOURCE POLICY ISSUES. (3 cr) Ellefson
Identification and analysis of major international, national, state issues of importance to natural resource management. Review of literature, case studies, guest speakers.

8213. TOPICS IN WILDLAND HYDROLOGY. (3 cr; prereq 5114, CE 5405 or #; offered alt yrs) Brooks
Lecture and discussion of current literature on the water resources of wildlands (nonurban, nonagricultural lands).

French and Italian

Professor: Tom C. Conley, *chair;* Ronald F. Akehurst; Armand A. Renaud (emeritus); Marilyn Schneider; Joseph L. Waldauer

Associate Professor: Eileen B. Sivert, *director of graduate studies;* Betsy K. Barnes; Réda Bensmaïa; Maria M. Brewer; Ronald L. Martinez; Maria F. Paganini; Judith Preckshot; Peter H. Robinson

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 will 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 each quarter) 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 will be 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 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 (French, Italian, Portuguese, Spanish, or German). Other preparation will be considered if suited to student needs.

For Further Information—A department general information bulletin and a three-year projection of graduate-level courses to be offered is available from the director of graduate studies, Department of French and Italian, 200 Folwell Hall, University of Minnesota, 9 Pleasant Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

French (Fren)

5012. STYLISTICS. (4 cr; prereq 3017 or #) Staff
Structural dimensions of literary works, principally as they relate to language. Variety of genres and periods. Taught in French.

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) 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.

5269. FRENCH ROMANTICISM. (4 cr; prereq 3209 or above) Sivert
Reading of principal theoretical and literary works.

5275. HUYSMANS AND VILLIERS DE L'ISLE-ADAM: THE REACTION. (4 cr; prereq 3209 or above) Sivert
Late 19th-century literature: the reaction to realism and naturalism in the works of Huysmans, Villiers de l'Isle-Adam, and others.

5281. EARLY 20TH-CENTURY POETRY. (4 cr; prereq 3209 or above) Preckshot
Poetry as it emerged out of the experiments undertaken at the end of the 19th century that led to a revolution in poetic form and theory; readings from Apollinaire, Jacob, Péret, Breton, Eluard, Aragon.

5289. TOPICS IN AFRICAN LITERATURE. (4 cr; prereq 3209 or above) Bensmaia
African values and views of reality compared with "European" values and views, through the analysis of literary creations. Comparison with other arts.

5303. MEDIEVAL FRENCH DRAMA. (4 cr; prereq 5207 or #) Akehurst
Medieval French theatre from its origins to the Renaissance.

5307. MEDIEVAL FRENCH ALLEGORY AND SATIRE. (4 cr; prereq 5207 or #) Akehurst
Satire and allegory in the French *Fabliaux*, the *Roman de Renart*, and *Roman de la rose*.

5311. RENAISSANCE POETRY BEFORE THE PLÉÏADE. (4 cr; prereq 3209 or above) Conley
The *grands rhétoriqueurs*, Lemaire, Marot, Saint-Gelays, Louise Labé, and others; includes study of elegy, emblem, *blason*, and *art poetique*.

5312. PLÉÏADE AND BAROQUE. (4 cr; prereq 3209 or above) Conley
Ronsard, Du Bellay, and other poets of the Pléïade 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.

5335. THE NOVEL OF THE 17TH CENTURY. (4 cr; prereq 3209 or above) Conley

5339. SHORT STORIES OF THE 16TH AND 17TH CENTURIES. (4 cr; prereq 3209 or above) Conley
Narrative and allegory in short stories in France during the 16th and 17th centuries.

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.

5359. VOYAGERS AND PHILOSOPHES IN THE 18TH CENTURY. (4 cr; prereq 3209 or above)
Relationships between voyage literature and the construction of the concept of "man."

5367. 19TH-CENTURY DRAMA: MUSSET. (4 cr; prereq 3209 or above) Sivert

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.

5382. VALÉRY AND THE HERITAGE OF SYMBOLISM. (4 cr; prereq 3209 or above) Preckshot
The poetry of Valéry; sources of his concept of poetry.

5383. 20TH-CENTURY FRENCH DRAMA TO EXISTENTIALISM. (4 cr; prereq 3209 or above)
Main trends, themes, and dramatic theories (surrealist, existentialist, contemporary theatre).

5385. ART AND LITERATURE. (4 cr; prereq 3209 or above)
Relationship among literary texts, aesthetics, semiologies, and the plastic arts.

5391. RECENT FRENCH POETRY. (4 cr; prereq 3209 or above) Preckshot
Mid-century poets: Ponge, Michaux, Char, Bonnefoy, St. John-Perse, Breton, and others.

5397. LE NOUVEAU ROMAN. (4 cr; prereq 3209 or above) Brewer
Last existentialist novels and innovations of Sarraute, Robbe-Grillet, Butor, Simon, and others.

5415. RABELAIS. (4 cr; prereq 3209 or above) Conley
Gargantua and *Pantagruel* in original text.

5418. MONTAIGNE. (4 cr; prereq 3209 or above) Conley
The *Essais* studied in terms of mimesis and ideology.

5434. BAROQUE TRAGEDY: CORNEILLE. (4 cr; prereq 3209 or above)

5438. PASCAL. (4 cr; prereq 3209 or above)
The literary originality of the *Provinciales*; major attention to *Les Pensées*.

5443. CLASSICAL COMEDY: MOLIÈRE. (4 cr, §3607, §5607; prereq 3209 or above)

5444. CLASSICAL TRAGEDY: RACINE. (4 cr; prereq 3209 or above)

5457. ROUSSEAU. (4 cr; prereq 3209 or above) Waldauer

5458. VOLTAIRE. (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

5462. RIMBAUD. (4 cr; prereq 3209 or above) Robinson

5463. HUGO. (4 cr; prereq 3209 or above) Sivert

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

5489. SARTRE. (4 cr; prereq 3209 or above)
Creative works and critical essays.

5505. TOPICS IN FRENCH CIVILIZATION. (4 cr; prereq 3201 or above, knowledge of French)
Problems of theory and method in study of French civilization. Institutions (e.g., state, media, monarchy, university), concepts defining cultural period (e.g., baroque, postmodern), moments of significant crisis (e.g., 1789, 1859, 1940, and 1968)

5588. ASPECTS OF CONTEMPORARY CRITICISM. (4 cr; prereq 3209 or above and #)
Criticism in contemporary France. Taught in French.

5599. PROFICIENCY TEACHING OF FRENCH. (6 cr [not for CLA degree credit]; prereq teaching certification in French or #)
Intensive work with implications of ACTFL Proficiency Guidelines for the Classroom Teacher, combined with intensive proficiency-oriented language instruction in French.

5607. CLASSICAL COMEDY: MOLIERE IN TRANSLATION. (4 cr, §3607, §5443; prereq grad work in theatre arts or #)
Similar to 3607 or 5443; independent reading and research assignments in consultation with instructor.

5701. STRUCTURE OF MODERN FRENCH: PHONOLOGY AND MORPHOLOGY. (4 cr; prereq 3015 or #) Barnes
Linguistic study of sound systems and word forms of contemporary French.

5702. STRUCTURE OF MODERN FRENCH: SYNTAX. (4 cr; prereq 3015 or #) Barnes
Linguistic study of grammar of contemporary French.

5800. CIEE CONTEMPORARY FILM PROGRAMS IN PARIS. (1-45 cr [undergrad], 1-15 cr [grad]; prereq 1105, #)
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)

5910. TOPICS IN FRENCH LITERATURE. (3-5 cr per qtr [15 cr max])

5999. FOREIGN LANGUAGE TEACHING: THEORY AND PRACTICE. (4 cr; prereq grad student or #) Barnes
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])

8050. SEMINAR IN FICTION. (3-5 cr per qtr [max 15 cr])

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]) Bensmaia, Conley

8110. SEMINAR IN PROBLEMS OF MEDIEVAL WRITING. (3-5 cr per qtr [max 15 cr])

8120. SEMINAR IN PROBLEMS OF 16TH-CENTURY WRITING. (3-5 cr per qtr [max 15 cr])

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])

8170. SEMINAR IN PROBLEMS OF 19TH-CENTURY WRITING. (3-5 cr per qtr [max 15 cr])

8190. SEMINAR IN PROBLEMS OF 20TH-CENTURY WRITING. (3-5 cr per qtr [max 15 cr])

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 PROVENCAL. (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; prereq #, △)

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.

5321. CHIVALRIC POETRY: BOIARDO, ARIOSTO, TASSO. (4 cr; prereq 3015) Martinez

5328. RENAISSANCE PROSE WRITERS: MACHIAVELLI, CASTIGLIONE. (4 cr; prereq 3015) Martinez

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.

5384. MODERN DRAMA. (4 cr; prereq 3015 or #) Schneider
Teatro grottesco, Pirandello, De Filippo, Fo, and others. Textual analysis; evolution of modern drama emphasizing historical context. Taught in Italian.

5385. 20TH-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
The *Divina Commedia*; Dante's minor works.

5411. PETRARCH. (4 cr; prereq 3015) Martinez
Class taught in English. Reading in English (nonmajors) and Italian (majors).

5418. BOCCACCIO. (4 cr; prereq 3015) Martinez
Taught in English. Readings in English (nonmajors) and Italian (majors).

5461. 19TH-CENTURY POETRY. (4 cr; prereq 3015 or #) Schneider
Leopardi, Pascoli, D'Annunzio, and others. Taught in Italian.

5481. MONTALE. (4 cr; prereq 3015 or #)
Reading and interpretation of Montale's poetic work.

5568. FRENCH SYMBOLISM AND ITALIAN HERMETICISM. (4 cr; prereq at least one pertinent course either in French or Italian literature or #) Robinson
Poetry of Rimbaud, Mallarmé, and Valéry; Campana, Ungaretti, and Montale.

5569. NATURALISM IN THE FRENCH AND ITALIAN NARRATIVE. (5 cr; prereq at least one pertinent course in French or Italian literature or #) Sivert
Flaubert, Maupassant, Zola, and other naturalist writers; Verga, Deledda, Fogazzaro, and others.

5601, 5602, 5603. ITALIAN LITERATURE IN ENGLISH TRANSLATION. (4 cr per qtr) Martinez, Schneider
Movements, genres, or themes in representative works from medieval times to present day.

5609. DANTE (IN ENGLISH). (4 cr; prereq #) Martinez

5701-5702. ITALIAN LANGUAGE. (4 cr per qtr; prereq #)

5900. TOPICS IN ITALIAN LITERATURE. (4 cr; prereq 3209 or above)

8209. LITERARY CRITICISM. (4 cr) Martinez, Schneider

8301. EARLY ITALIAN POETRY. (4 cr)
From origins to the *dolce stil nuovo*.

8303. FORMS OF THE ITALIAN DRAMA. (4 cr) Staff
The *sacra rappresentazione, commedia dell'arte*, tragedy, comedy, pastoral drama, melodrama.

8501. RESEARCH METHODS AND MATERIALS. (4 cr) Staff

8970. DIRECTED READINGS FOR GRADUATE STUDENTS. (1-5 cr) Staff

French and Italian (FrIt)

5219. HUMANISM AND ITALIANISM IN THE LITERATURE OF THE 16TH CENTURY. (4 cr, §Fren 5219, §Ital 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. French and Italian literary texts.

5505. SENIOR SEMINAR: THEORIES OF CULTURE. (4 cr)
Comprehensive seminar on contemporary continental theories of language, writing, and culture. Beginning with analysis of structuralist linguistics of Ferdinand de Saussure, study of how structuralism has influenced recent conceptions of language, ideology, and culture as symbolic systems.

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. (See also Span 5533, The Baroque in European Literature: Spain.)

5568. FRENCH SYMBOLISM AND ITALIAN HERMETICISM. (4 cr; prereq at least one pertinent course in French or Italian literature or #) Robinson
Poetry of Rimbaud, Mallarmé, Valéry, Campana, Ungaretti, and Montale.

5569. NATURALISM IN THE FRENCH AND ITALIAN NARRATIVE. (4 cr; at least one pertinent course in French or Italian literature or #) Sivert
Flaubert, Maupassant, Zola, and other naturalist writers; Verga, Deledda, Fogazzaro, and others.

Genetics (GCB)

Professor: Dwight L. Anderson (microbiology); V. Elving Anderson (genetics and cell biology); Fritz H. Bach (laboratory medicine and pathology); Robert M. Brambl (plant pathology); Richard S. Caldecott (genetics and cell biology); Jaroslav Cervenka (oral pathology and genetics); R. Dennis Cook (applied statistics); Sharon L. Desborough (horticulture); John W. Eaton (medicine); Franklin D. Enfield (genetics and cell biology); David P. Fan (genetics and cell biology); Anthony J. Faras (microbiology); James A. Fuchs (biochemistry); Burle G. Gengenbach (agronomy and plant genetics); James V. Groth (plant pathology); Robert K. Herman (genetics and cell biology); Leonard L. Heston (psychiatry); Ross G. Johnson (genetics and cell biology); Richard A. King (medicine); William Krivit (pediatrics); Paul T. Magee (genetics and cell biology); Larry L. McKay (food science and nutrition); Ronald L. Phillips (agronomy and plant genetics); Howard W. Rines (agronomy and plant genetics); Irwin Rubenstein (genetics and cell biology); Walter Sauerbier (microbiology); Burton L. Shapiro (dentistry); John R. Sheppard (genetics and cell biology); Michael J. Simmons (genetics and cell biology); D. Peter Snustad (genetics and cell biology); Leon A. Snyder (genetics and cell biology); Francis A. Spurrell (large animal clinical sciences); Carl J. Witkop (oral pathology and genetics).

Associate Professor: Perry B. Hackett (genetics and cell biology), *director of graduate studies;* Martin Blumenfeld (genetics and cell biology); James W. Curtsinger (genetics and cell biology); Victoria Iwanij (genetics and cell biology); Paul A. Lefebvre (genetics and cell biology); Dennis M. Livingston (biochemistry); Matthew K. McGue (psychology); Harry T. Orr (laboratory medicine and pathology); Bernard E. Reilly (dentistry, microbiology); Stephen S. Rich (laboratory medicine and pathology); Janet L. Schottel (biochemistry); Carolyn D. Silflow (genetics and cell biology); David A. Somers (agronomy and plant genetics); Howard C. Towle (biochemistry).

Assistant Professor: Judith G. Berman (botany); Susan A. Berry (pediatrics); Robert J. Brooker; Glenn R. Furnier (forest resources); James S. Gantt (botany); Kevin S. Guise (animal science); David C. LaPorte (biochemistry); Walter C. Mahoney (genetics and cell biology); R. Scott McIvor (Institute of Human Genetics, laboratory medicine and pathology); Neil E. Olszewski (botany); Mary E. M. Pierpont (pediatrics); Robert E. Pruitt (genetics and cell biology); Jocelyn E. Shaw (genetics and cell biology); Eric A. Wong (animal 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—The program provides students with a broad understanding of genetics and related scientific disciplines and with training in basic genetic theory. Students are expected to gain competence in one or more of the specialty areas in genetics. Areas of research in the program include molecular genetics, plant genetics, population and quantitative genetics, human and behavioral genetics, developmental genetics, and cytogenetics. (This classification is for convenience of description only; categories overlap and many research programs fall into more than one category.) Special institutes in human genetics, plant molecular genetics, and biological process technology provide opportunities for graduate study.

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 interested in molecu-

lar 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 February 1. 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. Advanced courses in genetics (including the core sequence GCB 8131, 8132, and 5033) and biochemistry are required, in addition to specialty courses designed to meet the individual student's needs. An oral final examination is required for both plans.

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 (including the core sequence GCB 8131, 8132, and 5033) 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 prior to enrollment.

Minor Requirements for Students Majoring in Other Fields—Proposed minor courses typically include the genetics core series (GCB 8131, 8132, and 5033) supplemented with advanced genetics courses appropriate to the student's field of specialization.

For Further Information—Inquiries about admission and financial support should be directed to the director of graduate admissions, Department of Genetics and Cell Biology, 250 BioScience Center, University of Minnesota, 1445 Gortner Avenue, St. Paul, MN 55108. Inquiries about graduate program activities, courses, and research opportunities should be directed to the director of graduate studies in genetics at the same address.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5022f,w,s,su. GENETICS. (3 cr, §3022, §Biol 5003; not open to grad students in genetics)
Mechanisms of heredity, their implications for biological populations and applications to practical problems.

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 procaryotes and single-cell eucaryotes, a nematode and Drosophila.

5030s. LABORATORY: GENETICS. (2 cr; prereq 3022 or 5022 or Biol 5003) Staff
Investigative approaches to analysis of genetic problems. Focus on a given organism or related group of organisms may differ from quarter to quarter.

5033s. POPULATION AND QUANTITATIVE GENETICS. (4 cr; prereq 3022 or Biol 5003, course in biometry or statistics or #)
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.

5034w. INTERMEDIATE MOLECULAR GENETICS. (4 cr; prereq Biol 5003, 5004, advanced bioscience undergrad or non-bioscience grad student)
Molecular genetics of procaryotes and eucaryotes, concentrating on characterization and regulation of gene expression; techniques used to study gene expression.

5042f. QUANTITATIVE GENETICS. (4 cr; S-N only; prereq 5033, Stat 5301 recommended) Enfield
Selection with reference to population changes in gene frequencies and means of quantitative characters. Information required for predicting effects of selection and related research. Emphasis on logical analysis.

5043f. HUMAN GENETICS. (3 cr; prereq 3022 or Biol 5003 or #) Anderson
Principles of human genetics at the molecular, cellular, individual, and population levels. Chromosomal and biochemical disorders; gene mapping; mutation and natural selection; variation in intelligence and behavior; genetic screening, counseling, and therapy.

5044w. HUMAN POPULATION GENETICS. (4 cr; prereq 5043, biostatistics [PubH 5452 or equiv] or #) Anderson
Biometric methods for research in human genetics. Use of genetic concepts and appropriate statistical techniques in exploring new problems. Use of statistical packages and genetic programs to analyze population data and model genetic systems. Individual study of current problems and group discussion.

5061. DEVELOPMENTAL BIOLOGY. (4 cr, §5011; 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.

5063s. THEORETICAL POPULATION GENETICS. (3 cr; college level calculus, basic statistics and genetics; offered alt yrs) Simmons
Population genetic theory as related to problems of natural populations.

5073s. ADVANCED HUMAN GENETICS. (4 cr; prereq 5031 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.

5970. DIRECTED STUDIES. (Cr ar; prereq #, △)
Individual study of selected topics or problems with emphasis on selected readings and use of scientific literature.

5990. DIRECTED RESEARCH. (Cr ar; prereq #, △)
Laboratory or field investigation of selected areas of research.

8060f,w,s. CURRENT TOPICS. (2 cr [may be repeated for cr])
Several sections offered each quarter, each devoted to a different topic.

8131f. ADVANCED GENETICS I. (4 cr, §5031; prereq 3022 or Biol 5003, Biol 5001 or BioC 5751 or #) Lefebvre
Comparative organization of genetic material in procaryotic and eucaryotic organisms. Mutation, complementation, and recombination as operational criteria for genetic analysis.

8132w. ADVANCED GENETICS II. (4 cr, §5032; prereq 8131) 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, §5048; prereq Biol 5004 or #) Iwanij, Johnson
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, §5049; prereq Biol 5003, Biol 5004) Johnson, 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 5753 or GCB 5032 or #)
Lectures, readings, and discussions. DNA replication, recombination and gene conversion, regulation of gene expression in procaryotes, 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 5753 or GCB 5032 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]; offered S-N only)

8910f,w,s. JOURNAL CLUBS. (1 cr; prereq △; offered S-N only)
Critical evaluation of selected current literature.

8920f,w,s. SPECIAL TOPICS. (1-5 cr; prereq △; offered S-N only)
Participation in organized symposia and short courses.

8950. PRACTICUM: TEACHING IN GENETICS. (1 cr; prereq △; offered 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 △; offered 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.

8970f,w,s,su. DIRECTED STUDIES. (Cr ar; prereq #, △) Staff
Content determined by interests of individual in consultation with instructor; independent, nonlaboratory study.

8990f,w,s,su. RESEARCH. (Cr ar; prereq #) Staff

Other Courses of Interest

Agro 8230. CYTOGENETICS

Biol 5003. GENETICS.

Biol 5125. RECOMBINANT DNA LABORATORY

Biol 5951. SOCIAL USES OF BIOLOGY

EBB 5044. EVOLUTION

GCB 5001. SCANNING ELECTRON MICROSCOPY LAB

GCB 5002. TRANSMISSION ELECTRON MICROSCOPY LAB

GCB 5052. QUANTITATIVE TECHNIQUES, CELL BIOLOGY

GCB 5605. CELL BIOLOGY LABORATORY

MicB 8112. MICROBIAL GENETICS

OPat 8012. HUMAN AND MEDICAL CYTOGENETICS

OPat 8015. METHODS OF GENETIC COUNSELING AND TREATMENT

OPat 8300. HUMAN DEVELOPMENT GENETICS I

Geo-Engineering (GeoE)

Professor: Charles Fairhurst, *head;* Steven L. Crouch; Andrzej Drescher; Anthony M. Starfield; Otto D. L. Strack; Ioannis Vardoulakis

Associate Professor: Hans-Olaf Pfannkuch; Raymond L. Sterling

Assistant Professor: Randal J. Barnes; Joseph F. Labuz; Vaughan R. Voller

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.Geo.E., M.Geo.T., and Ph.D.

Curriculum—The graduate program in geo-engineering is administered in the Department of Civil and Mineral Engineering. As such, the graduate program is closely allied with civil engineering. The master of geo-engineering program is designed for engineering graduates who are particularly interested in planning, design, operation, or management in geotechnical areas. The master of geotechnology degree is designed 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 geo-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. and M.Geo.T. programs. 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. and M.Geo.T. 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—Contact the secretary for graduate studies, Civil and Mineral Engineering Building, University of Minnesota, 500 Pillsbury Drive S.E., Minneapolis, MN 55455.

Note—Students should also consult courses list under Mineral Engineering later in this bulletin.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5180. GEOCHEMICAL EXPLORATION. (3 cr; prereq IT sr or #)
Geochemical principles and techniques involved in the search for ore bodies. Basic premises, primary and secondary distribution halos, Eh-pH, geochemical provinces. Interpretation of data, case studies. Laboratory work on colorimetric analysis of rock, soil, water.

5190. MINING GEOLOGY. (4 cr; prereq MinE 5620 or #, IT student or grad IT major)
Analysis of geologic guides and techniques in location and delimitation of ore bodies. Geologic environment of typical ore bodies of economic minerals. Application of geologic theory, data, and techniques in mineral exploration.

5216. GEO-ENGINEERING I. (3 cr; prereq IT student or grad IT major; offered when feasible)
Site investigations, geologic defects, rock properties, geophysical methods, vibration damage criteria, design of rock mass improvement systems including rock bolting, prestressing, and grouting. Cleft-water pressures, case histories.

5218. TUNNEL TECHNOLOGY. (3 cr; prereq 5302 or #, IT student or grad IT major)
Tunneling systems, site problems. Analysis of stress and load. Design of linings and support. Materials handling. Planning. Special problems, case histories.

5260. (formerly MinE 5670). DRILLING AND BLASTING TECHNOLOGY. (2 cr; prereq CE 3300 or #, IT upper div or grad student)
Rock fracture under surface loading. Mode of activity and performance of rotary, rotary-percussive drills. Properties of explosives. Rock fracture under explosive load. Techniques for controlled blasting.

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.

5300. THEORY OF GEOMECHANICS. (4 cr; prereq CE 3300, IT student or grad IT major)
Groundwater flow. Introduction to linear elasticity. Consolidation; settlement calculations. Limit analysis, bearing capacity.

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 GEO-ENGINEERING PROBLEMS. (Cr and hrs ar; prereq IT sr or #)
Literature survey, research work, or design study in geo-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, modelling and simulation. Applications in geological engineering and related fields.

8336. ANALYTICAL METHODS IN ROCK MECHANICS. (4 cr; prereq #)
Development and application of methods of analysis in rock mechanics, closed form and numerical solution techniques. Generation of appropriate mathematical models, including material properties and boundary conditions for different types of rock mechanics problems. Emphasis on obtaining practical engineering solutions using best method for given problem.

8350. ADVANCED ROCK MECHANICS I. (4 cr; prereq 5302)
Implementation of rock mechanics techniques in civil and mining engineering practice, involving laboratory 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.

8352. ADVANCED ROCK MECHANICS II. (4 cr; prereq 5302)
Rock dynamics and blasting mechanics, including body waves in three dimensions, transmission and reflection of waves, effect of cracks on rock dynamic properties, surface waves, rock fracture under impulsive loads, blast design, perimeter blasting, and development blasting.

8601-8602-8603. SEMINAR: GEO-ENGINEERING. (Cr ar; prereq #)

8612, 8613, 8614. GEO-ENGINEERING RE8612, 8613, 8614. GEO-ENGINEERING RESEARCH PROBLEMS. (Cr ar; prereq #)

Geography (Geog)

Regents' Professor: John R. Borchert

Professor: Richard H. Skaggs, *chair, director of graduate studies;* John S. Adams; Ward J. Barrett; Dwight A. Brown; Philip J. Gersmehl; John F. Hart; Mei-Ling Hsu; Fred E. Lukermann; Eugene C. Mather (emeritus); Philip W. Porter; John G. Rice; Joseph E. Schwartzberg; Eric S. Sheppard

Associate Professor: Russell B. Adams; Helga Leitner; Roger P. Miller; Earl P. Scott; Roderick H. Squires; Connie H. Weil

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; physical geography; urban and economic geography; cartography and geographic information systems; regional geography; and history of geographic thought. 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.

Special Application Requirements—Three letters of recommendation must be sent directly to the department. Tardy letters will delay processing of the application. Scores from the General (Aptitude) Test of the Graduate Record Examination (GRE) are required of students with baccalaureate degrees from U.S. institutions.

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, 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 "Geography at Minnesota" from the director of graduate studies.

Language Requirements—Although there is no formal requirement, 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 selection of the appropriate skills is the responsibility of the adviser and the student.

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—Contact the director of graduate studies, Department of Geography, 414 Social Sciences Building, University of Minnesota, 267 19th Avenue South, Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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) 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)
Intensive geographical analysis of selected regions east of the Great Plains. Regions selected vary from year to year.

5112. WESTERN UNITED STATES. (4 cr) Mather
Physical and human resources of Western United States.

5113. CANADA AND ALASKA. (4 cr) Mather
Physical and human geography; internal and external areal relationships.

5131. COLONIAL MEXICO AND THE CARIBBEAN. (4 cr) Barrett
Exploration, discovery, livelihood, and circulation to about 1800.

5132. SOUTH AMERICA. (4 cr) Weil
Regional survey of physical resources, population, agriculture, manufacturing, and transportation in South America.

5142. GEOGRAPHY OF EAST AFRICA. (4 cr) 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 contracts.

5143. GEOGRAPHY OF WEST AFRICA. (4 cr) 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) 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) Leitner
Physical and human geography considered as a whole, followed by a more intensive discussion of selected topics on the British Isles, France, and Low Countries, the Rhine basin.

5172. EASTERN EUROPE. (4 cr) R Adams, 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, §Scan 5173) Rice
Physical and human geography of Sweden, Finland, Denmark, Norway, and Iceland; emphasis on population change and settlement patterns.

5175. HISTORICAL GEOGRAPHY OF THE BRITISH ISLES. (4 cr) Rice
Peoples and cultures of Britain and Ireland from Neolithic times to the present. Development of rural and urban landscapes. Introduction to approaches and methods used by historical geographers.

5176. CELTIC BRITAIN AND IRELAND. (4 cr) Rice
Historical treatment of cultural, political, and economic geography of Ireland, Scotland, and Wales. Considerable attention to ties with England and their impact on patterns of human activity.

5178. SCANDINAVIA IN THE MIDDLE AGES. (4 cr, §Scan 5118) 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. U.S.S.R. REGIONS AND PLANNING. (4 cr) R Adams
Regionalization, production specialization, and interchange within the U.S.S.R., effects of policies of centralization and regional autonomy; present trends and prognosis.

5191. AGRICULTURAL MARKETING IN AFRICA. (4 cr) 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 landholders.

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.

5322. POLITICAL GEOGRAPHY OF ASIA. (4 cr; prereq 3321 or a regional course on any part of Asia or #) Schwartzberg
Geographical analysis of political development within particular countries of Asia and of problems of regional and interregional conflict and cooperation.

Topical Studies

5311, 5312. TIME GEOGRAPHY I, II. (4 cr per qtr) Miller
5311: Conceptual frameworks for integration of time and space in geographic research; development of time-geographic methodology; applications of time-geography in social planning; use of time-geographic perspective to analyze interrelationships among daily activity patterns and social, economic, and institutional structures. 5312: Analyzing reproduction of social and institutional structures; application of time-geographic perspectives to research topics.

5344. HISTORICAL GEOGRAPHY OF RESOURCE USE IN THE UNITED STATES. (4 cr; prereq 3101 or 3344 or grad) Squires
Analysis of selected topics in development of American landscape, focusing on how resources have been used.

5345. LAND IN AMERICA. (4 cr; prereq 3344, 3343, or #)
Development of land market in U.S., emphasizing role of government in shaping and guiding it.

5371. NORTH AMERICAN CITIES. (4 cr; prereq 1301 or 1501 or 1970 or 3371 or 3973 or 5001 or #)
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) J Adams
Urban systems and metropolitan areas, structure and growth; daily urban systems; simulated urban systems; metropolitan dynamics; social area analysis; transportation systems; travel behavior; land use; retail structure change.

5373. METRO ANALYSIS II: URBAN ECONOMIC GEOGRAPHY. (4 cr) J Adams
Neighborhood transition; conflicts in housing, location of facilities, and urban renewal.

5375. AMERICAN METROPOLITAN EVOLUTION. (4 cr) Borchert
Spread of urbanization across the U.S.; differentiation of city sizes and functions within the nation's resource regions and circulation system; development of today's system of cities.

5376. AMERICAN METROPOLITAN REGIONS. (4 cr) Borchert
Development of major metropolitan areas of the United States and their tributary regions; changing metropolitan patterns of population, wealth, and land use.

5381. LOCATION THEORY AND SERVICES. (4 cr) R Adams
Localization of economic activity; classical and current models and theory; methods of solving optimal location problems; case studies of industries and services at national, regional and local levels; outside speakers on specialties.

5382. APPLIED LOCATIONAL MODELS. (4 cr; prereq 3331 or #) R Adams, Sheppard
Practical problems of optimal location in geographic space. Solution of applied facility location problems in private and public sectors. Application of various locationally oriented programming techniques; packaged programs.

5383. TRANSPORTATION GEOGRAPHY. (4 cr; prereq 3331 or #) R Adams
Principles and theory of spatial development of transport systems; interaction of resource use and network growth; commodity and passenger flows; case studies at national, regional, and local levels.

5393. LOOK OF THE LAND. (4 cr) 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) Weil
Concepts and methods, including distribution and diffusion of disease; impact of environmental, population, and social change on health; distribution, accesssibility, and utilization of health practitioners and facilities.

5423. ADVANCED CLIMATOLOGY. (4 cr; prereq 3421 or Soil 5420 or #) Skaggs
Selected topics including energy balances, synoptic climatology, climate models.

5424. APPLIED CLIMATOLOGY. (3 cr, §Soil 5424; prereq 3421 or Soil 5420 or #) Skaggs, Baker
Application of climatic principles and data to selected problems in environmental management and agriculture.

5444. GEOGRAPHY OF WATER RESOURCES. (4 cr; prereq two courses physical geography 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) Borchert
Context of planning within changing geographic patterns of land use. Nature of land use plans; purpose and process of land use planning.

Technical Studies

5511. CARTOGRAPHIC ANALYSIS. (4 cr; prereq 3511 or basic statistics course) Brown, Hsu, Porter
Methods of data compilation; quantitiative analysis of maps, map types, graphic correlation, composite mapping; area sampling, classification, and other generalization problems.

5512. CARTOGRAPHY: TOPICS. (4 cr; prereq 3511 or #) Brown, Hsu, Porter
Selected topics: the system of cartographic communication, map design, map reading, map analysis, history of cartography.

5522. COMPUTER-ASSISTED CARTOGRAPHY. (4 cr; prereq basic knowledge of FORTRAN and 3511 or #) Hsu
Geocoding and geographical information systems, library mapping programs, programming for mapping and geographical analysis, mapping via an interactive cartographic system.

5530. CARTOGRAPHY INTERNSHIP. (2-5 cr per qtr [10 cr max, incl combined cr at 3xxx and 5xxx levbels]; prereq #) Staff
Internship with institution, government agency, or private company arranged through and supervised by department.

5531. QUANTITATIVE RESEARCH DESIGN. (4 cr; prereq basic statistics course[s]) R Adams, Sheppard, Skaggs
Introduction to intermediate statistical methods for handling geographical data; multivariate methods, regionalization, spatial pattern analysis.

5562. INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS. (4 cr, §LA 5562; prereq jr or sr in Geog or LA, or grad, or #) Brown, Gersmehl
Geographic information systems structure; theory and applications for geographic research, location and resource analysis, and regional planning; location principles, data structure, and variable attributes.

5701. FIELD RESEARCH. (4 cr; prereq 12 cr geography and #) 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 departmental supervisor specifying work to be accomplished and means of reporting achievement.

History and Philosophy of Geography

5001-5002. GEOGRAPHICAL ANALYSIS I, II. (4 cr per qtr) Sheppard
5001: Order, science, and geography; measurement, relationship, and classification; location and spatial interaction; spatial diffusion processes; spatial decision making. 5002: Specialized investigation of certain geographical theory. Critiques of, and alternatives to, classical theories. Investigation of radical theories.

5801. DEVELOPMENT OF GEOGRAPHIC THOUGHT. (3 cr, §3801; prereq sr or grad student, three courses geography) Lukermann
Concepts and methods of geography; differing schools of geographic thought as expressed in contemporary geographic 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.

Directed Studies

5900. TOPICS IN GEOGRAPHY. (4 cr; prereq sr or grad student and △)
Course on special topics and regions offered by visiting professors in their research fields.

8010. SEMINAR: THEORETICAL GEOGRAPHY. (3 cr; prereq #; offfered 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: HISTORICAL GEOGRAPHY OF PUBLIC LANDS. (1 cr; prereq #) Squires

8126. SEMINAR: HISTORICAL GEOGRAPHY OF PUBLIC LANDS. (3 cr; prereq 8125) Squires

8140. SEMINAR: AFRICA. (3 cr; prereq #) Porter, Scott

8160. SEMINAR: HISTORICAL GEOGRAPHY OF EUROPE. (3 cr; prereq #) Rice

8180. SEMINAR: SOVIET UNION. (3 cr; prereq #) R Adams

8200. SEMINAR: EAST ASIA. (3 cr; prereq #) Hsu

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.

8310. SEMINAR: CULTURAL GEOGRAPHY. (3 cr; prereq #) Hart

8330. SEMINAR: RURAL GEOGRAPHY. (3 cr; prereq #) Mather

8340. SEMINAR: LAND USE PLANNING. (3 cr; prereq #) J Adams, Borchert

8344. SEMINAR: FEDERAL PUBLIC LAND POLICY. (3 cr; prereq #) Squires

8345. SEMINAR: STATE PUBLIC LAND ADMINISTRATION. (1-3 cr; prereq 8344) Squires

8350. SEMINAR: WORLD POPULATION PROBLEMS. (3 cr; prereq #) Staff

8371-8372-8373. CITY REGIONS OF THE WORLD: THEORY, RESEARCH METHODS, CASE STUDIES. (3 cr per qtr; prereq #) J Adams

8380. SEMINAR: MEDICAL GEOGRAPHY. (3 cr; prereq 5411 or #; offered when feasible) Weil

8400. SEMINAR: PHYSICAL GEOGRAPHY. (3 cr; prereq #) Staff

8401. SEMINAR: SURVEY OF PHYSICAL GEOGRAPHY. (3 cr; prereq #) Brown, Gersmehl, Skaggs
Historical development of research in physical geography, current research trends, and transfer of current research to undergraduate education.

8420. SEMINAR: CLIMATOLOGY. (3 cr; prereq #; offered when feasible) Skaggs
Detailed study of selected topics. Topics vary from year to year; examples include modeling, climatic variability, predictability, severe local storms, drought, and energy balance.

8440. QUARTERNARY BIOGEOGRAPHY. (1-3 cr; prereq #; offered when feasible) Squires

8510. SEMINAR: CARTOGRAPHY. (1-3 cr; prereq #; offered alt yrs) Brown, Hsu, Porter

8530. SEMINAR: QUANTITATIVE GEOGRAPHY. (3 cr; prereq #; offered when feasible) Adams, Sheppard, Skaggs

8700. SEMINAR: HISTORICAL FIELD. (4-6 cr; prereq #; offered when feasible) Lukermann

8800. SEMINAR: DEVELOPMENT OF GEOGRAPHIC THOUGHT. (3 cr; prereq #) Lukermann

8970. DIRECTED READINGS. (1-5 cr) Staff

8980. TOPICS IN GEOGRAPHY. (3 cr; prereq #)

8990. RESEARCH PROBLEMS IN GEOGRAPHY. (Cr ar) Staff

Geology and Geophysics (Geo)

Professor: Peter J. Hudleston, *head;* James H. Stout, *director of graduate studies;* E. Calvin Alexander, Jr.; Subir K. Banerjee; Roger L. Hooke; V. Rama Murthy; Hans-Olaf Pfannkuch; Frederick J. Sawkins; William Seyfried, Jr.; Joseph Shapiro; Robert E. Sloan; Paul W. Weiblen; Tibor Zoltai

Associate Professor: George H. Shaw, *associate head;* Emi Ito; David Yuen

Assistant Professor: Karen L. Kleinspehn; Christopher Paola; Frederick R. Schult; Christian P. Teyssier

Other: Val W. Chandler; 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, geomorphology, glaciology, groundwater geology, limnology, and sedimentology. The geophysics major includes the areas of applied and theoretical geophysics, paleomagnetism and rock magnetism, and seismology. Minor and supporting fields are normally 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 will also be 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 will be 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. A general review of student progress is made in May. A written evaluation examination in mathematics, physics, chemistry, and geology is given during the first year of residence. Admission to degree programs is based in part on this examination.

Master's Degree Requirements—A general oral final examination and defense of the thesis is required for Plan A; a general oral final examination is required for Plan B.

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—Contact the director of graduate studies, Department of Geology and Geophysics, University of Minnesota, Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

General Geology

5004. MINERALOGY. (4 cr, §3401; prereq Math 1221, 1 term college chemistry, #; not open to geology, geophysics, or geological or mineral engineering majors)
Introduction to crystallography, crystal chemistry, and crystal physics. Physical and chemical properties, crystal structures and chemical equilibria of major mineral groups. Laboratory includes crystallographic and polarizing microscopes. X-ray diffraction exercises, hand specimen mineral identification.

5051. PHYSICAL GEOLOGY FOR TEACHERS. (4 cr, §1001, §1111; prereq education degree, 1 term college chemistry or physics; no grad credit for geo/geophys majors)
Introduction to scientific methods and the nature of the 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 plus 1001 or 1111 or 5051 or #; no grad credit for geo/geophys majors) Sloan
Introduction to origin of the earth, physical evolution of its crust through geological time, and biological changes that occurred during its history. Laboratory, fieldwork, and seminar.

5100. ADVANCED GENERAL GEOLOGY. (1-2 cr [may be repeated for cr]; S-N only; prereq 1001 or 1111, #)
Seminar course on geology of an area, followed by field trip to location being studied. Region studied varies from year to year. Not offered every year.

5108. ADVANCED ENVIRONMENTAL GEOLOGY. (4 cr; prereq geology core curriculum 1111 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 the earth. Land use planning, environmental impact assessment, ecogeologic world models. Field project.

5111. FIELD GEOLOGY. (5-9 cr; restricted to majors in geology, geophysics, or geo-engineering; prereq 5201, #; no grad credit for geo/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 field work.

5151. INTRODUCTION TO PALEONTOLOGY. (5 cr; prereq 1002 or 3112 or #; no grad credit for geo/geophys majors) Sloan
Morphology and classification of major fossil groups.

5152. INVERTEBRATE PALEONTOLOGY. (5 cr; prereq 5151; offered when demand warrants) Sloan
Detailed studies of morphology, classification, and ecology of selected groups of invertebrate fossils.

5154. VERTEBRATE PALEONTOLOGY I. (5 cr; prereq 5151 or EBB 5114) Sloan
Morphology, evolution, and stratigraphic distribution of fossil fish, amphibians, reptiles, and birds.

5155. VERTEBRATE PALEONTOLOGY II. (5 cr; prereq 5154 or EBB 5114) Sloan
Morphology, evolution, and stratigraphic distribution of fossil mammals.

5156. ZOOARCHAEOLOGY. (5 cr; primarily for paleontology, anthropology, and classics students; prereq 5155 or #; 3 lect and 2 lab hrs per wk; offered alt yrs) Sloan
Identification and interpretation of animal remains in an archaeological context.

5201. STRUCTURAL GEOLOGY. (5 cr; prerq 3102, 3401 or #, IT upper div major in geology, geophysics, geo-engineering, mineral engineering or CLA jr or sr geology major; no grad credit for geo/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 5002 or #) Sawkins, 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 1111 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; prereq 5201 or #; 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 3221 or equiv 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 3112 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. GENERAL GEOCHEMISTRY. (4 cr; prereq 2 qtrs college chemistry or #) Ito, Seyfried
Principles pertinent to the distribution and control (structural, thermodynamic and kinetic) of chemical species in the 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. NUCLEAR GEOLOGY. (4 cr; prereq 5311 or #) Alexander, 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 or 5404, 5201 or #) Sawkins
Nature and distribution of sulfide deposits and analysis of processes by which metals are concentrated in magnetic, hydrothermal, and sedimentary environments.

5352. ECONOMIC GEOLOGY: FERROUS METALS AND URANIUM DEPOSITS. (4 cr; prereq 3401, 5201 or #) Sawkins
Environmental setting, mineralogy, and genesis of ferrous metal ore deposits and nonmetallic deposits.

5404. MINERAL SYSTEMS I. (4 cr, §3401, §5004; prereq 1 qtr chemistry) Zoltai
Crystallography: basic and compound symmetry operations, point and space groups, crystal forms and coordinate systems. Systematics of basic and derivative close-packed and coordination polyhedral structures of rock forming and ore minerals. Demonstrations of crystallographic and crystal structural concepts.

5405. OPTICAL MINERALOGY. (2 cr; prereq 3401 or ¶3401 or 5404 or ¶5404) Shaw
Optical properties of minerals; symmetry and crystal optics; identification of minerals using polarizing microscope.

5452. IGNEOUS AND METAMORPHIC PETROLOGY. (5 cr; prereq 3102, Chem 5520 or 5521, Math 3211 or #) Stout
Theoretical course that develops basic thermodynamic tools and chemographic analysis for the interpretation of chemical processes in igneous and metamorphic rocks. Laboratory, field trip, problem sets, and term paper.

5601. LIMNOLOGY. (4 cr §EBB 5601; prereq Chem 1005 or equiv) 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. CASE STUDIES IN LIMNOLOGY. (3 cr; prereq 5601 or EBB 5601, #) Shapiro
Detailed analyses of specific studies of lakes and their problems throughout the world.

5603. GEOLOGICAL LIMNOLOGY. (4 cr; prereq 5601 or EBB 5601)
Tectonic and climatic setting of lakes; physical, chemical, and biological processes of sedimentation in lakes.

5611. GROUNDWATER GEOLOGY. (4 cr; prereq 1001 or 1111, Math 1231, 1 qtr physics and chemistry or #) Pfannkuch
Origin, occurrence, and movement of groundwater viewed in context of hydrologic cycle. Characteristics of aquifer systems. Exploratory investigations. Hydrogeologic units and boundaries of regional systems. Analysis of surface water groundwater interaction, recharge. Quality and chemistry of groundwater supplies.

5613. TRACERS IN HYDROGEOLOGY. (3 cr; prereq 5611 and #) Alexander, Ito, Pfannkuch
Review of use of tracers in hydrogeology to determine source, age, and mixing parameters of water in various natural reservoirs.

5615. PETROLEUM RESERVOIR GEOLOGY. (2 cr; prereq 1001 or #) Ito, Pfannkuch
Introduction to subsurface geology and its application to evaluation of petroleum and natural gas reservoirs.

5621. LIMNOLOGY LABORATORY. (2 cr, §EBB 5621; prereq 5601 or EBB 5601 or #) Megard
Laboratory to accompany Geo 5601 (EBB 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.

5651. SEDIMENTOLOGY. (5 cr; prereq 3102, Phys 1271, IT upper div major in geology, geophysics, geoengineering, mineral engineering or CLA jr or sr geology major or #; no grad credit for geo/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 3102, 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 modelling, and geochronology of sedimentary basins.

5654. MARINE SEDIMENTARY ENVIRONMENTS. (4 cr; prereq 5651 or #; offered alt yrs) Kleinspehn
Principles of facies analysis of modern and ancient marine depositional systems.

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. (4 cr; prereq 5651 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 #)

8202. ADVANCED STRUCTURAL GEOLOGY. (3 cr; prereq 5201 or 5002; 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. Laboratory research on selected topics. Field trips.

8203. GEOTECTONICS. (3 cr, §5203; prereq 5201 or 5002 or #) Sawkins, 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 #) 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 #)
Stable isotope fractionations in geological, environmental, and biological systems. Theory and application pertinent to research interests of students.

8351. ADVANCED MINERAL DEPOSITS. (3 cr; prereq 5351, 5313 or #) Sawkins, Seyfried
Geochemistry of hydrothermal ore deposits. Application of solution chemistry to mineral deposit problems. Stability and solubility of hydrothermal minerals. Chemistry of ore-forming fluids and formation of hydrothermal ore deposits.

8402. X-RAY MINERALOGY. (4 cr; prereq 1 yr college physics and chemistry; 3 lect and 2 lab hrs per wk) Zoltai
Review of basic crystallography with emphasis on symmetry of the lattice. Principles of X-ray diffraction of polycrystalline material. Introduction to single-crystal methods. Indexing of diffraction patterns and determination of space groups.

8404. X-RAY CRYSTALLOGRAPHY. (4 cr; prereq 8402 or #; offered when demand warrants) Zoltai
Introduction to principles and practice of single-crystal X-ray diffraction. Space group determination. Crystal structure determination methods and problems.

8413. MECHANICS OF SEDIMENT TRANSPORT. (3 cr, §CE 8413; prereq CE 8422 or #) Paola
Theories of sediment transport in boundary layers: bed, suspended and total load. Application mainly to rivers and bed forms.

8453. PHASE EQUILIBRIA IN MINERAL SYSTEMS. (3 cr; prereq 5452, Chem 5520, Math 3221; offered yearly 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 yearly 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 yearly 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, §EBB 8602; prereq 5601, EBB 5601, or #; offered alt yrs) Shapiro
Detailed study of selected problems in limnology using current and classical literature. Term paper required.

8611. TRANSPORT PHENOMENA IN NATURAL POROUS MEDIA. (2 or 3 cr; prereq CE 3400 or Chem 5520 or equiv or #; 2 lect hrs per wk and term project ar; offered when demand warrants) Pfannkuch
Microscopic flow parameters, momentum, mass and energy transport through porous media, rak processes, coupled processes and nonequilibrium thermodynamics, geologic controls of natural flow systems in porous media and aquifers.

8612. ANALYTICAL GEOHYDROLOGY. (3 cr [4 cr with term paper]; prereq Math 3221, CE 3400 or #) 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.

8613. MECHANICS OF SEDIMENT TRANSPORT. (3 cr, §CE 8413; prereq CE 5410 or #) Paola
Theories of sediment transport; transport processes and types of movement; interrelationship of sediment transport, channel geometry, channel stability in alluvial streams; applications to river regulation, artificial channels, local scour, deposition in reservoirs, beach processes, other areas.

8621. TRACERS IN HYDROGEOLOGY. (3 cr; prereq #) Alexander, Pfannkuch
Use of tracers in hydrogeology to determine source, age, and mixing parameters of water in various natural reservoirs.

Geophysics

5501w. GEOPHYSICAL METHODS IN GEOLOGY. (4 cr; prereq 3102, Phys 1291, upper div [CLA students require △] or #; no grad credit for geo/geophys majors)
Geophysical properties of the earth and earth materials, internal structure and constitution, geophysical exploration methods and geologic interpretation, radioactivity and thermal structure of the earth, physical basis for plate tectonics.

5505. PHYSICS AND CHEMISTRY OF THE EARTH I. (4 cr; prereq 1111, Phys 1295)
Earthquake seismology; physical structure of the earth's crust and deep interior.

5506. PHYSICS AND CHEMISTRY OF THE EARTH II. (4 cr; prereq 1111 and Phys 1291, 5505 not required) Banerjee,
Gravity and magnetic fields of the earth; paleomagnetism; thermal history of the earth.

5507. PHYSICS AND CHEMISTRY OF THE EARTH III. (4 cr; 5505 or 5506 not required) Alexander
Origin and chemical evolution of the earth through geologic time.

5511. PRINCIPLES OF GRAVITY AND MAGNETIC EXPLORATION. (3 cr; prereq Phys 1291)
Instruments, surveying techniques, data reduction, interpretation, case histories.

5512. PRINCIPLES OF SEISMIC EXPLORATION. (3 cr, §5522; prereq Phys 1291)
Reflection and refraction seismology; theory, interpretation, instruments.

5513. PRINCIPLES OF ELECTRICAL EXPLORATION. (3 cr; prereq Phys 1291)
Resistivity, electromagnetic, induced polarization, and other methods.

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.

5521. DATA PROCESSING METHODS IN GEOPHYSICS. (3 cr; prereq 5512, 1 yr calculus)
Digital data processing techniques used in geophysical exploration.

5531. HIGH PRESSURE MINERALOGY WITH GEOPHYSICAL APPLICATIONS. (3 cr; prereq 3401 or #) Shaw
Phase transformations in solids at high pressures and temperatures with emphasis on silicates and silicate analogs, likely mineralogic constitution of the mantle, and detailed structure of mantle.

5535. GEOLOGICAL THERMOMECHANICAL MODELLING. (4 cr; prereq Math 3221 or #) 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 #) Yuen
Scaling of equations for geological approximations, applications to geological situations, rheology.

5541. GEOMAGNETISM. (3 cr; prereq 1 qtr each geology, physics, mathematics; offered alt yrs) Banerjee
Present geomagnetic field, secular variation and westward drift, Dynamo Theory for the origin of the field. Origin of natural remanent magnetization and its stability, paleomagnetic measurement techniques, axial dipole hypothesis and virtual geomagnetic poles, field reversal versus self-reversal. Polar wandering and continental drift, seafloor spreading, and plate tectonics.

8521. LINEAR DATA PROCESSING WITH GEOPHYSICAL APPLICATIONS. (3 cr, §5521; prereq 5512 and 1 yr calculus)
Modern digital data processing methods used in geophysics, based on Fourier and z transforms.

8531-8532. THEORY OF ELASTIC WAVE PROPAGATION I, II. (3 cr per qtr; prereq 5505 or 5512, 1 yr calculus; offered when demand warrants)
Mathematical theory underlying elastic wave propagation with applications to earthquake and exploration seismology. Elasticity theory, ray theory, surface wave analysis, seismometer theory, anelastic effects, and synthetic seismogram computations.

8542. PRINCIPLES OF ROCK MAGNETISM I. (3 cr; prereq 5541 or #) Banerjee
Magnetic ordering of ionic compounds. Magnetic properties of single crystals of natural magnetic minerals; e.g., magnetite, hematite, and their titanium-substitute compounds. Temperature and grain size dependence of magnetic parameters.

8543. PRINCIPLES OF ROCK MAGNETISM II. (3 cr; prereq 8542 or #) Banerjee
Remanent magnetizations, their classification and origins. Primary versus secondary magnetizations. Separation of multicomponent magnetizations. Paleointensities from rocks and meteorites.

8564. PROPERTIES OF THE EARTH'S MANTLE: RELATIONSHIP TO CRUSTAL MOTION. (3 cr; prereq 5505 or 5506 or 5507 or #) Banerjee, Shaw
Surface heat flow; temperature vs. depth; chemical composition, mineralogy, crystallography, and rheology of the mantle. Equation of state; thermal convection, crustal expression; geotectonics.

8571. GEODYNAMICS I. (3 cr; prereq Math 3221 or #) Yuen
Theory of mantle convection, thermal history of Earth, viscoelastic processes in Earth, postglacial rebound, and mantle rheology.

Geophysics

See Geology and Geophysics.

Geotechnology

See Geo-Engineering.

German (Ger)

Professor: Gerhard H. Weiss, *chair;* Ruth-Ellen B. Joeres, *director of graduate studies;* Evelyn S. Firchow; Frank D. Hirschbach; Anatoly Liberman; Jochen Schulte-Sasse; Wolfgang F. Taraba

Associate Professor: Leonard L. Duroche; Ray M. Wakefield

Assistant Professor: G. Lee Fullerton; Richard W. McCormick; Gary C. 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) 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 a supplemental reading list 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 an intellectual biography describing the applicant's intellectual development and plans for the future. For the master's program, the General (Aptitude) Test of the Graduate Record Examination is required. 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. All financial aid application materials are due February 1; all teaching assistant application materials are due March 1.

Master's Degree Requirements[1]—Students must complete Ger 8111 or 8701; 8112 or 8100; one course in 18th-century literature; one course in 19th-century literature; 2 courses in philology; and 2 or more elective German courses. Consult the current *Graduate Study in German* brochure for more details. All candidates must demonstrate proficiency in German either by passing a special examination or by completing Ger 5011 with a B or better. Plan B students must submit three research papers of high quality, one of which must be written in German. The final examination is both written and oral, involving not only the areas included in coursework but also the works specified in the department reading list.

Doctoral Degree Requirements—A minimum of ten courses beyond the M.A. level is required, including two philology courses, two theory of literature courses and six literature courses. In addition, five or six courses (totaling at least 18 credits) outside the department are required for a minor or supporting program. Students must design their program of study by the end of their second quarter in residence; the program must be planned in consultation with the adviser and approved by the department Graduate Committee. For the written preliminary examination, students select three areas of emphasis and, together with the adviser, compile a reading list for each area. The oral preliminary examination will include 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, reasonable competence in at least one language other than German and English is required; the choice of the language must be approved by the adviser. Language competence may be demonstrated by scoring in at least the 65th percentile of the Graduate School Foreign Language Test, or by evidence of completion of advanced work in the language. (*Note*—This requirement is being revised. Contact the German Department for updated information.) For the Ph.D. degree, competence in two languages other than German and English must be demonstrated.

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.

For Further Information—Contact the director of graduate studies, Department of German, 219 Folwell Hall, University of Minnesota, 9 Pleasant Street S.E., Minneapolis, MN 55455.

Note—Since not all courses listed below will be offered every year, see current *Graduate Study in German* brochure for course selection in a given year.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

[1]*These requirements are being revised. Contact the German Department for updated information.*

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

German Language, Literature, and Culture Studies

5008. GERMAN PROFICIENCY TEACHING IN ACTION. (6 cr [not for CLA degree cr], §5103; prereq 8 Ger cr at 3-level or #)
Intensive work with testing and curricular implications of *ACTFL Proficiency Guidelines* combined with intensive proficiency-oriented language instruction in German to improve language skills and to demonstrate and critique various techniques.

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.

5020. GERMAN STYLISTICS. (4 cr per qtr [8 cr max]; prereq 5011 or #)
Practice in advanced composition and conversation; discussion and analysis of style levels, theory of stylistics, rhetoric.

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.

5371. THE RADIO PLAY AS LITERARY FORM. (4 cr; prereq 3104, 3105, 3 additional German literature courses or equiv)
Representative radio plays by such authors as Dürrenmatt, Frisch, Eich, Jens, Böll, and Grass; unique features dictated by the medium.

5510. TOPICS IN CONTEMPORARY GERMAN CULTURE. (4 cr [may be repeated for max 8 cr]; prereq 3513 or equiv)

5601, 5602, 5603. DRAMA IN TRANSLATION. (4 cr per qtr; prereq 8 cr theatre arts or literature above 3001; knowledge of German language not required; cannot be used for German major or minor)

5611. GERMANIC HEROIC POETRY IN TRANSLATION. (4 cr)
Overview of all Germanic heroic poetry (Old English, Old Norse, and Old High German). Definition of genre, function of heroic poetry in Teutonic society, historicity of Old Germanic epics, and heroic poems as works of art.

5621. GERMAN CINEMA FROM CALIGARI TO HITLER. (4 cr; prereq 3xxx-level 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 gold 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-level 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-level 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 (Schlomdorff, 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-level 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).

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 [12 cr max], §8740)
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.

5801. GERMAN SCRIPT SINCE 1500. (4 cr; prereq reading knowledge of German)
Handwriting and printed book scripts from 1500 to nineteenth century.

5970. DIRECTED STUDIES. (1-5 cr; prereq #, △, CLA approval)

8100. PROSEMINAR IN GERMAN LITERATURE. (4 cr; prereq 1st- or 2nd-yr grad student)
Experience in using techniques of research, presentation of oral reports, and writing of seminar papers.

8111, 8112, 8113. FUNDAMENTALS OF THE STUDY OF GERMAN LITERATURE. (4 cr per qtr)
8111: Bibliography. 8112: Introduction to the study of *Germanistik*. 8113: Studies in literary theory and criticism.

8201. INTRODUCTION TO MIDDLE HIGH GERMAN LANGUAGE AND LITERATURE. (4 cr)

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 [12 cr max])

8212. GERMAN LITERATURE OF THE 17TH CENTURY. (4 cr)

8217, 8218, 8219. LITERATURE OF THE 19TH CENTURY. (4 cr per qtr)
Literature, literary movements and influences represented in drama, lyric, and shorter prose forms.

8220. TOPICS IN 18TH-CENTURY GERMAN LITERATURE. (4 cr per qtr [12 cr max])

8221, 8222, 8223. ROMANTICISM. (4 cr per qtr)

8235, 8236. EIGHTEENTH CENTURY: FROM AUFKLÄRUNG THROUGH STURM UND DRANG. (4 cr per qtr)

8241, 8242. EXPRESSIONISM IN GERMAN LITERATURE. (4 cr per qtr)

8250. GERMAN LITERATURE 1933-45. (4 cr per qtr [8 cr max])
National Socialist literature and *Kulturpolitik*; works by non-Nazis and "inner emigrants"; German literature by exiled writers.

8261, 8262. GERMAN LITERATURE SINCE WORLD WAR II. (4 cr per qtr)

8301, 8302, 8303. THE 19TH-CENTURY NOVEL. (4 cr per qtr)

8307, 8308, 8309. THE GERMAN NOVELLE: FROM GOETHE TO KAFKA. (4 cr per qtr)

8311, 8312, 8313. THE 20TH-CENTURY NOVEL. (4 cr per qtr)

8321, 8322, 8323. THE 19TH-CENTURY DRAMA. (4 cr per qtr)

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 [12 cr max])
An issue or movement in 19th-century German literature, using a variety of critical approaches.

8331, 8332. THE 18TH-CENTURY NOVEL. (4 cr per qtr)
Selected readings, theoretical writings on the novel; several contemporaneous non-German novels by English writers.

8333, 8334, 8335. LYRIC POETRY. (4 cr per qtr)
8333: Klopstock through Goethe. 8334: Novalis through Nietzsche. 8335: Liliencron to present.

8340. TOPICS IN 20TH-CENTURY GERMAN LITERATURE. (4 cr per qtr [12 cr max])

8341, 8342. LITERATURE OF THE GERMAN DEMOCRATIC REPUBLIC. (4 cr per qtr)
GDR cultural policy, novels, short stories, drama, and poetry since 1949.

8345. AUSTRIAN LITERATURE: 20TH CENTURY. (4 cr)
Austrian literature as a discernible separate entity within German literature: historical and cultural background, philosophic traditions, thematic and formal profile.

8351. ROMANTHEORIE. (4 cr)
Analysis of 20th-century criticism of the genre *Roman*.

8403, 8404. LESSING. (4 cr per qtr)

8405, 8406, 8407. GOETHE. (4 cr per qtr)

8411, 8412, 8413. SCHILLER. (4 cr per qtr)

8421, 8422. HEINRICH VON KLEIST. (4 cr)

8431. HEINE. (4 cr)

8451, 8452, 8453. FRIEDRICH NIETZSCHE. (4 cr per qtr)

8454. HÖLDERLIN. (4 cr)

8521. PSYCHOANALYSE, GESELLSCHAFT, ERZÄHLUNG FREUD. (4 cr)

8810. THE GERMAN WOMAN AS WRITER. (4 cr per qtr [8 cr max])
German women writers from 18th to 20th century, using methods of feminist critical analysis.

8820. ADVANCED THEORETICAL SEMINAR. (4 cr per qtr [12 cr max]; 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 [12 cr max], §5740; prereq #)

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 #)

Germanic Philology

Professor: J. Lawrence Mitchell (English), *director of graduate studies;* Evelyn S. Firchow (German); Calvin B. Kendall (English); Anatoly Liberman (German); Robert Sonkowsky (Classics)

Associate Professor: Kaaren Grimstad (Scandinavian)

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 medieval 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. Since Germanic philology is not listed in the GRE department codes, applicants should use the department code for English when taking the test. GRE results should be forwarded to the Department of English.

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, will be 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 from the following: Swedish, Norwegian, Danish, Faroese, Modern Icelandic, Dutch, French, Italian, Spanish, Classical or Modern Arabic, Classical Greek, Classical Latin, Sanskrit, Hebrew, Russian, Czech, and Polish.

Minor Requirements for Students Majoring in Other Fields—For a master's degree minor, one medieval language sequence and two additional philological courses are required. All courses must be selected with the help of a philology adviser from the committee. For a doctoral degree minor, emphases in medieval literature, medieval language, modern language, and a combination of these are available. Students take a two-hour final written examination; a final oral examination for the minor is conducted in conjunction with the preliminary oral examination in the major field.

For Further Information—Contact the director of graduate studies, Germanic Philology, 207 Lind Hall, University of Minnesota, 207 Church Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Gerontology

Professor: Frank M. Lassman (otolaryngology, communication disorders), *director of graduate studies;* David O. Born (health ecology, dentistry); Nancy N. Eustis (public affairs); Robert L. Kane (public health); Rosalie A. Kane (health services research and policy, public health, social work); Donald G. McTavish (sociology); Jeylan T. Mortimer (sociology); John R. Sheppard (genetics and cell biology, medicine); June L. Tapp (child development); James W. Vaupel (public affairs); Shirley L. Zimmerman (family social science)

Associate Professor: Dennis A. Ahlburg (industrial relations); Harlan G. Copeland (curriculum and instruction, education); Lois J. Heller (physiology[1]); March L. Krotee (physical education and recreation); Matthew K. McGue (psychology); Jean K. Quam (social work); Muriel B. Ryden (nursing); Caroline R. Weiss (physical education and recreation); Robert E. Yahnke (General College)

Assistant Professor: Patrick W. Irvine (medicine); Sharon K. Ostwald (health services administration, public health)

Adjunct Assistant Professor: Barton W. Galle, Jr. (social, administrative, and hospital pharmacy)

Senior Fellow: Sharon K. Patten (public affairs)

Course of Study—Minor in gerontology, applicable to either master's or 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 approximately 40 courses offered by many disciplines.

Prerequisites for Admission—Admission to the minor program is contingent upon prior admission to the Graduate School and to a master's or doctoral program in a degree-granting department. 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 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—Contact the director of graduate studies, Graduate Mi-

[1]*University of Minnesota, Duluth*

nor Program in Gerontology, All-University Council on Aging, 330 Humphrey Center, University of Minnesota, 301-19th Avenue South, Minneapolis, MN 55455.

CPsy 5305; Educ 5440; PA 5414; PubH 5520; 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.

[1]**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.

[1]**HUMANITIES AND AGING.** (2 cr)
Aging through perspectives of literature, music, art, philosophy, and history. Historical experience of today's elderly cohorts; paternalism; generational conflict; cross-cultural ceremonies of aging; and changing attitudes toward the elderly in America.

Students may review additional courses in aging by requesting a copy of "Courses on Aging at the Univerity of Minnesota" from the All-University Council on Aging.

Greek

See Classical and Near Eastern Studies.

Health Informatics (HInf)

Professor: Laël C. Gatewood, *director, health computer sciences;* Eugene Ackerman; Paul E. Johnson; Donald G. McQuarrie

Associate Professor: Stanley M. Finkelstein, *director of graduate studies;* Donald P. Connelly; Lynda B. Ellis; Ilene B. Harris; Stephen S. Rich; George L. Wilcox

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 is concluded with an oral examination. For the

[1]*Consult with the director of graduate studies concerning the departmental offering for this course.*

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-level 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.

For Further Information—Contact the director of graduate studies, Division of Health Computer Sciences, Box 511 UMHC, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5430. HEALTH INFORMATICS I: COMPUTER APPLICATIONS IN HEALTH CARE. (4 cr; prereq algebra or #)
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: COMPUTER DATA BASES FOR HEALTH ANALYSES. (4 cr; prereq 5430, PubH 5420, programming or #)
Characteristics, coding, indexing, storage, and retrieval of health-related data. Introduction to public health and biomedical data bases and access strategies.

5432. HEALTH INFORMATICS III: COMPUTER SYSTEMS FOR CLINICAL RESEARCH. (4 cr; prereq 5430, programming or #)
Development of data-base models and management systems for clinical research. Introduction to data-base management systems for specific types of clinical studies.

5433. COMPUTER METHODOLOGY IN THE DELIVERY OF HEALTH CARE I: PHYSIOLOGICAL MONITORING AND TESTING. (3 cr; prereq 5432 or #)
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 #)
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.

5435. COMPUTER METHODOLOGY IN THE DELIVERY OF HEALTH CARE III: SYSTEMS ANALYSIS AND OPERATIONS RESEARCH METHODS FOR HEALTH SERVICES. (3 cr; prereq 5432, PubH 5452, FORTRAN or #)
Introduction to systems analysis and operations research techniques as applied to health services systems. Models for queuing, inventory, networks, linear programming, and scheduling.

5436. SEMINAR: HEALTH INFORMATICS. (1-3 cr)
Presentation and discussion of research problems and current literature.

5446. BIOCOMPUTING CONSULTING SEMINAR. (3 cr; prereq HInf major, 5432, PubH 5454 or #)
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 data-base 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 #) Staff
Computer systems design for health sciences, small computer concepts and utilization, computers for clinical services, computer-aided medical decision making, biomedical image processing pattern recognition. All topics treat techniques and incorporate actual examples or case studies from the health sciences.

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, Policy, and Administration (PubH)[1]

Professor: John Kralewski, *director of graduate studies;* Mario F. Bognanno; Jon B. Christianson; Bright M. Dornblaser; Roger Feldman; Robert L. Kane; Rosalie A. Kane; Theodor J. Litman; Ira Moscovice; Vernon E. Weckwerth

Associate Professor: Thomas Choi; N. Tor Dahl; Bryan E. Dowd; G. Kenneth Gordon; George O. Johnson; Richard J. Oszustowicz; Michael D. Resnick

Assistant Professor: Michael D. Finch

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 faculty and research positions related to health services in leading academic institutions, government, and 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—Although no single program of undergraduate studies is recognized as the best preparation for the doctoral program, prior training in the social sciences, administration, research methods and statistics is recommended. Applicants are expected to have demonstrated proficiency in microeconomics and quantitative methods before admission to the doctoral program. Advanced training in such fields as health administration, business administration, medical sociology, economics, public administration, public health, nursing, health planning, or medicine is also desirable.

Special Application Requirements—An undergraduate and graduate grade average of B or better plus above average performance on the Graduate Record Examination (GRE) and Miller Analogies Test (minimum raw score of 60) are required for admission. Foreign students whose native language is not English must attain a TOEFL score of 550 or higher to be considered 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. When possible, a personal interview with members of the admissions committee is desirable.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Division of Health Services Research and Policy, School of Public Health, 15-205 Phillips-Wangensteen Bldg., Box 729 Mayo, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Note—Courses in health services research, policy, and administration are listed and described under Public Health in this bulletin. See PubH 5790, 5793, and 8750 to 8796.

[1]*A professional Master of Hospital Administration (M.H.A.) degree is available through the School of Public Health.*

Hispanic and Luso-Brazilian Literatures and Linguistics

Professor: Antonio Ramos, *chair;* Nicholas Spadaccini, *director of graduate studies;* Rene Jara; Ronald W. Sousa; Hernan Vidal; Anthony N. Zahareas

Associate Professor: Kathleen Houlihan; Ruth E. Jones; Lawrence C. Mantini; Roberto Reis; Constance A. Sullivan

Assistant Professor: Carol A. Klee

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.

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 Study 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 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, especially 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—Students are issued the department's *Graduate Handbook* on admission. For further information, contact the Department of Spanish and Portuguese, 34 Folwell Hall, University of Minnesota, 9 Pleasant Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Portuguese (Port)

5110. TOPICS IN PORTUGUESE LITERATURE. (4 cr per qtr [max 12 cr]; prereq 3211 or 3212 or 3213 or three 3xxx or 5xxx literature courses in Spanish with △)
Major issues of Portuguese literature; treats important authors, movements, currents, genres. Problems, socioaesthetic questions, literary techniques related to Portuguese subjects. Topics specified in *Class Schedule*, but usually include: medieval Portuguese literature (overview of authors, intellectual currents, movements, conventions, genres, and themes); Camoes and the Portuguese Renaissance (*Os Lusiadas* and the learned epic); Eca de Queiroz and the novel of the 19th century; Fernando Pessoa and modern poetry; the *Cancioneiros*; lyric poets of the Renaissance and baroque (Portuguese versions of Halianate modes, *conceptismo* and *culteranismo*).

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 △)
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 △)
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 △)
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."

5523. LITERATURE EXPRESSION IN PORTUGUESE AMERICA (1500-1807). (4 cr; prereq three 3xxx Portuguese courses or △)
Literary movements and figures from discovery to independence and imperial status. Literature as a dimension of sociocultural movement in which Brazil changed from supplier of raw materials to implicit hegemonic status as the strongest economic entity in the Lusophone world.

5524. LITERATURE IN THE RISE OF THE BRAZILIAN BOURGEOISIE (1807). (4 cr; prereq three 3xxx Portuguese courses or △)
Literary movements and figures from Brazil's independence through monarchical and republican eras to current state. Literature as a dimension of sociocultural movement in an era of changing strategies for making and/or stabilizing an independent economic and cultural entity.

5525. LUSOPHONE AFRICA: STATE AND ACCULTURATED LITERATURE. (4 cr; prereq three 3xxx Portuguese courses or △)
Literary movements and figures in Lusophone Africa from early documents through independence. Literature as a dimension of sociocultural movement from colonial status, to "autonomy," to the forging of national entities. Combative literature and literature in a revolutionary society.

5721. INTRODUCTION TO ROMANCE PHILOLOGY. (4 cr, §Span 5721; prereq 3721 or Span 3721 or #)
Comparative view of the origins and development of Romance languages. Effects of language change on Romance languages examined individually and as a group. Selected medieval texts surveyed in terms of time, place, and cultural setting.

5910. TOPICS IN LUSO-BRAZILIAN LITERATURE. (4 cr; prereq Span 3104 or SpPt 3104 or △)
Portuguese, Brazilian, or other Lusophone literatures treated in important groups, movements, trends, methods, genres. Topics specified in *Class Schedule*.

5940. FIGURES IN LUSO-BRAZILIAN LITERATURE. (4 cr; prereq Span 3104 or SpPt 3104 or △)
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 △, 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 #, △, 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*.

8930. RESEARCH: SOCIAL APPROACHES TO PORTUGUESE LITERATURE. (4 cr)
Functioning of literature in Portuguese society according to one or more theories of social formation. Cultural or socioliterary issues, specific movements, authors, or works.

8940. RESEARCH: SOCIAL APPROACHES TO BRAZILIAN LITERATURE. (4 cr)
Functioning of literature in Brazilian society according to one or more theories of social formation. Cultural or socioliterary issues, specific movements, authors, or works.

8950. RESEARCH: SOCIAL APPROACHES TO LUSOPHONE AFRICAN LITERATURE. (4 cr)
Function of literature in Lusophone African societies according to one or more theories of social formation. Cultural or socio-literary issues, or analysis of specific movements, authors, or works.

8960. RESEARCH: COMPARATIVE LUSOPHONE LITERARY TEXTS. (4 cr)
Application of a sociocultural analytical framework to aspects of literary culture similar in nature or manifestation throughout the Lusophone world.

8970. DIRECTED READINGS IN ROMANCE LANGUAGES. (Cr ar) Staff
Rigorously supervised readings in aspects of Luso-Brazilian language, literature, and cultural history. Readings dependent on student needs and generally do not duplicate material of regular courses.

Spanish (Span)

Linguistics, Philology, History of the Language, and Research Methods

5011. SPANISH STYLISTICS. (4 cr; prereq 10 cr from 3001-3005 series or #)
Linguistic analysis of different types of writing styles used in standard and dialectical Spanish: descriptions, biographies, letters, articles for publication, dialogues, others.

5012. ADVANCED PROBLEMS IN THE SPANISH LANGUAGE. (4 cr; prereq 10 cr from 3001-3005 series or #)
Problematic aspects of Spanish pronunciation, grammar, and idiomatic expressions for advanced speakers of Spanish as a second language. Polish acquired through supervised contact with beginning and intermediate students. Also for students whose primary language is Spanish.

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 10 cr 3001-3005 or #)
Comparative study of origins and development of the Ibero-Romance languages; evolution of Spanish and Portuguese compared to and contrasted with evolution of Catalan.

5711, 5712, 5713. THE STRUCTURE OF MODERN SPANISH: PHONOLOGY, MORPHOLOGY, SYNTAX. (4 cr per qtr; prereq 10 cr from 3001-3005 series or #)
Scientific approach to structure of present-day Spanish with attention to syntax, phonology, word formation, and dialectal differences. Pertinent for those who plan to teach Spanish language. 5711: (Phonology) Theoretical and practical aspects of sound system of Spanish. Segmentals (vowels and consonants) and suprasegmentals (intonation, stress, and juncture). Dialectal differences. 5712: (Morphology) Spanish affixes used to change meaning of words. Both slight and radical changes in Spanish (modificative vs. transformative). New affixes and modern meanings; division between inflectional and derivational morphology. 5713: (Syntax) Compares and contrasts different types of grammars in terms of basic Spanish structure. Dialectal differences in Spanish syntax. Problems that English speakers have in 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.

5721. INTRODUCTION TO ROMANCE PHILOLOGY. (4 cr, §Port 5721; prereq 3721 or Port 3721 or #)
Comparative view of the origins and development of Romance languages. Effects of language change on the Romance languages examined individually and as a group; selected medieval texts surveyed in terms of time, place, and cultural setting.

5729. SPANISH DIALECTOLOGY: INTRODUCTION. (4 cr; prereq 5711, 5712, 5713)
Introduction to history, principles, and theories of dialectology as they relate to descriptive study of Spanish. Linguistic geography and delineation of national and social dialects.

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 U.S.: 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.

8101. LITERARY CRITICISM AND RESEARCH METHODS. (4 cr)
Aspects of literary criticism through various types of scholarship, ranging from formalist approaches to Marxism, and from linguistic theories to contemporary structuralist studies. Representative literary genres of Spain, Portugal, Latin America, and Brazil analyzed according to diverse approaches; field of literary science represented by known American and European Hispanists as well as by international scholars, theorists of criticism, and literary historians. Aims, methods, results of bibliography in Spanish and Portuguese.

8934. RESEARCH METHODS IN DESCRIPTIVE LINGUISTICS. (4 cr per qtr; prereq 5711, 5713, 5729 or #)
Recent studies of regional and social dialects in Spain and Spanish America, including discussion of their possible adaptation to the descriptive study of Spanish dialects utilized in the United States.

8936, 8937. DIRECTED FIELDWORK IN THE DESCRIPTIVE STUDY OF SPANISH. (4 cr per qtr; prereq 5729, 8934 and 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

5105. THE LITERATURE AND CULTURE OF MUSLIM SPAIN. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese)
Major literary works of the Arabic culture in the Iberian peninsula—epic, lyric, philosophical prose—in terms of historical interaction among Arabic, Christian, and Jewish literary traditions in the Middle Ages.

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 △)
Historical function of literary techniques, narrative perspectives, and ironic discourse of Cervantes' major work during the period of imperial decadence. Tradition of Erasmian 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 △)
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.

5272. THE GENERATION OF 1898. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or △)
Various genres by major figures between 1895 and 1903: Ganivet, Unamuno, Baroja, Azorín, Valle-Inclán, Machado, J. R. Jiménez, Maeztu, others. Crisis of restoration Spain (Costa); intellectual, artistic renovations. Break with 19th-century realism and with philosophical rationalism among both *modernistas* and *noventayochistas*.

5316. THE PICARESQUE NOVEL. (4 cr; prereq three 3xxx or 5xxx literature courses in Spanish or Portuguese or △)
Major picaresque narratives—*Lazarillo, Guzmán, Buscón*, Cervantes' *picaros, 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.

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. THE MIDDLE AGES: STUDIES IN NARRATIVE POETRY *(JUGLARIA AND CLERECIA).* (4 cr; prereq 1 yr Latin or #; required of all PhD candidates)
Concentration of *Cantar de Mio Cid* and the heroic tradition; *Libro de buen amor* and literary autobiography; *La Celestina* and the end of the Middle Ages. Each masterpiece studied in its genre and time. Appraisal of research, criticism, views of major scholars and historians.

8212. SPANISH LITERATURE OF THE 16TH CENTURY: DRAMA UP TO LOPE DE VEGA. (4 cr)
Important innovators—Encina, Gil Vicente, Torres Naharro, Sánchez de Badajoz, Lope de Rueda, Cristobal de Virués, Juan de la Cueva, Cervantes—their sources, themes, and contribution to development of dramatic theory and theatrical forms. Studied aganist background of social and cultural history.

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)
Beginnings and development of *costumbrista* and romantic movements through analysis of representative works such as *articulos* of Larra, poetry of Espronceda, romances and plays of Duque de Rivas and Zorrilla, *rimas* and *leyendas* of Becquer, the prose of Fernán Caballero.

8271. SPANISH THEATRE IN THE 20TH CENTURY. (4 cr)
Modes of Spanish theatrical expression since Galdós; technical innovations of Benavente; grotesqueries of Valle-Inclán; metaphoric experiments of Lorca and Alberti; existential preoccupations of Unamuno, Buero, and Sastre; grotesque tragedies of Arniches; other minor genres.

8300. RESEARCH IN HISTORIOGRAPHY OF SPANISH LITERATURE. (4 cr)
Main historiographical approaches to literary production in Spain from the Romantic period to the present.

8312. THE *LIBRO DE BUEN AMOR* AND *LA CELESTINA*. (4 cr)
Comparative study of two Spanish masterpieces in terms of their sources, historical background, and artistic viewpoint. Traditions of Ovid, elegiacal literature, medieval Latin comedy (*Pánfilo*). Social world of *Libro, Celestina*. Problems of authorship. Oriental, Semitic, and Christian influences. Art and morality.

8354. SPANISH THOUGHT, LETTERS, MOVEMENTS OF THE 19TH CENTURY. (4 cr)
Traditionalism and liberalism in modern Spain. Thought of Donoso and Balmes. Krausists's influence on philosophy, religion, science, literature, and education. Revolution of 1868 as focal point of ideological conflict in 19th-century intellectual life. Menendez y Pelayo's scholarship.

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 Azofin, Unamuno, Baroja, Valle-Inclán, Pérez de Ayala, Miró, Jarnés.

8372. SPANISH 20TH-CENTURY ESSAY. (4 cr)
Introduction to modern Spanish thought through the works of Unamuno, Ortega y Gasset, and others. Rationalism and irrationalism. Ortega's philosophy of history and society. Political ideas in the crisis of contemporary Spain from Maeztu to Azana.

8392. CONTEMPORARY SPANISH POETRY (1936 TO PRESENT). (4 cr)
Major postwar Spanish poets including Dámaso Alonso, José Luis Hidalgo, Blas de Otero, Gil de Biedma, Claudio Rodríguez, others. Continuity of pre- and post-war poetry. Problems of poetic expression under the Franco regime; social and hermetic poetry; prison poems of Miguel Hernández.

8400. SPANISH LITERATURE AND THE INTERACTION OF NATIONAL CULTURE. (4 cr)
Cross-cultural aspects of Spanish literature from the early Middle Ages to the present.

8502. HISPANO-ARABIC LITERATURE AND CULTURE. (4 cr)
Literary styles and genres in classical and modern writings; compositions based on texts studied.

8503. HISPANO-ARABIC LITERATURE AND CULTURE. (4 cr)
Literary styles and genres in classical and modern writings; compositions based on texts studied.

8504. THE MORISCOS THROUGH THEIR LITERATURE. (4 cr; prereq 5501 and some knowledge of Arabic recommended)
Survey of Aljamiado literature—a literature written in Romance but using Arabic script; its format and content, local environment, and relation to Arabic models.

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 △)
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 △)
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 Spanish or Portuguese or △)
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 △)
Spanish-American literature between the eve and aftermath of the two great wars. Impact of modernization, industrialization, 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 △)
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 △)
Introduction to literary texts in Spanish produced by U.S. Hispanic population. Focus on expanding corpus of Mexican-American and Puerto Rican literature, relation to large Hispanic world.

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

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 SpPt 3104 or △)
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-Guard. Topics specified in *Class Schedule.*

5920. TOPICS IN SPANISH-AMERICAN LITERATURE. (4 cr; prereq Span 3104 or SpPt 3104 or △)
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 △)
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 SpPt 3104 or △)
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 #, △, 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.

5990. DIRECTED RESEARCH. (1-5 cr ar; prereq #, △, 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 U.S.

8930.* SPANISH DIALECTOLOGY. (4 cr)

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 △)
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)

5021. MEDIEVAL SPANISH, PORTUGUESE, AND CATALAN TEXTUAL READINGS. (4 cr; prereq Span 3721 or Port 3721 and three 3xxx or 5xxx literature courses in Spanish or Portuguese or △)
Distinctive linguistic, literary, and cultural features of medieval Iberian languages; reading of Spanish, Catalan, and Galaico-Portuguese texts in the original.

5950. SELECTED TOPICS ON HISPANIC-LUSO-BRAZILIAN LITERARY INTERRELATIONSHIP. (4 cr; prereq reading knowledge of Spanish and Portuguese)
Common conceptions, background, and influences among peninsular Spanish, Spanish-American, Portuguese, and Brazilian literatures in the essay, drama, poetry, and fiction.

5960. SELECTED COMPARATIVE PROBLEMS IN THE WORKS OF HISPANIC AND LUSO-BRAZILIAN AUTHORS. (4 cr; prereq reading knowledge of Spanish and Portuguese)
Common conceptions, background, and influences among major peninsular Spanish, Spanish-American, Portuguese, and Brazilian authors.

5999. THE TEACHING OF COLLEGE-LEVEL SPANISH AND PORTUGUESE: THEORY AND PRACTICE. (4 cr)
For new teaching assistants in Department of Spanish and Portuguese.

8005. IBERO-ROMANCE BIBLIOGRAPHICAL RESEARCH. (4 cr)
Problems in bibliography, documentation, and information sources for Spanish, Spanish-American, and Luso-Brazilian literature.

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: James D. Tracy, *chair*; Carla R. Phillips, *director of graduate studies;* Josef L. Altholz; Bernard S. Bachrach; Paul W. Bamford; Hyman Berman; Kinley J. Brauer; Clarke A. Chambers; Caesar E. Farah; Edward L. Farmer; Barbara A. Hanawalt; John R. Howe; Allen F. Isaacman; Thomas Kelly; David Kopf; Stanford E. Lehmberg; Byron K. Marshall; Russell R. Menard; John K. Munholland; Paul L. Murphy; David W. Noble; Thomas S. Noonan; Kathryn L. Reyerson; Richard L. Rudolph; Joel B. Samaha; Stuart B. Schwartz; Theofanis G. Stavrou; Romeyn Taylor; John A. Thayer; Rudolph J. Vecoli; William E. Wright

Associate Professor: Jeffrey P. Brooks; John K. Evans; Sara M. Evans; John M. Eyler; George D. Green; Andrea Hinding; David O. Kieft; Mary Jo Maynes; Robert E. McCaa; Michael F. Metcalf; Brenda G. Plummer; Steven Ruggles; Allan H. Spear; Dennis Valdes

Assistant Professor: Victoria Coifman; Susan N. G. Geiger; Melissa L. Meyer; Gianna Pomata; Ann B. Waltner; Luise S. White

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 African and Afro-American Peoples, Ancient, Chicano, East Asian, English, Latin American, Medieval European, Early Modern World, Modern European, Russian, South Asian, and United States history. Subfields with particular strength include constitutional, economic, immigration, social, demographic, and women's history. Special facilities are the Center for Austrian Studies, the Immigration History Research Center, Modern Greek Studies, 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 under-

graduate 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 January 15. Forms and instructions should be requested from the department.

Master's Degree Requirements—Plan A requires nine courses in history, including thesis credits for the equivalent of four of these, and two courses in other fields. Plan B requires 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.

Minor Requirements for Students Majoring in Other Fields—For the master's degree, Plan A (a Plan B minor is not available), 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—Contact the director of graduate studies, Department of History, 633 Social Sciences Building, University of Minnesota, 267 19th Avenue South, Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Methodology

5011, 5012. QUANTITATIVE METHODS IN HISTORICAL RESEARCH. (4 cr per qtr; prereq # for 5011, one postsurvey course in any social science for 5012) 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.

5797. METHODS OF POPULATION HISTORY. (4 cr; prereq #; offered alt yrs) McCaa, Phillips, 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.

5921. HISTORY AND THEORY FROM A MARXIST PERSPECTIVE. (4 cr per qtr; offered alt yrs) Isaacman
Comprehensive, rigorous, and critical introduction to Marxist social sciences with particular emphasis on issues of importance to historians. Two-quarter seminar.

5960. RESEARCH IN QUANTITATIVE HISTORY. (4 cr; prereq 5011 or 5012 or 5797 and #; offered when feasible) Ruggles
Proseminar to expand projects done in 5011, 5012, or 5797, or other history courses.

5970. DIRECTED STUDY. (1-15 cr; prereq #, △, CLA approval) Staff
Qualified senior and graduate students may register for work on a tutorial basis.

5990. DIRECTED RESEARCH. (1-15 cr; prereq #, △, 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)
Introduction to goals, interpretive frameworks, methods, and assumptions of certain recent tendencies in social history through intensive examination of selected texts.

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.

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

5432. PROBLEMS IN CONTEMPORARY AFRICA. (4 cr) Issacman, White
Problems of political, social, and economic development in Africa since World War II. Post independence politics and problems of southern Africa.

5436. SOCIAL HISTORY OF AFRICAN WOMEN: 1850 TO PRESENT. (4 cr; prereq # for undergrads) Staff
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.

5444, 5445. PROBLEMS IN CENTRAL AND SOUTHERN AFRICAN HISTORY. (4 cr per qtr) Isaacman, White
Nature and process of change in precolonial, colonial, and independent central and southern Africa.

5447. PROBLEMS IN EAST AFRICA. (4 cr) Isaacman, White
Advanced course in African history focusing on specific themes and methodological problems.

5864, 5865. AFRO-AMERICAN HISTORY. (4 cr per qtr; offered alt yrs) Menard, Plummer

5930. TOPICS IN COMPARATIVE THIRD WORLD HISTORY. (4 cr; prereq #) Isaacman, Kopf, Schwartz
Recurring themes in third world history. Topics vary from quarter to quarter.

5931. HISTORY OF AFRICA: SOCIAL GROUPINGS, CONFLICTS. (4 cr; prereq #; offered alt yrs) Isaacman, White
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, White
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, White
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, White

8944, 8945, 8946. AFRICAN HISTORY. (3 cr per qtr; prereq #; offered when feasible) Isaacman, White
Specific themes and methodological problems. Research based on primary historical data as well as anthropological, linguistic, and archaeological sources.

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.

5561-5562-5563†. 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

8051f-8052w-8053s†. ANCIENT HISTORY. (3 cr per qtr; prereq #; offered when feasible) Kelly, J Evans

East Asia

5461. ANCIENT CHINA. (4 cr) Taylor
Origins of Chinese civilization, classical philosophies, and Han empire (to 220 A.D.).

5462. BUDDHIST CHINA. (4 cr; offered alt yrs) Taylor
Disintegration of Han empire; aristocratic society; barbarian invasions; spread of Buddhism and reintegration of empire in T'ang period (220-906 A.D.).

5463. RENAISSANCE CHINA. (4 cr; offered alt yrs) Taylor, Waltner
Disappearance of medieval aristocracy; commercial and maritime expansion; neo-Confucian renaissance; growth of Chinese science and technology; Mongol conquest and Yuan dynasty.

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 cr, §3467; prereq 3467) 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.

5471. TWENTIETH-CENTURY JAPAN. (5 cr, §3471) Marshall
Development of industrial society, parliamentary government, mass culture, and imperialism from Meiji reforms of late 19th century through World War II to contemporary period.

5472. EARLY MODERN JAPAN. (5 cr, §3472) Marshall
Tradition and change in society and culture under Tokugawa shoguns, 1600-1867; growth of cities and decline of the samurai class; response to Western intrusion.

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.

5474. JAPAN AND THE SECOND WORLD WAR. (4 cr; offered when feasible) Marshall
From origins of war in China through Pearl Harbor decision, conquest of Southeast Asia, defeat in Pacific, impact of atomic bomb, American occupation, and creation of U.S.-Japanese alliance.

5510. TOPICS IN EAST ASIAN HISTORY. (4 cr per qtr [may be repeated for cr]; prereq #; offered when feasible) Farmer, Marshall, Taylor
Readings in Western languages on history of China, Japan, and associate areas (e.g., Vietnam and Korea) for graduate students, including those from other departments or other areas within history preparing secondary fields in East Asian history.

5511w. SOCIAL AND INTELLECTUAL CHANGE IN LATE CHOU AND HAN CHINA. (4 cr; prereq #; offered odd yrs) Taylor
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.

5512s. RELIGION AND SOCIETY IN LATE IMPERIAL CHINA. (4 cr; prereq #; offered even yrs)
Chinese traditional society approached through institutions of official and popular religion, Buddhism and Daoism.

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.

8464f, 8465w, 8466s. RESEARCH IN LATE IMPERIAL CHINA: YUAN, MING, AND QING. (3 cr per qtr; prereq reading knowledge of Chinese, #; offered when feasible) Farmer, Taylor, Waltner
8464: Reseach methods. 8465: Reading and use of documents. 8466: Research seminar.

8471, 8472, 8473. HISTORY OF JAPAN. (3 cr per qtr; prereq 2 qtrs proseminar in Japanese history or #, reading knowledge of Japanese; offered alt yrs) Marshall
8471: Research materials. 8472: Research methods. 8473: Research seminar.

South Asia

5456. SEXUALITY AND ORIENTAL RELIGIONS. (4 cr; offered when feasible) Kopf
Exploration of pronounced sexual component in Eastern religions such as Hinduism, Buddhism, Islam, Shintoism, and Taoism, from perspective both of Western Orientalists and Asians.

5491. HISTORY OF BANGLADESH. (4 cr, §Indc 5491; prereq some coursework in history of South Asia; offered when feasible) Kopf
Classical accounts of the linguistic and cultural unit, Bengal from the 4th century B.C. to the creation of the modern state of Bangladesh in 1972.

5501, 5502, 5503. HISTORY OF INDIA. (4 cr per qtr; prereq #; offered when feasible) Kopf

5547. HISTORIOGRAPHY OF MODERN SOUTH ASIA. (4 cr; prereq #; offered when feasible) Kopf
Historical literature of modern South Asia; definition of major problems facing students in the field.

8451f-8452w†. HISTORY OF INDIA. (3 cr per qtr; prereq #; offered when feasible) Kopf

Near East

5131. BYZANTINE HISTORY. (4 cr; offered when feasible) Bachrach, Noonan, Stavrou
History of Byzantium from reign of Emperor Justinian in the mid-sixth century to fall of Constantinople in 1453.

5274, 5275. MODERN NEAR EAST: OTTOMAN EMPIRE AND SUCCESSOR STATES. (4 cr per qtr) Stavrou
5274: Eighteenth-century background and Ottoman institutions; rise of Balkan nationalism; the Eastern question up to Congress of Berlin. 5275: From Congress of Berlin to present; European imperialism and rise of Arab nationalism.

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.

5774-5775†. READINGS IN THE MODERN NEAR EAST. (4 cr per qtr; prereq 5274, 5275 or equiv, #) Stavrou
Significant disruptive forces in the Ottoman Empire during the last two centuries of its existence. The role of and relations between Islamic and non-Islamic groups of the empire.

Medieval Europe

5100. SELECTED TOPICS IN MEDIEVAL EUROPE. (4 cr per qtr; prereq #; offered when feasible) Bachrach, Hanawalt, Reyerson
From fall of Roman Empire through end of Middle Ages.

5115, 5116. MEDIEVAL LATIN HISTORIANS. (4 cr per qtr; 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.

5131. BYZANTINE HISTORY. (4 cr; offered when feasible) Bachrach, Noonan, Stavrou
History of Byzantium from reign of Emperor Justinian in the mid-sixth century to fall of Constantinople in 1453.

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.

5610s. MEDIEVAL EUROPEAN HISTORY AND ITS HISTORIANS. (4 cr; prereq #; offered odd yrs) Reyerson
Major historiographical debates in medieval European history, including consideration of types of sources available for addressing historical problems and methodologies used.

5611, 5612, 5613. MEDIEVAL HISTORY. (4 cr per qtr; prereq 1 yr of medieval history or equiv, reading knowledge of French or German, #) Bachrach, Reyerson

5634, 5635. MEDIEVAL RUSSIAN HISTORY. (4 cr per qtr; prereq 5134, 5135, 5136, # and reading knowledge of Russian, French or German; offered when feasible) Noonan

5641-5642-5643. MEDIEVAL ENGLISH HISTORY. (4 cr per qtr; prereq 1 yr of medieval history or equiv, #, reading knowledge of French or German; offered when feasible) Bachrach, Hanawalt, Lehmberg

8111f-8112w-8113s†. MEDIEVAL HISTORY. (3 cr per qtr; prereq #; offered when feasible) Bachrach, Hanawalt, Reyerson

8141f-8142w-8143s†. MEDIEVAL FRENCH HISTORY. (3 cr per qtr; prereq #; offered when feasible) Bachrach, Reyerson

Early Modern Europe

5021, 5022. OCEANIC HISTORY: EAST AND WEST. (4 cr per qtr; offered when feasible) Bamford
5021: Medieval and early modern maritime science and technology, resources and motivation, and the process of expansion, to 1715. 5022: European empires overseas, industrialization, and the transportation revolution on the oceans, to 1945.

5132. RUSSIAN HISTORY FROM THE ORIGINS TO PETER THE GREAT. (4 cr, §3636; offered alt yrs) Noonan
Survey of Russian history: up to Peter the Great.

5135. FROM KHAN TO TSAR: RUSSIA, 1240-1530. (4 cr; offered alt yrs) Noonan
Mongol rule of Russia, rise of Lithuania, emegence 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 from quarter to quarter.

5211. FRANCE IN THE OLD REGIME. (4 cr; offered when feasible) Bamford
France to the Revolution of 1789.

5289. HISTORY OF EUROPEAN PENAL SYSTEMS. (4 cr; offered when feasible) Bamford
Comparative analysis of medieval, early modern, and 19th-century European systems.

5617. SPAIN, THE EARLY MODERN PERIOD, 1450-1750. (4 cr; prereq #; offered when feasible) Phillips
Topics may include government and bureaucracy, Habsburg and Bourbon dynasties, social and economic elites, peasants and rural life, overseas expansion and trade; structures of belief, social customs, the arts, foreign policy, intellectual life.

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
Focus on emergence of an absolute monarchy.

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.

5651f-5652w-5653s†. ENGLISH HISTORY: TUDOR AND STUART PERIODS. (4 cr per qtr; prereq #) Lehmberg
Critical study of principal writings about English history, covering periods 1485-1558 (5651). 1558-1625 (5652), 1625-1689 (5653).

5764. RUSSIAN PEASANT REVOLTS OF THE 17TH CENTURY. (4 cr; prereq #; offered when feasible) Noonan, Stavrou
Enserfment of Russian peasantry.

5765. RUSSIAN PEASANT REVOLTS OF THE 18TH CENTURY. (4 cr; prereq #; offered when feasible) Noonan, Stavrou
Zenith of serfdom in Russia.

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 #) Bamford

8121f-8122w-8123s. RENAISSANCE HISTORY. (3 cr per qtr; prereq #; offered alt yrs) Pomata, Tracy

8150. SEMINAR IN ENGLISH HISTORY. (3 cr [may be repeated for cr]; prereq #; offered when feasible) Altholz, Hanawalt, Lehmberg
Topics vary from quarter to quarter.

8231f-8232w-8233s†. 17TH-CENTURY FRANCE. (3 cr per qtr; prereq #; offered when feasible) Bamford

8630. SEMINAR IN EARLY MODERN HISTORY. (4 cr; prereq grad student in history, #; 5630 recommended) Staff

Modern Europe

5021, 5022. OCEANIC HISTORY: EAST AND WEST. (4 cr per qtr) Bamford
5021: Medieval and early modern maritime science and technology, resources and motivation, and the process of expansion, to 1715. 5022: European empires overseas, industrialization, and the transportation revolution on the oceans, to 1945.

5035. THE GERM THEORY AND THE MEDICAL PROFESSION. (4 cr, §HMed 5035) Eyler
Formulation of the germ theory of disease and its consequences for medical procedures (therapeutics, surgery, management of hospitals), for public health programs, and for the structure and prestige of the medical profession.

5133. RUSSIAN HISTORY FROM PETER THE GREAT TO THE PRESENT. (4 cr, §3637; offered alt yrs) Stavrou
Survey of Russian history since Peter the Great.

5142. LAW AND THE 18TH-CENTURY ENGLISH CONSTITUTION. (4 cr; prereq jr or sr or grad student) Samaha
Nature of English law and constitution, emphasizing their relation to formation of American constitutional and legal systems, especially criminal law. Use of actual cases and criminal law materials.

5143. LAW AND PUBLIC POLICY IN MODERN ENGLAND. (4 cr; prereq jr or sr or grad student) Samaha
Forces in British society that shaped Victorian and 20th-century law and the Constitution, emphasizing criminal law reform, growth of bureaucracy, birth of modern welfare state, and decline in individualism.

5171f, 5172w, 5173s. 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 from quarter to quarter.

5212. FRENCH REVOLUTION AND NAPOLEON. (4 cr; offered when feasible) Bamford
The reform movement and upheavals in France to 1799; emergence and rise to power of Bonaparte; Napoleonic regime.

5231. MODERN FRANCE FROM 1848 TO DE GAULLE. (4 cr) Munholland
Survey of French society and political life from revolution of 1848 to contemporary France.

5252. DEVELOPMENT OF THE SCANDINAVIAN WELFARE STATE. (4 cr, §Scan 5252; offered alt yrs) Metcalf
Political, social, and economic development in Scandinavia between 1870 and 1980. Why Scandinavian states have led in developing "welfare state" policies and programs.

5264. MODERN RUSSIA: 18TH-CENTURY BACKGROUND. (4 cr; offered alt yrs) Stavrou
Foundation of the Russian empire, modernization and expansion under Peter the Great and Catherine the Great. Russia's Europeanization.

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
Bismarck; Imperialism; Eastern Question.

5285. DIPLOMATIC HISTORY OF EUROPE, 1900-1945. (4 cr; offered when feasible) Kieft
The world wars.

5286. DIPLOMATIC HISTORY OF EUROPE, 1945 TO PRESENT. (4 cr; offered when feasible) Kieft
The Cold War.

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. 5294: Through 19th century. 5295: 20th century.

5671f-5672w-5673s†. MODERN ENGLAND: 1783 TO PRESENT. (4 cr per qtr; prereq #; offered alt yrs) Altholz

5702. MEDICINE AND SOCIETY IN THE ENLIGHTENMENT. (4 cr, §HMed 5102; prereq #; limited to 15 students) Eyler
Readings and research seminar dealing with interrelations of medicine and society from late 17th to early 19th centuries. Emphasis on methods and materials used by medical historians.

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.

5711f-5712w-5713s†. FRENCH REVOLUTION AND NAPOLEON. (4 cr per qtr; prereq #; offered when feasible) Bamford

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.

5741-5742†. GERMANY AND CENTRAL EUROPE IN 18TH CENTURY. (4 cr per qtr; prereq #; offered alt yrs) Maynes, Wright
Enlightenment, reason, reform, war.

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 Vörmarz, 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, German or French or #; offered alt yrs) Stavrou

5766. RUSSIAN PEASANT REVOLTS OF THE 19TH CENTURY. (4 cr; prereq #; offered when feasible) Noonan, Stavrou
Decline of serfdom and emancipation.

5767s. LITERATURE AND SOCIETY IN 19TH- AND 20TH-CENTURY RUSSIA. (4 cr; prereq #; offered even yrs) Brooks
Social and historical context of Russian literature. Reading publics, media, critical traditions, writing as a profession, censorship, and literary movements. Late imperial and Soviet periods.

5772, 5773. SCANDINAVIAN HISTORY. (4 cr per qtr, §Scan 5772, 5773; prereq reading knowledge of one Scandinavian language or Finnish, #) Metcalf
Topics and chronological emphasis vary from year to year.

5777-5778†. HISTORY OF THE HABSBURG MONARCHY. (4 cr per qtr; prereq #; offered alt yrs) Wright

5781, 5782. MODERN EUROPEAN INTELLECTUAL HISTORY. (4 cr per qtr; prereq #) Thayer

5784-5785†. DIPLOMATIC HISTORY OF 19TH- AND 20TH-CENTURY EUROPE. (4 cr per qtr; prereq #; offered when feasible) Kieft
5784: 1815 to 1914. Major historical literature on events such as the Congress of Vienna, unification of Germany and Italy, institution of the Bismarck alliance system, others. 5785: 1914 to present. World War I, Paris Peace Conference, World War II, the Cold War.

5791-5792. SOCIAL AND ECONOMIC HISTORY OF MODERN EUROPE SINCE 1750. (4 cr per qtr; prereq #; offered when feasible) Rudolph

5940-5950. HISTORICAL TOPICS: MEDICINE AND THE MODERN STATE. (4 cr per qtr [max 16 cr]; prereq #; offered alt yrs) Eyler
Topics vary from year to year. Emphasis on mid-18th century to present.

8150. SEMINAR IN ENGLISH HISTORY. (3 cr [may be repeated for cr]; prereq #; offered when feasible) Altholz, Hanawalt, Lehmberg
Topics vary from quarter to quarter.

8211, 8212. FRENCH REVOLUTION AND NAPOLEON. (3 cr per qtr; prereq #; offered when feasible) Bamford

8221-8222†. MODERN FRENCH HISTORY. (3 cr per qtr; prereq #; offered when feasible) Munholland

8223. RECENT EUROPEAN HISTORY. (3 cr; prereq #) Munholland

8241f-8242w-8243s†. 19TH-CENTURY GERMANY. (3 cr per qtr; prereq 5241, 5242, 5243 and #; offered when feasible) Kieft, Maynes

8244f-8245w†. HISTORY OF THE HABSBURG MONARCHY. (3 cr per qtr; prereq #; offered alt yrs) Wright

8261f-8262w-8263s†. RUSSIAN HISTORY. (3 cr per qtr; prereq #; offered when feasible) Stavrou

8291f-8292w-8293s†. EUROPEAN ECONOMIC AND SOCIAL HISTORY. (3 cr per qtr; prereq #; offered when feasible) Rudolph

Latin America

5420. TOPICS IN LATIN AMERICAN HISTORY. (4 cr per qtr; prereq #) McCaa, Phillips, Schwartz, Valdes
Detailed treatment of historical themes common to entire Latin American area. Topics vary from quarter to quarter.

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.

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.

5930. TOPICS IN COMPARATIVE THIRD WORLD HISTORY. (4 cr per qtr; prereq #) Isaacman, Kopf, Schwartz
Recurring themes in third world history.

8401f-8402w-8403s. LATIN AMERICAN HISTORY. (3 cr per qtr; prereq #; offered when feasible) McCaa, Schwartz

United States

5009. HISTORY OF THE AMERICAN INDIAN POPULATION. (4 cr, §Soc 5571) Meyer, Thornton
Population (demographic) history of American Indians in what is now the United States. Pre-European contact size, drastic decline from first European contact until turn of 20th century, recent partial recovery.

5045. MEDICAL PROFESSION IN AMERICA. (4 cr, §HMed 5045) Eyler
Historical analysis of the American medical profession in the 19th and 20th centuries emphasizing the role of institutions, influence of social and moral values, and consequences of specialization and scientific innovation.

5255. POLITICAL PARTIES TO 1789: EUROPE AND AMERICA. (4 cr; prereq #; offered when feasible) Metcalf
Comparative study of origins, development, and functions of political parties in England, Sweden, and Anglo-American colonies, 1688-1789, incorporating literature from both history and political science.

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.

5336, 5337. CRIMINAL JUSTICE IN AMERICAN HISTORY. (4 cr per qtr; prereq jr or sr or grad student) Samaha
Social, political, and intellectual context of crime, justice, and punishment. 5336: Colonial morality prosecutions, witchcraft, early forms of punishment, urban violence, rise of penitentiary, professional police. 5337: Changing patterns of crime, criminal class, southern justice, political justice, politics of law and order, criminal justice "reform," Watergate and beyond.

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
Specific problems in colonial history with emphasis on intellectual and cultural history.

5381su. MINNESOTA HISTORY WORKSHOP. (5 cr)
Survey of Minnesota history with emphasis on local resources for constructing such accounts, and appropriate methodologies. Themes vary from year to year.

5389. RUSSIAN-AMERICAN RELATIONS, 1917 TO PRESENT. (4 cr; prereq #; offered alt yrs) Brauer, Brooks
Russian-American relations since the Russian Revolution, emphasizing political, diplomatic, economic, and military problems and American foreign policy.

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.

5801-5802†. 17TH- AND 18TH-CENTURY AMERICAN HISTORY. (4 cr per qtr; prereq #; offered alt yrs) Menard

5805. THE AMERICAN REVOLUTION. (4 cr; prereq #; offered when feasible) Howe
The American Revolution: its colonial and imperial background and its internal development through the federal Constitution.

5806. JACKSONIAN AMERICA. (4 cr; prereq #; offered when feasible) Howe
The developing republic from the perspective of the Jacksonian era.

5807. RESEARCH IN REVOLUTIONARY AND JACKSONIAN AMERICA. (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. 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.

5821-5822†. AMERICAN HISTORY IN THE 20TH CENTURY. (4 cr per qtr; prereq #) Chambers

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.

5854-5855†. AMERICAN URBAN HISTORY. (4 cr per qtr; prereq #) Ruggles
Proseminar discussion of historical literature on U.S. urbanization, cities, and urban social relations. Emphasis on social history, demography, geography, urban politics, and institutions. Historiographical or research paper required.

5857-5858†. SOCIAL HISTORY OF AMERICAN WOMEN. (4 cr per qtr; prereq #) S Evans
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.

5864, 5865. AFRO-AMERICAN HISTORY. (4 cr per qtr; offered alt yrs) Menard, Plummer

5871f-5872w†. INTELLECTUAL HISTORY OF THE UNITED STATES IN THE 19TH AND 20TH CENTURIES. (4 cr per qtr; prereq #; offered alt yrs) Noble
Discussion of writings by 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 [12 cr max]; prereq #) Meyer
Social history of American Indian groups, focusing on historical demography, gender roles, interracial relationships, urbanization, and internal differences within Indian communities.

5940-5950†. HISTORICAL TOPICS: MEDICINE AND THE MODERN STATE. (4 cr per qtr [max 16 cr], §HMed 5120-5130; prereq #; offered alt yrs) Eyler
Topics vary from year to year. Emphasis on mid-18th century to present.

5957. LAW, SOCIETY, AND AMERICAN CRIMINAL JUSTICE. (4 cr; prereq #)
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.

8321, 8322. 20TH-CENTURY AMERICAN HISTORY. (3 cr per qtr; prereq #; offered when feasible) Chambers

8331. AMERICAN LEGAL AND CONSTITUTIONAL HISTORY. (3 cr; prereq #; offered when feasible) Murphy

8341. AMERICAN ECONOMIC HISTORY. (3 cr; prereq #; offered when feasible) Green

8344f-8345w-8346s†. AMERICAN LABOR HISTORY. (3 cr per qtr; prereq #) Berman

8347. SOCIAL HISTORY OF AMERICAN WOMEN. (3 cr; prereq 5857-5858 or #; offered when feasible) S Evans
Research seminar on women in the United States from colonial period to the present.

8361-8362-8363. HISTORY OF AMERICAN IMMIGRATION. (3 cr per qtr; prereq #; offered when feasible) Vecoli

8371f-8372w-8373s†. INTELLECTUAL HISTORY OF THE UNITED STATES IN THE 19TH AND 20TH CENTURIES. (3 cr per qtr; prereq #; offered when feasible) Noble

8381, 8382. HISTORY OF AMERICAN FOREIGN RELATIONS. (3 cr per qtr; prereq 5881, 5882 and #; offered when feasible) Brauer

8387f-8388w-8389s†. AMERICAN IMPERIALISM. (3 cr per qtr; prereq #; offered when feasible) Brauer
Theories of modern imperialism, practice of imperialism by the United States, and domestic and foreign consequences of American imperialism, 1607 to present.

8390. RESEARCH IN AMERICAN INDIAN SOCIAL HISTORY. (4 cr; prereq #)
Individual research in social history of American Indian groups. Variable topics, resources, and research methods.

8897. AMERICAN HISTORIOGRAPHY. (4 cr; prereq #) Green
Introduction to history of United States and its colonial antecedents. Historiography, historical methodology, and changing interpretations in various fields of American history.

History of Medicine and Biological Sciences (HMed)

Professor: Leonard G. Wilson, *head and director of graduate studies*

Associate Professor: John H. Beatty; John M. Eyler

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 will take 21 credits in the history of medicine and 8 credits in history. Doctoral students will 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.

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.

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 will be 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—Write to the Department of History of Medicine, 510 Diehl Hall, University of Minnesota, 505 Essex Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-16 cr per qtr)

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 from year to year. 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 anaesthesia.

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.

5410, 5411, 5412. SEMINAR: EMERGENCE OF MODERN MEDICINE, 1750-1900. (3 cr per qtr; prereq #) 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.

8240f, 8241w, 8242s. SEMINAR: HISTORY OF EVOLUTIONARY BIOLOGY. (3 cr per qtr; offered when feasible) Wilson
8240: History of scientific thought and discovery leading up to publication in 1859 of Darwin's *Origin of Species*, which students will read. 8241, 8242: Historical impact of evolutionary theory on biological sciences, including medicine, and on religious and social thought.

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: Roger H. Stuewer, *director;* Edwin T. Layton, *director of graduate studies;* Alan E. Shapiro

Associate Professor: John Beatty; John M. Eyler; 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 B only) and Ph.D.

Curriculum—The program emphasizes the conceptual developments within science and technology, as well as the 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—The M.A. degree is offered under Plan B only. Programs vary with the student's needs and background, but typically include at least six "foundation courses" from the following areas: history of physical science; history of biology; and history of technology (including information processing). 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 six or more "foundation courses" (see Master's Degree Requirements). In addition, students complete specialized courses and 8xxx seminars in the major field, as well as a minor or supporting program, usually consisting of four 5xxx and 8xxx courses (totaling a minimum of 18 credits).

Language Requirements—It is very desirable for students to have a reading knowledge of at least one foreign language before admission. 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. The language proficiency should be gained as quickly as possible; it must be acquired before taking the final oral examination required for the M.A. or the qualifying examination for the Ph.D.

Minor Requirements for Students Majoring in Other Fields—Requirements are arranged on an individual basis.

For Further Information—The publication *A Guide to Graduate Study in the History of Science and Technology* supplies more detailed information about requirements. A copy should be requested from the director of graduate studies, Program in History of Science and Technology, 125 Mechanical Engineering, University of Minnesota, 111 Church Street S.E., Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr pr qtr)

5011. THEORIES OF COLOR: NEWTON TO HELMHOLTZ. (4 cr) Shapiro
Physical and physiological investigations of color from the 17th to the mid-19th centuries, focusing on fundamental contributions of Newton, Young, Maxwell, and Helmholtz.

5111. PHYSICAL SCIENCES IN ANTIQUITY. (4 cr) Shapiro
Mathematics and astronomy in Babylonia; Greek mathematics; Euclid and Archimedes; Aristotle's physics and cosmology; the emergence of mathematical and experimental natural science in Greece; Ptolemaic astronomy.

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.

5311. TECHNOLOGY IN AMERICAN LIFE. (4 cr) Norberg
History of technology in America with emphasis on the sociocultural relations of technology. Growth of American technology in its cultural and intellectual context from colonial period to present.

5321. HISTORY OF COMPUTING. (4 cr) 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.

5511. WHAT SCIENCE WAS. (4 cr) Beatty
Changing views of aims and methods of science as seen through the eyes of philosopher-scientists of past; how notions of "explanation," "hypothesis," "evidence," for example, have changed.

5681. STRUCTURES AND MACHINES IN HISTORY. (4 cr)
History of civil and mechanical engineering since Industrial Revolution, emphasizing complementary roles of structures and machines. Interaction of structure with aesthetics and of machines with science.

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; spies, 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 #) Stuewer
Experimental and theoretical developments in nuclear physics to World War II in their institutional, social, and political contexts. Life and work of Becquerel, Curie, Rutherford, Chadwick, Gamow, Lawrence, Fermi, Bohr, Hahn, Meitner, and others.

5970. DIRECTED STUDIES. (1-15 cr; prereq #)

5990. DIRECTED RESEARCH. (1-15 cr; prereq #)

8111. HISTORIOGRAPHY OF HISTORY OF SCIENCE AND TECHNOLOGY. (4 cr; prereq grad student in HSci or #) Staff
Analysis of nature of historical study in history of science and technology. Differences of style in physical, biological, and engineering histories; nature of controversy in these areas; and internal/external approaches to history of science and technology.

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

8970. DIRECTED STUDIES. (1-5 cr per qtr [max 15 cr]; prereq #)

8990. DIRECTED RESEARCH. (1-5 cr per qtr [max 15 cr]; prereq #)

Home Economics Education

See Vocational and Technical Education.

Horticulture (Hort)

Professor: James F. Bartz, *head;* Mark L. Brenner, *director of graduate studies;* Peter D. Ascher; John V. Carter; David W. Davis; Sharon L. Desborough; Wesley P. Hackett; C. Gustav Hard; Leonard B. Hertz; Florian I. Lauer; Pen H. Li; Robert Mullin; Harold M. Pellett; Joseph R. Sowokinos; Eduard J. Stadelmann; Bert T. Swanson; Donald B. White; Harold F. Wilkins

Associate Professor: Emily E. Hoover; James J. Luby; Albert H. Markart; Shirley T. Munson; Joan Nassauer; Peter J. Olin; Luther Waters; David K. Wildung

Assistant Professor: Vincent A. Fritz; Carl J. Rosen

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 and Landscape Architecture administers this program, which is closely aligned with the interdepartmental programs of genetics, plant breeding, and plant physiology (see the appropriate headings in this bulletin). All four majors are offered in the Department of Horticultural Science and Landscape Architecture.

Prerequisites for Admission—Applicants are expected to have successfully completed college-level training in horticulture, biology, chemistry, and mathematics.

Special Application Requirements—Three letters of recommendation submitted on the department's form, a statement

of 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.

Master's Degree Requirements—Students are expected to participate in and present a seminar (8042). A final oral examination is required.

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. Students are expected to participate in and present at least one seminar (8042) and to earn 2 credits in such discussion courses as 8060, 8061, 8062, 8063, 8064, 8065, and 8066.

Language Requirements—For the master's degree, none. For the Ph.D. degree, students have the option of learning a foreign language or taking courses in a collateral field that will enrich and broaden their base of knowledge. Courses considered to be necessary for the individual student's area of specialization are not approved for the collateral field. Foreign students may substitute a supporting program in public administration for the language/collateral field requirement.

For Further Information—Contact the director of graduate studies, Horticulture, Department of Horticultural Science and Landscape Architecture, 305 Alderman Hall, University of Minnesota, 1970 Folwell Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5020s. HORTICULTURAL TECHNIQUES FOR EDUCATION MAJORS. (3 cr [no cr for horticulture majors]; prereq education major or #)
Horticultural and botanical concepts and their impact on the use of horticultural plants in the classroom. Development of specific single concept classroom demonstration and pupil-oriented activities relating to horticultural plants.

5021s. ORNAMENTAL PLANT MATERIALS. (5 cr, §1021, §1022; offered alt yrs) Mullin
Identification and use of wide range of ornamental plant materials, including trees, shrubs, annuals, perennials, and plants for interior design. Application of information and personal observations to individual student's area of study.

5026f. LANDSCAPE MANAGEMENT. (5 cr)
Application of basic biological principles to establishment and maintenance of horticultural plantings including commercial, private utility, recreational, highway, and park lands. Techniques and equipment for landscape plantings; adoptive management models for business and institutional organization.

5032. TREE FRUIT PRODUCTION. (4 cr; prereq 1100; PlPhy 3131 recommended; offered fall of even yrs) Hoover
Principles of tree fruit production. Tree fruits of the world, with emphasis on temperate tree fruits. Site selection, cultural and management practices, taxonomic classification, physiological and environmental control of plant development, dwarfing, growth regulating compounds, pest control. Lectures, laboratory, and field trips.

5033. SMALL FRUIT PRODUCTION. (3 cr; prereq 1100; PlPhy 3131 recommended; offered fall of odd yrs) Hoover
Principles of small fruit production. Major small fruit crops of the U.S. Site selection, cultural and management practices, systematics, physiological and environmental control of plant development, pest control. Lectures, laboratory, and field trips.

5034. COMMERCIAL VEGETABLE PRODUCTION I: TUBER, ROOT, AND BULB CROPS. (3 cr; prereq 1036, Soil 1122 or #) Davis
Crop cultural and product handling and use systems in various world cultures. Seed and stand establishment considerations, vegetative propagation. Pest problems, soil-borne insects and diseases. Crop management as related to applied physiology and genetics of bulb and tuber initiation, sink development, maturation and quality. Storage.

5035s. COMMERCIAL VEGETABLE PRODUCTION II: FRUIT, SEED, AND LEAFY CROPS. (3 cr; prereq 1036, Soil 1122 or #)
Fruit, seed, and leafy types as world food sources; nature and scope of production and distribution systems. Physiological and genetic control of plant and product development, including principles of stand establishment, maturation and seed production. Impact of nutrition, irrigation, postharvest handling and other variables on crop performance and product quality.

5037. SYSTEMATICS AND UTILIZATION OF VEGETABLE CROPS GERMPLASM. (3 cr; prereq Agro 5020 or #; offered fall of odd yrs) Davis
Systematic and historical relationships of germplasm resources of vegetable taxa. Product form, structure, quality and development of improved types.

5038w.* RESEARCH METHODS IN PLANT PROPAGATION. (3 cr; prereq 1036 or #)
Basic concepts, theory, and techniques involved in propagating plants. Students design and conduct experiments with plants or propagation techniques of special interest.

5040w. PLANT GROWTH REGULATION. (4 cr; prereq 15 cr in plant sciences incl 3 cr in plant physiology) Brenner, Hackett
Principles of plant growth and development in relation to optimizing cropping efficiency and product quality. Emphasis on analysis of physiological and morphogenetic basis of horticultural practices used to regulate growth and development. Exercises in utilization of these principles to solve horticultural problems.

5041f. ENVIRONMENTAL PHYSIOLOGY OF HORTICULTURAL PLANTS. (3 cr; prereq 15 cr in plant science, PlPh 3131; offered alt yrs) Markhart
Lectures and assigned readings on relation of light, temperature, and water to growth and culture of horticultural plants.

5042f.* TURF GRASS SCIENCE. (5 cr; prereq 3072, PlPa 1001, PlPh 3131) 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 AND PRODUCTION I. (4 cr, 5046-5047-5048†; prereq 1021, 1036, 1100) 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.

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. Laboratory includes field trips and greenhouse and field training in nursery operations. Field trips required.

5052f. COMMERCIAL FLORICULTURE, FALL CROPS. (4 cr; prereq 1016)
Physiological and cultural aspects of optimized production of principal florist crops of economic importance. Chrysanthemums, carnations, cut flowers, and potted plants especially adapted to Christmas sales. Lectures, reference readings, and field trips to greenhouses, wholesalers, and retail flower stores.

5053w. COMMERCIAL FLORICULTURE, WINTER CROPS. (3 cr; prereq Biol 1103, PlPh 3131 or #) Wilkins
Physiological and cultural aspects of bulbous plants (tulips, narcissi, bulbous irises, hyacinths, crocuses, and lilies) and year-round production of azaleas. Major emphasis on latest research in growth, developmental and flowering physiology of these commercially important floricultural crops. Lectures, reference readings, laboratory experiences, and field trips.

5054s. COMMERCIAL FLORICULTURE, SPRING CROPS. (4 cr; prereq 1016) Widmer
Physiological and cultural aspects of optimized production of principal florist crops of economic importance. Roses, snapdragons, gloxinias, geraniums, bedding plants, and other spring crops. Lectures, reference readings, and field trips to greenhouses, wholesalers, garden centers, and retail stores.

5091.* DIRECTED STUDIES. (2-6 cr; prereq 8 cr upper div hort course, △) Staff
Written or oral report based on library, laboratory, or field research.

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, Luby
Methods applied to improving asexually propagated plants. Apomixis, polyploidy, chimeras, mutations, and interspecific hybridization.

8023f.* EVOLUTION OF CROP PLANTS. (3 cr) 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) Bartz
Organization and administration in agricultural experiment stations; project development and research outlines.

8042f,w,s.* HORTICULTURAL SEMINAR. (1 cr; prereq 9 cr in horticulture) Staff
Reports and discussions of problems and investigational work.

8045w.* PLANT HARDINESS. (3 cr; prereq 15 cr plant sciences incl 6 cr plant physiology plus 6 cr biochemistry; offered alt yrs) Carter
Physiological and physical bases of plant injury and survival related to low temperature, high temperature, drought, chemicals, and radiation. Emphasis on physiology of fall hardening and low temperature survival.

8051f,w,s,su.* ADVANCED PROBLEMS IN HORTICULTURAL CROP BREEDING. (3-9 cr; prereq #) Staff
Written report based on library, laboratory, or field research.

8052f,w,s.* ADVANCED PROBLEMS IN PHYSIOLOGY OF HORTICULTURAL CROPS. (3-9 cr; prereq #) Staff
Written report based on library, laboratory, or field research.

8060f,w,s. DISCUSSIONS IN POTATO RESEARCH. (1 cr) Desborough, Lauer
Covers all aspects of potato genetics, breeding, and physiology. Emphasis on current research and literature.

8061f,w,s.* SEMINAR: DISCUSSIONS IN INCOMPATIBILITY. (1 cr; prereq #) Ascher
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 #) Wilkins
Emphasis on physiological aspects.

8065w,s.* SEMINAR: DISCUSSIONS IN POSTHARVEST PHYSIOLOGY. (1 cr; prereq #) Li, Munson, Wilkins
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; prereq #) Luby
Emphasis on research being conducted by graduate students in the department.

Other Courses of Interest

LA 5010. PRINCIPLES OF OUTDOOR RECREATION DESIGN AND PLANNING

LA 5101. SITE PLANNING AND DESIGN

LA 5103. URBAN LANDSCAPE DESIGN

LA 5105. RECREATIONAL PLANNING AND DESIGN

LA 5107. REGIONAL LANDSCAPE DESIGN

LA 5110. ADVANCED LANDSCAPE PLANNING AND DESIGN

PlPh 5167. PHYSIOLOGY OF THE PLANT CELL

PlPh 5168. EXPERIMENTAL PROTOPLASMATOLOGY

PlPh 5183. WATER, MINERALS, AND TRANSLOCATION

PlPh 5721, 5723, 5726. METHODS OF PLANT ANALYSIS

PlPh 8281. GROWTH AND DIFFERENTIATION OF PLANTS

Hospital Pharmacy

Professor: Albert I. Wertheimer

Associate Professor: Paul W. Abramowitz; David N. Angaran; Daniel Canafax; Robert J. Cipolle; James C. Cloyd; Ronald S. Hadsall; John C. Rotschafer

Assistant Professor: Charles E. Daniels, *director of graduate studies;* Ronald L. Broekemeier; Courtney V. Fletcher; Ricci M. Giese; Nina M. Graves; Henry Mann; Shabir M. Somani; Kathleen Teasley

Clinical Assistant Professor: 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 management and practice of pharmacy in organized health care settings. Research focuses on the delivery of pharmacy services and drug therapy in these settings.

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 hospital 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—Contact the director of graduate studies, Hospital Pharmacy, 7-159 Health Sciences Unit F, University of Minnesota, 308 Harvard Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Note—The following courses in hospital pharmacy are described under Social and Administrative Pharmacy in this bulletin:

SAPh 8100. SEMINAR

SAPh 8200. RESEARCH PROBLEMS

SAPh 8270. CLINICAL CONFERENCES

SAPh 8280. ADMINISTRATIVE CLERKSHIP

SAPh 8290. CLINICAL CLERKSHIP

SAPh 8301, 8302. CLINICAL THERAPEUTICS

SAPh 8400. SPECIAL CLINICAL PROBLEMS

SAPh 8700. HOSPITAL ADMINISTRATION

SAPh 8701, 8703. HOSPITAL PHARMACY ADMINISTRATION I, II

SAPh 8702. HOSPITAL PHARMACY SURVEY

Industrial Education

See Vocational and Technical Education.

Industrial Engineering

See Mechanical Engineering.

Industrial Relations (IR)

Professor: John A. Fossum, *chair;* Richard D. Arvey; Hyman Berman; Mario F. Bognanno; John P. Campbell; Rene V. Dawis; Marvin D. Dunnette; John J. Flagler; Morris M. Kleiner; Jeylan T. Mortimer; James G. Scoville; Norman J. Simler; C. Arthur Williams; Mahmood A. Zaidi

Associate Professor: Dennis A. Ahlburg, *director of graduate studies;* Ross E. Azevedo; Avner Ben-Ner; Paul R. Sackett

Assistant Professor: Rebecca A. Luzadis; Raymond A. Noe; Cheri L. Ostroff; Joshua L. Schwarz

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 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 macro economics, psychology, and statistics.

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 TOEFL.

Entry in the M.A. program is for fall or spring quarter only. Priority application deadlines are December 15 for fall and spring quarters. 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. The evening program is designed for students whose daytime obligations interfere with enrollment. For Plan A, a minimum of twelve courses, 16 thesis

credits, and a thesis are required (64 credits). Major coursework includes 8002, 8001, 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 three courses in an approved field or fields of study related to industrial relations. Commonly selected fields are business administration, economics, psychology, sociology, or statistics. One additional course must be taken in IR or an outside 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, 8012, and four additional industrial relations courses. A minimum of 16 graduate credits must be earned in at least two related fields, at least 8 credits of which must be in a single field. It is recommended that students include at least 8 credits or two courses in each of the two related fields. Commonly selected fields are business administration, economics, psychology, sociology, or statistics. A Plan B paper must be written in conjunction with 8001 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 completed and 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 pass a qualifying comprehensive examination usually taken in the second year of study and successfully complete examinations in research methodology and two of the five industrial relations subfields.

Ph.D. programs should be composed of a major, a supporting program, and either a language or a research program. The supporting program must include a minimum of 24 credits in one or two fields in the social and behavioral sciences. If two fields are elected, each field must consist of at least 12 credits. Coursework used to satisfy a part of the major or research technique program may not be used as part of the supporting program.

The graduate faculty in industrial relations may require higher performance standards than those specified in the General Information section of this bulletin.

Language Requirements—For the master's degree, none. For the doctoral degree, students must fulfill a language and/or research technique requirement. Options for fulfillment of this requirement are: 1) study of two foreign languages related to research and teaching interests; 2) study of one language and completion of a research technique course sequence; 3) demonstration of proficiency in a computer language relevant to the proposed research area and completion of research technique course sequence; and 4) completion of a research technique course sequence and an additional 4-credit course from the relevant sequence. (For relevant course sequences under each option, see the director of graduate studies.)

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 and pass the qualifying comprehensive examination in industrial relations. For specific minor and related field requirements, consult the director of graduate studies.

For Further Information—Contact the director of graduate studies, Industrial Relations Center, 537 Management and Economics Building, University of Minnesota, 271 19th Avenue South, Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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 laboratory exercises, with students participating in dispute resolution simulations applied to real world conflicts.

5990. INDEPENDENT STUDY IN PERSONNEL AND INDUSTRIAL RELATIONS. (1-8 cr) Staff
Individual readings or research topics in human resource management.

8000. GRADUATE TOPICS IN INDUSTRIAL RELATIONS. (Cr ar; prereq 8002 and #) Staff
Selected topics.

8001. QUANTITATIVE METHODS IN INDUSTRIAL RELATIONS. (4 cr; prereq 8002, Stat 5021 and computer access course or # and IR grad or △) Ahlburg, Azevedo, Bognanno, Keane, McCall, Noe, Schwarz
Theory and applications of alternative quantitative methods and techniques in formulation and analysis of various problems and practices. Cases, problem sets, and computer exercises.

8002. AN INTRODUCTION TO INDUSTRIAL RELATIONS. (4 cr, §3002; prereq Econ 1001, Econ 1002, Psy 1001 and IR grad or △) 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 # and IR grad or △) Arvey, Noe, Ostroff, Sackett
Introduction to processes of recruiting, selecting, training, and developing employees in complex organizations. Cost-benefit analysis of individual selection and training strategies, management of special employee problems, and emerging training techniques.

8004. ORGANIZATIONAL THEORY AND ANALYSIS. (4 cr; prereq 8002 or # and IR grad or △) Arvey, Ben-Ner, Ostroff
Introduction to micro and macro organizational issues, application to administrative issues of organizational structuring, coordination, control, job design, organizational decision making, leadership and organizational development.

8005. EMPLOYEE COMPENSATION AND REWARD. (4 cr; prereq 8002 or # and IR grad or △) Azevedo, Fossum
Introduction to systems of employee compensation and reward in organizations. Concepts, models, and theories relating to processes of compensation designed to influence worker behavior and performance within constraints. Wage structuring, fringe benefits, individual appraisal and reward, employee motivation, and compensation controls.

8006. LABOR MARKET ANALYSIS. (4 cr; prereq 8002 or # and IR grad or △) Ahlburg, Azevedo, Bognanno, Keane, Luzadis, McCall, Zaidi
Introduction to labor supply and demand, wages, employment, and unemployment. Basic concepts and data sources, their application to market analysis for human resource development, allocation, and utilization.

8007. COLLECTIVE BARGAINING IN THE PUBLIC AND PRIVATE SECTORS. (4 cr; prereq 8002 or # and IR grad or △) Bognanno, Flagler, Schwarz
Introduction to collective bargaining and administration. Legal frameworks imposed on public and private sector negotiators.

8012. INDUSTRIAL RELATIONS SYSTEMS. (4 cr; prereq completion of the core course sequence in IR or # and IR grad or △) Arvey, Scoville
Integration and application of elements of industrial relations to human resource management issues in public and private sectors.

8013. ORGANIZATION AND STAFFING. (4 cr; prereq 8003 or # and IR grad or △) Arvey, Noe, Ostroff, Sackett
Integration of organization goals and objectives with individual needs and objectives through staffing processes of human resources planning, recruitment, selection/reduction, allocation and evaluation of human resources.

8014. ORGANIZATION DESIGN AND ADMINISTRATION. (4 cr; prereq 8004 or # and IR grad or △) Arvey, Ben-Ner
Principles of design and arrangement of tasks, positions, and functions in organization. Organization design in relation to surrounding environment and as an influence on achievement of organizational goals and individual objectives. Design implications for effective internal organizational operations.

8015. COMPENSATION, REWARD, MOTIVATION, AND PERFORMANCE. (4 cr; prereq 8005 or # and IR grad or △) Azevedo, Fossum
Theories of motivation, reward, performance and behavior. Application to master issues and policies regarding human resource allocation, development, and utilization. Theoretical aspects of occupational choice and career compensation, negotiated compensation, job enrichment, and job performance.

8016. MICRO LABOR MARKET ANALYSIS. (4 cr; prereq 8006 or # and IR grad or △) Ahlburg, Azevedo, Bognanno, Luzadis, McCall, Zaidi
Micro analysis of demand for and supply of labor. Investment in human capital, occupational choice, job search and turnover, compensation, and discrimination.

8017. THEORIES OF LABOR-MANAGEMENT RELATIONSHIPS AND NEGOTIATIONS. (4 cr; prereq 8007 or # and IR grad or △) Bognanno
Analysis of conflict within employment relationships and collective bargaining negotiations. Industrial conflict analyzed from the theory of games perspective, bargaining, and approaches to prevention, reduction, and resolution of industrial conflict.

8022. INTERNATIONAL HUMAN RESOURCE MANAGEMENT. (4 cr; prereq 8002 or MBA 8015 or #) Bognanno, Scoville, Zaidi
Introduction to personnel practices in international arena. Legal, institutional, and market aspects of work arrangement; their impact on the multinational and transnational corporations operating in foreign countries.

8023. TRAINING AND DEVELOPMENT. (4 cr; prereq 8003 or # and IR grad or △) Arvey, Noe, Sackett
Integration of appropriate learning principles and organizational objectives into training programs. Design implementation and evaluation of training systems to effect development, utilization, and conservation of human resources.

8024. ORGANIZATION ANALYSIS AND ENVIRONMENTAL SYSTEMS. (4 cr; prereq 8004 or # and IR grad or △) Arvey, Ben-Ner
Theory and application of interorganizational relations. Impact of environmental systems on goals, values, and power of actors within economic organizations. Work organizations in terms of general and specific environmental conditions: technological, legal, political, economic, demographic, ecological, and cultural.

8025. EMPLOYEE BENEFITS AND ADMINISTRATION. (4 cr; prereq 8005 or # and IR grad or △) Azevedo, Luzadis, Williams
Concepts and procedures for administration of employee benefits in both public and private sector. Alternative benefit forms and approaches to analyzing, planning, and contracting employee benefits. Procedures for developing individualized benefit systems, legal aspects of employee benefit administration.

8026. MACRO LABOR MARKET ANALYSIS. (4 cr; prereq 8006 or # and IR grad or △) Ahlburg, Azevedo, Keane, Zaidi
Macro analysis of demand for and supply of labor. Unemployment, inflation, impact of unions on compensation, and public sector labor market operation.

8027. METHODS FOR DISPUTE RESOLUTION. (4 cr; prereq 8007 or # and IR grad or △) Bognanno, Flagler
Methods for resolution of impasses/disputes in contract negotiations and grievance procedures in public and private sectors. Current practices regarding mediation, fact finding, arbitration. Newly emerging approaches.

8032. COMPARATIVE AND INTERNATIONAL LABOR MOVEMENTS. (4 cr; prereq 8002 or # and IR grad or △) 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. MANAGEMENT DEVELOPMENT. (4 cr; prereq 8003 or # and IR grad or △) Noe
Current issues in managerial human resources planning, selection, training, career planning, motivation, compensation, appraisal, and career development. Basic policy, current problems, and research findings related to management development in industry, universities, and government. Methods and techniques of development viewed in context of theory of adult development.

8035. MOTIVATION AND WORK BEHAVIOR. (4 cr; prereq 8005 or 8004 or # and IR grad or △) Azevedo
Work behaviors and motivation models; frameworks appropriate to each behavior; relationship among motivation, performance, and satisfaction. Theories of work motivation, work performance, job attitudes, absence, turnover, job redesign, worker participation, and goal setting.

8036. HUMAN RESOURCE PLANNING. (4 cr; prereq 8006 or # and IR grad or △) Azevedo, Zaidi
Theoretical and empirical practices in human resource utilization. Developmental strategies for effective and efficient employment of workers, provision for their movement in internal labor market. Public and private human resource programs, external and internal labor markets, planning strategies, and cost-benefit analysis of utilization programs.

8037. THE LABOR MOVEMENT IN THE UNITED STATES. (4 cr; prereq 8007 or # and IR grad or △) Flagler
Constitutional arrangements, decision-making processes, and administration of AFL-CIO and international unions, local unions, state federations, and city central bodies. Policies and impact of U.S. labor movement.

8046. HUMAN RESOURCES AND FIRM PERFORMANCE. (4 cr; prereq 8006 or #, IR grad student or △)
Role that human resource policies and practices play in firm productivity, profitability, and market value.

8801. SEMINAR: INDUSTRIAL RELATIONS RESEARCH METHODOLOGY. (4 cr; prereq 8001 or #) 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 # and IR grad or △) 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 and/or # and IR grad or △) Arvey, Noe, Sackett
Staffing and training concepts, problems, and research.

8804. SEMINAR: ORGANIZATION THEORY. (4 cr; prereq 8004 and/or # and IR grad or △) Arvey, Ben-Ner
Organization theories, application in industrial relations research and practice.

8805. SEMINAR: COMPENSATION AND REWARD. (4 cr; prereq 8005 and/or # and IR grad or △) Fossum
Issues of employee compensation and reward; analysis of relevant theoretical models; formulation of research into compensation and reward issues.

8806. SEMINAR: LABOR MARKET THEORY AND RESEARCH. (4 cr; prereq 8006 and/or # and IR grad or △) Ahlburg, Bognanno, Keane, Luzadis, McCall, Zaidi
Functions and operations of labor markets, theory, and research.

8807. SEMINAR: COLLECTIVE BARGAINING AND LABOR RELATIONS. (4 cr; prereq 8007 and/or # and IR grad or △) Bognanno, Schwarz
Collective bargaining process; substance, procedures, determinants, and social/political/economic incidences.

8990. INDEPENDENT STUDY IN INDUSTRIAL RELATIONS. (Cr ar; prereq #) Staff
Individual readings and/or research projects especially useful to student's objectives and program.

Interfacial Engineering

Professor: D. Fennell Evans (chemical engineering and materials science), *director,* Center for Interfacial Engineering; Robert W. Carr (chemical engineering and materials science); Edward J. Cussler (chemical engineering and materials science); H. Ted Davis (chemical engineering and materials science); William H. Gerberich (chemical engineering and materials science); Benjamin Y. H. Liu (mechanical engineering); Larry L. Miller (chemistry); Wilmer G. Miller (chemistry); Christopher W. Macosko (chemical engineering and materials science); Richard A. Oriani (chemical engineering and materials science); Emil Pfender (mechanical engineering); Stephen Prager (chemistry); Subbiah Ramalingam (mechanical engineering); Michael S. Shur (mechanical engineering); Lanny D. Schmidt (chemical engineering and materials science); L. Edward Scriven (chemical engineering and materials science); William H. Smyrl (chemical engineering and materials science); Matthew V. Tirrell (chemical engineering and materials science); John H. Weaver (chemical engineering and materials science)

Associate Professor: Philip I. Cohen (electrical engineering); John F. Evans (chemistry); Alfonso Franciosi (chemical engineering and materials science); Richard D. James (aerospace engineering and mechanics); Klavs F. Jensen (chemical engineering and materials science)

Assistant Professor: Steven L. Girshick (mechanical engineering); Martha L. Mecartney (chemical engineering and materials science)

Course of Study—Minor in interfacial engineering, applicable to either master's or doctoral programs.

Curriculum—The Center for Interfacial Engineering (CIE) offers a structured interdisciplinary graduate curriculum for students specializing in interfacial engineering. The objective is to develop new formation processes for specific thin film materials, to develop new techniques for characterization of interfacial structure and composition, and to develop better control of the processes and properties of the materials created. The minor focuses the work of faculty and students on controlling the interfacial regions during synthesis of these materials.

Prerequisites for Admission—Admission to the CIE graduate minor program is contingent upon prior admission to the Graduate School and to a master's or doctoral program in a degree-granting department 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. 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—Both master's and doctoral students minoring in this program are required to take a mixture of core courses and electives from among those listed below. Coursework in the student's major field may not be applied toward fulfillment of course requirements for the minor. Master's students must take at least three of the courses listed below (at least two from the core courses) with the credits totalling 12 or more. Doctoral students must take at least five of the courses listed below (at least three from the core courses) with the credits totalling 20 or more.

Language Requirements—None specific to the minor program.

For Further Information—Contact the director of graduate studies, Center for Interfacial Engineering, 151 Amundson Hall, University of Minnesota, 421 Washington Avenue S.E., Minneapolis, MN 55455.

Core Courses

ChEn 5771. COLLOIDS AND DISPERSIONS. (3 cr; prereq physical chem; 3 lect hrs per wk)

ChEn 5810. PROCESSING OF ELECTRONIC MATERIALS. (3 cr; prereq MatS 5011 or #; 3 lect hrs per wk)

EE 5680. PRINCIPLES OF THIN FILM TECHNOLOGY. (4 cr; prereq #)

ME 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)

ME 5613. PRINCIPLES OF PARTICLE TECHNOLOGY. (4 cr; prereq 3303, IT or grad student; 4 lect hrs per wk)

Advanced Core Courses

Chem 8136. SURFACE AND THIN FILM ANALYSIS. (3 cr; prereq #)

ChEn 8104. INTERFACES AND INTERFACIAL PHENOMENA. (3 cr; prereq 8101; offered alt yrs)

ChEn 8402. CHEMICAL REACTION KINETICS-SURFACE CHEMISTRY. (3 cr; prereq #)

ChEn 8810. PROCESSING OF ELECTRONIC MATERIALS. (3 cr; prereq MatS 5011 or #; 3 lect hrs per wk)

ME 8360. INTRODUCTION TO PLASMA TECHNOLOGY. (3 cr; prereq 5342 or #)

Elective Courses

ChEn 5640. POLYMERIZATION REACTOR ENGINEERING. (4 cr [available to grad students for 3 cr]; prereq chem engr reactor design course or #; 3 lect and 1 lab hrs per wk)

EE 5670. BASIC MICROELECTRONICS. (4 cr; prereq #)

MatS 5200. OPTICAL AND ELECTRON MICROSCOPY OF SOLIDS. (4 cr; prereq upper div IT student, 3400 or #; 2 lect and 3 lab hrs per wk)

MatS 5610. POLYMER CHEMISTRY. (4 cr; prereq upper div IT student, ChEn 3301 or ChEn 3331 or #; 3 lect and 3 lab hrs per wk)

MatS 5620. PROCESSING OF POLYMERS AND THEIR COMPOSITES. (4 cr [3 cr w/o lab by dept permission]; prereq heat transfer and fluid mechanics or #; 3 lect and 1 lab-rec hrs per wk)

MatS 5630. POLYMER PHYSICAL PROPERTIES. (4 cr; prereq 5011 or 3400 and MatS/Chem 5610 or #; 3 lect and 1 open lab hrs per wk)

ME 5262. MATERIAL WORKING AND FABRICATION PROCESSES. (4 cr; prereq 5260, IT or grad student; 3 lect and 1 rec hrs per wk)

ME 5268. PROPERTIES AND FABRICATION OF PLASTICS. (4 cr; prereq 5260, IT or grad student; 3 lect and 1 lab-rec hrs per wk)

ME 5617. ADVANCED AEROSOL MEASUREMENT. (4 cr; prereq 5613 or #, IT or grad student)

Advanced Elective Courses

MatS 8112. SOLID STATE REACTIONS. (3 cr; prereq #)

MatS 8520. ELECTRON DIFFRACTION AND ELECTRON MICROSCOPY. (3 cr)

ME 8361. INTRODUCTION TO PLASMA TECHNOLOGY. (3 cr; prereq 8360 or #)

ME 8362. INTRODUCTION TO PLASMA TECHNOLOGY. (3 cr; prereq 8360, 8361 or #)

Italian

See French and Italian.

Japanese

See East Asian Studies.

Journalism

See Mass Communication.

Landscape Architecture (LA)

Professor: David G. Pitt, *chair;* Roger D. Clemence; Robert C. Einsweiler; C. Gustav Hard; John F. Hart; Roger Martin; Robert Mullin

Associate Professor: Robert Sykes, *director of graduate studies;* Timothy Knopp; Joan Nassauer; Peter J. Olin

Assistant Professor: Patrick Condon; Lance M. Neckar

Lecturer: Barbara Lukermann

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

Degree Offered—M.L.A. (Plan A and Plan B).

Curriculum—The master of landscape architecture program is organized around two tracks: the M.L.A. track for applicants who have earned a B.L.A., B.S.L.A. or equivalent before entry, and the B.L.A./M.L.A. track for applicants who have an earned baccalaureate in another field. The M.L.A. allows students in either track to work closely with faculty to pursue a highly individualized scholarly focus within the broad discipline of landscape architecture. The B.L.A. allows students who have not yet earned an accredited first professional degree to become familiar with the broad spectrum of landscape architecture work and also to earn their fundamental practice credential.

The M.L.A. program is structured around three sequential research seminars organized to provide a thorough approach to defining specific research areas. They utilize the unique metropolitan resources and ecological diversity of the state as well as interdisciplinary linkages to architecture, horticulture, forestry, geography and planning. Specific research areas include landscape theory; landscape perception, cognition, and evaluation; landscape history; technology and its implications for landscape processes; applied creativity in design; urban design. Opportunity is provided to explore teaching methodologies in relation to areas of landscape technology, graphics, theory, land development history, planting design and design studio.

Prerequisites for Admission—Applicants must have *completed a B.L.A. or B.S.L.A. degree* or equivalent *or apply for the combined B.L.A./M.L.A. program.* Applicants for the *combined B.L.A./M.L.A. program* must have earned a baccalaureate in another discipline. A statement of intent to pursue graduate work and to accomplish a course of study in a specialized area of landscape architecture must be submitted along with three letters of recommendation. All applicants must demonstrate undergraduate excellence as illustrated by high scholastic achievement. Applicants with an earned B.L.A. or B.S.L.A. must also demonstrate excellence in a portfolio or in design work. Submission of the portfolio is desirable but not required of B.L.A./M.L.A. combined degree applicants. The Graduate Record Examination is not required, but is encouraged for students seeking fellowships. Applicants wishing full consideration for fellowships and assistantships must apply by January 16.

Degree Requirements—B.L.A./M.L.A. candidates are required to take a minimum of 80 credits of additional basic professional coursework, including 8110 or 8111, with a design-oriented undergraduate degree, or a minimum of 102 credits of additional basic professional coursework, including 8110 or 8111, with a nondesign undergraduate degree. All candidates must take a minimum of 12 quarter credits of graduate-level landscape architecture courses, including 8281, 8282, 8283. For Plan A, a minimum of 28 quarter credits of graduate coursework, including the minimum 12 credits listed above, 4

credits of methods (one course), plus a thesis are required. For Plan B, a minimum of 44 quarter credits of graduate coursework, including the minimum 12 credits listed above, 4 credits of methods (one course), plus three Plan B papers are required. After completing 15 graduate credits, or by the third quarter of registration, candidates must file an official proposed program with the Graduate School. Since there is no minor requirement, M.L.A. candidates are expected to take courses in a variety of related disciplines to meet the objectives of the defined area of specialization. The final examination is written, oral, and graphic.

Language Requirement—None.

For Further Information—Contact the director of graduate studies, Landscape Architecture Program, 205 North Hall, University of Minnesota, 2005 Buford Avenue North, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

5010. PRINCIPLES OF OUTDOOR RECREATION DESIGN AND PLANNING. (4 cr, §FR 5233; 4 lect hrs per wk) Knopp
For advanced students associated with design, management, and planning of recreation facilities. Planning and design principles related to recreational land use and development: parks, campsites, water areas, highways, summer and winter recreational facilities.

5063. LANDSCAPE CONSTRUCTION: SPATIAL PERFORMANCE. (4 cr; prereq 3081 or #) Sykes
Lectures, projects, and exercises on use of space standards, proportions, and dimensions to achieve and evaluate spatial performance in landscape architecture; spatial accommodation of people and automobiles in basic array of landscape applications; land use controls and development standards.

5099. RESOURCE AND COMMUNITY DEVELOPMENT INTERDISCIPLINARY SEMINAR I. (4 cr, §RCD 5099; prereq RCD sr or #; A-F only)
Speakers, readings, and discussion topics on resource and community development analysis and implications for resource allocation. Students participate as a team to analyze complex resource problems.

5100. RESOURCE AND COMMUNITY DEVELOPMENT INTERDISCIPLINARY SEMINAR II. (4 cr, §RCD 4100; prereq RCD sr or #; A-F only)
(Continuation of 5099) Papers, presentations, and critiques on selected complex resource problems in 5099.

5101. SITE PLANNING AND DESIGN. (6 cr; prereq 3093; 2 lect and 12 lab hrs per wk) Clemence
Case study analysis and design of site organizational systems.

5103. URBAN LANDSCAPE DESIGN. (6 cr; prereq 3093; 2 lect and 12 lab hrs per wk) Neckar
Case study analysis and design of urban environments.

5105. RECREATIONAL PLANNING AND DESIGN. (6 cr; prereq 3093; 2 lect and 10 lab hrs per wk) Pitt
Analysis, development, and presentation of landscape design solutions for diverse, recreational land uses.

5107. REGIONAL LANDSCAPE DESIGN. (6 cr; prereq 3092; 3 lect and 12 lab hrs per wk) Nassauer
Land analysis techniques applied to large-scale land areas for resource analysis and policy design.

5110. ADVANCED LANDSCAPE PLANNING AND DESIGN. (6 cr; prereq terminal qtr of study; 2 lect and 12 lab hrs per wk)
Advanced studies in area of student's option.

5117. PLANTING DESIGN: AESTHETIC AND FUNCTIONAL CRITERIA. (4 cr; prereq 3083, Hort 1021 or #)
Lectures, presentations, field trips, readings, and projects exploring aesthetic and functional design principles related to use of plant materials in landscape. Historic and modern principles through design projects of various scales.

5119. PLANTING DESIGN: ECOLOGICAL PRINCIPLES/LAND USE CONCEPTS AND IMPLEMENTATION. (4 cr; prereq 3092 or #)
Lectures, presentations, field trips, readings, and projects related to principles and practices of using plant materials in an ecologically sound and environmentally sensitive manner. Principles derived from prairie, northwoods, riverine, and wetland environments. Integrating naturalized materials in environments of various scales. Historic and modern land use planting concepts. Planting implementation skills.

5131. DIRECTED STUDIES IN LANDSCAPE ARCHITECTURE HISTORY AND THEORY. (1-6 cr; prereq 3rd-yr LA student, △; student expected to have successfully completed 3xxx independent study courses)

5132. DIRECTED STUDIES IN LANDSCAPE ARCHITECTURE DESIGN. (1-6 cr; prereq 3rd-yr LA student, △; student expected to have successfully completed 3xxx independent study courses)

5133. DIRECTED STUDIES IN LANDSCAPE ARCHITECTURE TECHNOLOGY. (1-6 cr; prereq 3rd-yr LA student, △; student expected to have successfully completed 3xxx independent study courses)

5134. DIRECTED STUDIES IN EMERGING AREAS FOR LANDSCAPE ARCHITECTURE. (1-6 cr; prereq 3rd-yr LA student, △; student expected to have successfully completed 3xxx independent study courses, A-F only)

5136. GOVERNMENT RECREATION FACILITIES PLANNING. (4 cr; prereq 3rd yr LA student or #)
Exploration of design policies regarding development of specific recreational facilities at federal water resource projects. Lectures, discussions, and field trips relating to analysis of criteria for organization of federal recreational environments.

5140. INTERDISCIPLINARY STUDIES IN LANDSCAPE ARCHITECTURE. (2-6 cr per qtr [18 cr max]; prereq #)
Research, planning, and/or design project. Topics may include energy efficient design, historic preservation, downtown revitalization, agricultural land utilization, computerized land use planning, housing.

5224. CONTEMPORARY ISSUES IN LANDSCAPE ARCHITECTURE. (4 cr; prereq terminal year of study; 4 discussion hrs per wk) Pitt
Design principles and design goals in modern society. Review of current site development projects. Specific areas of land development.

5225. LANDSCAPE TECHNOLOGY: WORKING DRAWINGS AND SPECIFICATIONS. (4 cr; prereq 3072; 3 lect and 3 lab hrs per wk)
Lectures, exercises, and projects in working drawing and specification preparation.

5226. PROFESSIONAL PRACTICE. (4 cr; prereq terminal yr of study)
Professional ethics, responsibility, and relations in business. Office management, preparation of professional communications, estimates, specifications, and contracts. Lectures, written exercises, and office visits.

5227. IMPACT ASSESSMENT AND ENVIRONMENTAL MEDIATION. (5 cr; prereq sr or grad or #)
Lectures on history, laws, and analysis of impact assessment and environmental mediation. Interdisciplinary emphasis on fieldwork. Document preparation, presentation.

5228. SEMINAR: TOPICS IN CAMPUS PLANNING. (4 cr; prereq 3093 or #)
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.

5261. HISTORY OF LANDSCAPE ARCHITECTURE: THE EUROPEAN, ORIENTAL, AND AMERICAN TRADITION. (4 cr; prereq 1st-yr LA student)
Principles, techniques, and continuity of design imagination in specific examples of altered environment, both public and private spaces. Historical analysis of cultural, ecological, legal, strategic, economic determinants in design solutions.

5265. HISTORY OF LANDSCAPE ARCHITECTURE: INDIVIDUAL INFLUENCES. (4 cr; 3rd-yr LA student) Neckar
Lectures, presentations, field trips, readings, and projects. Aesthetic and functional design principles related to use of plant materials in landscape. Historic and modern principles through design projects of various scales.

5562. INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS. (4 cr; prereq jr or sr or grad major in Geog or LA or #) Nassauer
Theory and applications for landscape location and resource analysis and regional planning. Location principles, data structure, variable attributes.

8110. GRADUATE LANDSCAPE PLANNING AND DESIGN. (6 cr; prereq 5101, 5103, 5015, or 5107, grad)
Studio experience in comprehensive landscape planning, or design project in area of student's choice.

8111. DIRECTED STUDIO IN LANDSCAPE ARCHITECTURE. (6 cr; prereq 5101, 5103, 5105, or 5107, grad)
Studio experience in comprehensive project execution in landscape planning, or design in area of instructor's specialty.

8281. RESEARCH ISSUES IN LANDSCAPE ARCHITECTURE. (2 cr; prereq MLA student or #; A-F only) Pitt
Definition of research areas in landscape architecture; review of current research projects in related fields; organization of bibliographic search in a selected area of interest.

8282. RESEARCH ANALYSIS METHODS IN LANDSCAPE ARCHITECTURE. (2 cr; prereq 8281 or #; A-F only) Nassauer
Case study analysis of methods in specific research projects. Definition of appropriate research process methods; research project proposal formulation.

8283. RESEARCH PROPOSALS IN LANDSCAPE ARCHITECTURE. (2 cr; prereq 8282 or #; A-F only)
Analysis of research project approaches in terms of central problem and sub-problem definition; clarity of hypotheses; evaluation of specific research method options. Research activity chart organization; evaluation of data analysis methods and conclusions; evaluation of hypotheses.

8310. THEORETICAL FOUNDATIONS OF LANDSCAPE ARCHITECTURE. (2 cr; prereq MLA student or #) Condon
Research on theoretical base of discipline of landscape architecture in historic, present, and future terms. Comparisons with theoretical base of related disciplines, and between the discipline and the profession of landscape architecture.

8330. CONCEPTS OF LANDSCAPE EVALUATION. (2 cr; prereq 8108, MLA student or #)
Studies in philosophical bases for and wide-ranging approaches to evaluating qualitative aspects of landscape. Emphasis on aesthetic factors.

8350. SMALL COMMUNITY PLANNING AND THE CONSERVATION OF NATURAL RESOURCES. (2 cr; prereq MLA student or #)
Examination of small community planning processes in rural America, their impact on natural resource use, and identification of opportunities for conserving resources in the small community development process.

8370. URBAN OPEN SPACE PRESERVATION AND REGENERATION. (2 cr; prereq MLA student or #)
Search for effective methods of urban open space preservation; exploration of research methods, technical knowledge areas, and policies necessary for quality regeneration and renewal.

8390. DESIGNING THE LONG-TERM LANDSCAPE. (2 cr; prereq MLA student or #)
Problems of designing landscapes that must sustain their integrity over generations or centuries. Survey of historical examples. Design theory, principles, and strategies.

8500. LANDSCAPE ARCHITECTURE RESEARCH PROJECT. (1-6 cr; prereq 8283 or #; A-F only)

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.

Latin

See Classical and Near Eastern Studies.

Law

See American Legal Institutions.

Linguistics (Ling)

Professor: Michael B. Kac, *chair, director of graduate studies;* Gerald A. Sanders

Associate Professor: Bruce T. Downing; Jeanette K. Gundel; Kathleen Houlihan; Larry G. Hutchinson; Rocky V. Miranda; Amy L. Sheldon; Joseph P. Stemberger; Nancy J. Stenson; Elaine E. Tarone

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—Students may specialize in any subfield of theoretical or applied linguistics. All Ph.D. students must pass preliminary written examinations in phonology, syntax, and historical linguistics.

Prerequisites for Admission—For the master's program, at least one course in each of the following areas is required: phonetics, phonology, syntax, and historical linguistics. These requirements can be satisfied after admission.

For the doctoral program, students are ordinarily required to complete the M.A. degree before being considered for admission. In exceptional cases, a student will be allowed to bypass the M.A. and enter the Ph.D. program at the end of the first year of study if performance in coursework and on the Qualifying Examination (see Degree Program Prerequisites below) is sufficiently promising.

Special Application Requirements—Applicants must submit scores from the Graduate Record Examination and complete a supplementary questionnaire detailing background, interests, and accomplishments.

Degree Program Prerequisites—All students are required to take a written Qualifying Examination that, in conjunction with all other information regarding performance in the program, determines their eligibility to continue in the program. The examination must be taken at the end of the first year of study or, if that is not possible, at the next administration of the examination.

Master's Degree Requirements—For Plan A, the following courses are required: 5011, 5202, 5206, 5303, 5304, 5602, 5711, 5712 or 8510, and one additional course approved by the adviser. For Plan B, the following courses are required: 5011, 5202, 5206, 5211, 5303, 5304, 5602, 5711, 5712 or 8510, and two additional courses approved by the adviser. Students in both plans must take a final oral examination.

Doctoral Degree Requirements—Students are expected to complete a broad course of study including work in phonology, syntax, and historical linguistics beyond that required for the master's program. The Ph.D. program must include the following: 5211, if not completed for the M.A. degree; 5691 or 8841; three topics courses, representing at least two areas (topics courses include 8200, 8300, and 8600, although other 8xxx courses may,

with the permission of the director of graduate studies, be used toward satisfaction of this requirement); two 8xxx seminars; 5712, if not taken for the M.A. degree, or 8510 applied to a language different from that studied in the course taken for the M.A. degree, or a course approved as equivalent by the director of graduate studies; and additional courses approved by the adviser.

All Ph.D. students must pass a written examination and write a dissertation prospectus forming the basis for the preliminary oral examination.

Language Requirements—For the M.A. degree, proficiency in one language not native to the student as demonstrated through an examination approved by the director of graduate studies is required. For the Ph.D. degree, proficiency in two languages not native to the student as demonstrated through an examination approved by the director of graduate studies is required.

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—Contact the Department of Linguistics, 142 Klaeber Court, University of Minnesota, 320 16th Avenue S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5001. INTRODUCTION TO LINGUISTICS. (5 cr, §3001, §3005; 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 #)
Techniques for analyzing phonological, morphological, and syntactic data from a wide variety of languages; discovering, stating, and justifying generalizations; comparison of diverse languages.

5003. APPLIED PHONETICS. (5 cr, §3301, §5301; not open to linguistics majors; prereq 5001 or ¶5001 or #)
Primarily for teachers of English as a second language.

5006. EXPERIMENTAL PHONETICS. (4 cr; prereq 3301 or 5301 or #)
Physiological and instrumental studies of speech. Laboratory projects.

5008. TOPICS IN EXPERIMENTAL PHONETICS. (4 cr; prereq 5006 or #)

5011-5012-5013. MATHEMATICAL LINGUISTICS. (4 cr per qtr; prereq linguistics major or #)
The propositional and first-order predicate calculi; nonclassical logics; set theory; axiomatics; algebra; grammar; automata theory.

5101. LANGUAGE TYPES AND LINGUISTIC UNIVERSALS. (4 cr; prereq 3001 or 5001 or #)
Comparison of languages and language types; cross-linguistic similarities and universals of language, and their explanation.

5201-5202. INTRODUCTION TO SYNTAX. (4 cr per qtr; prereq 3001 or 5001 or #)
5201: Principles of grammar construction and evaluation; examination of syntactic phenomena in a variety of languages. 5202: Survey of modern syntactic theory.

5206. ADVANCED SYNTAX. (4 cr; prereq 5202, 5302 or #)
The nature of syntactic argumentation; validation and comparison of theories, models, and analyses.

5211. SEMANTICS. (4 cr; prereq 5011, 5202 or #)
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 #)
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 #)
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 #)
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.

5304. ADVANCED PHONOLOGY. (4 cr; prereq 5201, 5303 or #)
The nature of phonological argumentation; validation and comparison of theories, models, and analyses.

5401-5402. COMPUTATIONAL LINGUISTICS. (4 cr per qtr; prereq 3001 or 5001 or CSci 3107 or CSci 5101 for 5401, 3001 or 5001 and knowledge of LISP or Prolog for 5402, or #)
5401: Methods and issues in computer processing of natural language. LISP and Prolog programming languages. Case studies of implemented systems. (Does not require computer use.) 5402: Implementation of natural language understanding systems in LISP and Prolog. Laboratory projects.

5503. INTRODUCTION TO APPLIED LINGUISTICS. (4 cr; prereq 3001 or 3005 or 5001 or #)
The 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, §3601; prereq 3001 or 5001 or #)
Processes of language change in phonology, syntax, and semantics; linguistic reconstruction; origin of language; language families; development of writing.

5602, 5603. LANGUAGE CHANGE AND LINGUISTIC RECONSTRUCTION. (4 cr per qtr; prereq 3601 or 5601, 5201, 5302 or #)
Nature of phonological and syntactic change; internal and comparative approaches to linguistic reconstruction.

5605-5606. INDO-EUROPEAN LINGUISTICS. (4 cr per qtr; prereq 3601 or 5601 or #)
Reconstruction of Proto-Indo-European phonology, morphology, and syntax. Developments in major Indo-European languages.

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. CONTRASTIVE LINGUISTICS. (4 cr; prereq 5002, or 5201 and 5302, or 5003 or #)
Comparison of related sets of data in different languages; implications for linguistic theory and foreign language learning.

5702. SECOND-LANGUAGE ACQUISITION. (4 cr; prereq 3001 or 5001, 5002 or 5201 and 5302, 5701 or ¶5701 or #)
Empirical and theoretical studies of second language acquisition and processing.

5705su. INTRODUCTION TO ENGLISH AS A SECOND LANGUAGE. (5 cr; not open to ESL majors)
Current issues in teaching English as a second language; grammatical, phonological, and lexical systems of English; testing and evaluation; classroom applications to skills of listening, speaking, reading, writing; and evaluation of instructional materials. Lectures and discussion sessions.

5711-5712. FIELD METHODS IN LINGUISTICS. (4 cr per qtr; prereq 5202, 5303 or #)
Techniques for obtaining and analyzing linguistic data from unfamiliar languages through direct interaction with a native speaker.

5721. ENGLISH AS A SECOND LANGUAGE: METHODS. (4 cr; prereq 3001 or 5001 or #)
Linguistics applied to teaching of English as a second language.

5722. ENGLISH AS A SECOND LANGUAGE: PRACTICUM. (4 cr; S-N only; prereq major or minor in ESL, 5721, #)
Observation of and practice in teaching English as a second language.

5723. ENGLISH AS A SECOND LANGUAGE: MATERIALS. (3 cr; prereq 5721, 5722, #)
Application of linguistics to evaluation and preparation of materials for teaching of English as a second language.

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 #)
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.

5805. PSYCHOLINGUISTICS. (4 cr; prereq 5002, or 5201 and 5302, or #)
Empirical and theoretical studies of language acquisition and processing.

5806. FIRST LANGUAGE ACQUISITION. (4 cr; prereq 5002, or 5201 and 5302, or #)
Survey of empirical and theoretical studies of first language acquisition.

5811. INTRODUCTION TO LANGUAGE VARIATION. (4 cr; prereq 3001 or 5001 or #)
Basic issues in language variation: regional and social determinants of variation, multilingual speakers and their societies, language planning.

5821. SOCIOLINGUISTICS. (4 cr; prereq 3001 or 5001 or #)
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, #, △, CLA approval)

8200. TOPICS IN SYNTAX AND SEMANTICS. (4 cr [may be repeated for cr as topics change]; prereq 5206 or #)

8210. SEMINAR IN SYNTAX. (4 cr; prereq 5206, 5211 or #)

8211. FORMAL SEMANTICS OF NATURAL LANGUAGE. (4 cr; prereq 5011 or Phil 5201 or #)
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 #)

8300. TOPICS IN PHONOLOGY. (4 cr [may be repeated for cr as topics change]; prereq 5304 or #)

8310. SEMINAR IN PHONOLOGY. (4 cr; prereq 5304, 5602 or #)

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 #)

8610. SEMINAR IN HISTORICAL LINGUISTICS. (4 cr; prereq 5202, 5303, 5603 or #)

8703. LANGUAGE UNIVERSALS AND LANGUAGE ACQUISITION. (4 cr; prereq #)
Survey of research on language universals as they apply to research primarily in second language acquisition.

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.

8751. ENGLISH FOR SPECIAL PURPOSES. (4 cr; prereq 5741 and 5742, or #)
Critical review of the literature. Investigation of types of English used in fields such as engineering, nursing, and business.

8800. EXPERIMENTAL RESEARCH. (4 cr; prereq research proposal and #; 8731 recommended)
Directed research; open to graduate students involved in language-related experimental research.

8810. SEMINAR IN PSYCHOLINGUISTICS. (4 cr; prereq 5805 or #)

8820. TOPICS IN LANGUAGE AND COGNITION. (4 cr; prereq 5001 or #)
Language-related issues in cognitive science from linguistic perspective.

8841, 8842. PHILOSOPHY OF LINGUISTICS. (4 cr per qtr; prereq 5011, 5202, 5303, Phil 5601 or #)
Nature of scientific explanations and theories; philosophical positions within linguistics.

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.

Marketing Education

See Vocational and Technical Education.

Mass Communication

Professor: Walter H. Brovald; Roy E. Carter; Irving E. Fang; Donald M. Gillmor; John M. Lavine; MaryAnn Yodelis Smith; Phillip J. Tichenor; Daniel B. Wackman; Jean W. Ward; Donald E. Wells

Associate Professor: Donald L. Breneman; Hazel F. Dicken-Garcia; Ronald J. Faber; Theodore L. Glasser; Kathleen A. Hansen; Chin Chuan Lee; Nancy L. Roberts; Lawrence C. Soley

Assistant Professor: John C. Busterna; Robert L. Craig; Albert C. Gunther; Dona B. Schwartz; Albert R. Tims, Jr.

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 master's programs are offered. The general M.A. program focuses on the theoretical study of mass communication and emphasizes analysis of media systems. Students completing the general program are particularly suited for careers in communication, policy, research, or teaching at the community college level; they may also wish to pursue further graduate study. The professional M.A. program provides preparation for careers in the print and broadcast media, advertising, visual communication, and certain specialty areas such as

science journalism and media management. These degree programs combine general study in mass communication with professional skills courses. Although there may be exceptions, the general M.A. program usually follows Plan A; the professional program, Plan B.

The doctoral program offers training for academic careers in communication, research, or communication 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 Media Management and Economics Resource Center, the Silha Center for the Study of Media Ethics and Law, the Eric Sevareid Library, and the SJMC Research Division.

Prerequisites for Admission—The minimum requirement for admission is the B.A. or equivalent.

Special Application Requirements—In addition to Graduate School requirements, a departmental application, letters of recommendation, and scores from the General (Aptitude) Test of the Graduate Record Examination (GRE) are required. For students whose native language is not English, TOEFL scores, but not GRE and MAT scores, are required.

Prerequisites for Graduate Study—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 attempt to satisfy 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 (Grad 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.

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 (Grad 8888). 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 will be 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 Further Information—Detailed information about graduate programs and procedures is sent out in response to letters of inquiry. Write to the director of graduate studies, School of Journalism and Mass Communication, 111 Murphy Hall, University of Minnesota, 206 Church Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Journalism and Mass Communication (Jour)

5131.* INTERPRETIVE REPORTING. (4 cr; prereq 3121 or 3173 or 5155 or 5144, △) Glasser, Roberts, Tichenor, Ward
Advanced problems in reporting about government, politics, social problems, and the arts.

5133.* INTERPRETIVE REPORTING ABOUT SCIENCE. (4 cr; prereq 3121 or #, △) Tichenor
Role of journalistic communication in science; scientist-journalist relationships; communicating results of scientific investigations to public, specialized audiences, and industry.

5141.* OPINION WRITING IN AMERICA. (4 cr; prereq 3xxx writing course, major or grad status for professional journalism students with #, △; offered when feasible) Carter
Oral and written analysis of major political, economic, and social developments. Persuasive communication in newspapers and magazines; columnists; commentators.

5142.* INTERPRETATION OF CONTEMPORARY AFFAIRS. (4 cr; prereq sr, journalism major; offered when feasible)
Major economic developments and their social and political impacts; editorial and interpretative articles.

5143.* INTERPRETATION OF SCIENCE AND TECHNOLOGY. (4 cr; prereq 5133 or #, △) Tichenor
Analysis of scientific research and technological development for mass and specialized media; critical study of science content in media; audience impact.

5144.* URBAN JOURNALISM. (4 cr; prereq 3121 or grad student or professional experience with #, △; offered when feasible)
Urban problems and mass media role and performance, specialized reporting and commentary on urban media policy, news gathering techniques; analyasis of media content; reporting projects and appropriate readings.

5155.* ADVANCED REPORTING METHODS. (4 cr; prereq 3101 or grad student or professional experience with #, △)
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 3159, professional journalism major or #, △)
Case study approach to application of public relations principles in solution of problems in business, government, education, and community. For sharpening perceptions, insights, and judgments in examining practical and ethical questions.

5171.* ARTS REVIEWING. (4 cr; prereq 3xxx writing course, major or grad status for professional journalism students, #, △)
Book, theatre, visual media reviews. Analysis of leading critics and critical periodicals. Weekly reviews.

5174.* MAGAZINE EDITING AND PRODUCTION. (4 cr; prereq 3173 or 5302 or 5322, #, △)
Writing, editing, illustration, design, layout, photocomposition of a single-issue magazine.

5182.* SUPERVISION OF SCHOOL PUBLICATIONS. (4 cr; prereq professional journalism major status or #, △)
Emphasis on editorial content, staff organization, editing, typography, makeup, and business management for those who plan to advise high school or college newspapers, yearbooks, magazines.

5184.* MASS MEDIA AND THE CLASSROOM. (6 cr; prereq journalism major, #, △; offered when feasible)
Introduction to process of education with applications to mass media study. Interaction with leading media personalities; experimentation with video, sound print, and film production in developing individual and group messages; exposure to most recent materials.

5221.* PUBLICATION GRAPHICS. (4 cr; prereq 8 cr in 3xxx or 5xxx courses in art and design or #)
Role of printing processes in graphic communication. Technique and production of illustration. Significant developments in graphic arts technology.

5233.* GRAPHIC DESIGN ANALYSIS. (4 cr; prereq 3321 or #, △) Craig
Publication formats for design and efficiency; historical and current trends; field projects; creative problems.

5251.* PSYCHOLOGY OF ADVERTISING. (4 cr; prereq Psy 1001) 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.

5252.* PSYCHOLOGY OF CREATIVITY IN ADVERTISING. (4 cr; prereq 5251 or Psy 5751; offered when feasible)
Theories, mechanisms, and correlates of creativity. Theoretical, experimental, and pragmatically derived "explanations" and examples are considered and applied in supervised practicum sessions.

5261.* ADVERTISING: MEDIA ANALYSIS. (4 cr; prereq professional journalism major, 3201 or #, △) Soley
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 AND MEDIA STRATEGY. (4 cr; prereq professional journalism major status, 5261, Mktg 3000, or # and △) Busterna
Relation of campaign strategy to media measurement, evaluation, and planning. Coordination of advertising campaigns; media scheduling and purchasing.

5272. ADVANCED ADVERTISING COPYWRITING. (4 cr; prereq 3241, #, △)
Formulating creative strategy and writing advertising copy for print and broadcast media.

5274.* SOCIAL, ECONOMIC, AND REGULATORY ASPECTS OF ADVERTISING. (4 cr; prereq sr or grad status, △) Busterna
Advertising as an institution. Social and economic criticism. Ethics. Regulation and self-regulation.

5302.* ADVANCED PHOTOGRAPHIC COMMUNICATION. (4 cr; prereq 3301, △) Schwartz
Codes in photographic communication. Producing photographs for publication contexts. Color theory. Examination of important photographers. (Film, processing expenses.)

5303.* PROJECTS IN PHOTOGRAPHIC COMMUNICATION. (4 cr; prereq 5302, △) Schwartz
Advanced projects in documentary photography; structuring visual narratives. Comparison of exhibition/publication formats. History, ideology approaches to documentary photography. (Film, processing expenses.)

5316.* THEORIES OF VISUAL COMMUNICATION. (4 cr) 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.

5322.* NEWSPAPER DESIGN. (4 cr; prereq professional journalism major or #, △; offered when feasible) Brovald
Elements of newspaper design; historical survey of newspaper makeup; use of typography, photography, hand art to create visual and verbal communication; legibility studies; experimental formats.

5323. PUBLICATION DESIGN. (4 cr; prereq professional journalism major or #, △; offered when feasible) Brovald
Elements of small publication design; survey of magazine layout and design; use of typography, photography, hand art, and color to create visual and verbal communication; legibility studies; experimental formats.

5342.* ADVANCED CINEMATOGRAPHY. (4 cr; prereq professional journalism major, 3341 or #, △; offered when feasible)
Directed projects in planning, shooting, and editing silent and sound film. Creative production. Lectures, laboratory work, field experience.

5441.* ELECTRONIC NEWS GATHERING. (4 cr; prereq 3451 or 5302, △; 2 lect, 3 lab, 3 news production hrs per wk) Fang
Theory and practice of effective communication with video as applied to broadcast journalism. Lectures, demonstrations, and exercises in planning, lighting, shooting, editing, and scripting typical broadcast news assignments. Analysis of theory and research on social impact of electronic journalism.

5442.* ADVANCED TELEVISION NEWS. (4 cr; prereq 3451, △; 2 lect, 3 lab, and 3 news production hrs per wk) Fang
Newsfilm editing; preparing and delivering television newscasts. Current problems; legal and ethical considerations.

5444.* TELEVISION AND RADIO DOCUMENTARY. (4 cr; prereq 3451 or 5302 or 5174, △; 2 hrs lect per wk, field and lab hrs as needed) Fang
Scope and techniques. Production of television or radio news documentaries of broadcast quality.

5501.* COMMUNICATION AND PUBLIC OPINION I. (4 cr; prereq 16 cr in social science depts) Carter, Lee, Tichenor, Tims, Wackman
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 5501 or Soc 5355) Carter, Gunther, Lee, Tichenor, Wackman
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 12 cr in social or behavioral sciences, # for upper div undergrads; preference given to Jour grad students and to MPH and MS students in PubH and epidemiology)
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) 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.

5603.* TOPICS IN HISTORY OF JOURNALISM. (4 cr; prereq 5601, △; offered when feasible) Dicken-Garcia, Roberts
Intensive study of significant movements, organizations, individuals, and media in U.S. Individual research projects.

5606.* LITERARY ASPECTS OF JOURNALISM. (4 cr; prereq #, △; offered alt yrs) 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) 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.

5614.* HISTORY OF MASS COMMUNICATION TECHNOLOGY. (4 cr) Fang, Schwartz
History of the instruments of mass communication; how they work; their impact on our lives.

5615.* HISTORY OF VISUAL COMMUNICATION IN THE MASS MEDIA. (4 cr) Schwartz
Social history of photography, film, and video. Informational, documentary, and entertainment functions of visual communication. Organizational structures, visual styles, and audiences.

5721.* MASS MEDIA IN A DYNAMIC SOCIETY. (4 cr; prereq 16 cr in social science depts) Gillmor, Glasser, Ward
Economic, political, and social determinants of character and content of mass communication in America. Impact, structure, functioning of mass media. Problems, prospects, and criticism. Professionalism, technology, and reform.

5725.* THE MANAGEMENT OF MEDIA ORGANIZATIONS. (4 cr; prereq 16 cr in social science depts, △) Lavine, Wackman
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 16 cr in social science depts, #, △; 5725 recommended) Lavine, Wackman
How media managers make decisions dealing with money, marketing, product, personnel, and production information. Interaction between quality, price, service, and the limits of technology.

5731.* CURRENT COMMUNICATIONS PROBLEMS. (4 cr; prereq 16 cr in social science depts, #, △) Dicken-Garcia, Gillmor, Glasser
Individual project and seminar method of analysis of major contemporary problems of communication, both descriptive and normative.

5731H.* HONORS COURSE: CURRENT COMMUNICATIONS PROBLEMS. (4 cr; 16 cr in social science depts, #, △) Busterna, Dicken-Garcia, Gillmor, Glasser, Hansen, Roberts
For description, see 5731.

5777.* CONTEMPORARY PROBLEMS IN FREEDOM OF SPEECH AND PRESS. (4 cr; prereq 16 cr in social science depts) Gillmor, Glasser
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 16 cr in social science depts) Carter, Lee
Global telecommunications, channels, and artifacts of international mass communication. Problems in the free flow of information. Roles of international organizations, journalism. Mass communication in social, political, educational, economic development; implications for conflict resolution.

5825.* WORLD COMMUNICATION SYSTEMS. (4 cr; prereq 16 cr in social science depts)
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.

5826.* MASS COMMUNICATION SYSTEMS OF WESTERN EUROPE. (4 cr; prereq 16 cr in social science depts)
Implications of mass media and telecommunications, analyzed as to historical origins, contemporary sociocultural issues, and the roles of mass communication in Western European and international affairs.

5970.* ADVANCED PROJECTS IN JOURNALISM. (1-8 cr; prereq major status for professional journalism or mass communication students, B avg, #, △, □)
Individual research.

5970H.* HONORS COURSE: ADVANCED PROJECTS IN JOURNALISM. (1-8 cr; prereq major status for professional journalism or mass communication students, B avg, #, △, □)

5990.* SPECIAL TOPICS IN MASS COMMUNICATION. (4 cr per qtr [max 8 cr]; prereq major status for professional journalism or mass communication students, #, △)
Topics announced in *Class Schedule*.

8000. CONTEMPORARY STUDIES IN MASS COMMUNICATION. (1 cr per qtr; prereq consent of adviser; offered when feasible)
Survey and scope of current studies in mass media effects, advertising, international communications, history of mass communications, and mass media and social institutions. New developments in mass communications theory.

8001.* SEMINAR: MASS COMMUNICATION RESEARCH. (4 cr; prereq introductory course in statistics or ¶, #, △) Carter, Gunther, Tichenor, Tims, Wackman
Principles and perspectives; documentary research methods; problems in measurement of attitudes and opinions; current methodology; theoretical concepts in mass communication.

8101.* PERSPECTIVES ON MASS COMMUNICATION. (4 cr) Glasser, Tichenor, Ward
Introduction to mass communication scholarship through examination of major communication theories, analysis of media institutions, and overview of mass communication as a field of study.

8102.* MASS COMMUNICATION RESEARCH IN ACTION. (4 cr; for MA students only) Busterna, Glasser, Tims
Introduction to purposes and practices of mass communication research through examination of research methods and findings that bear on contemporary issues and problems faced by communication professionals.

8510 (formerly 8002).* SEMINAR: MASS COMMUNICATION RESEARCH. (4 cr; prereq introductory statistics course or ¶, #, △)
Principles and perspectives; documentary research methods; problems in measurement of attitudes and opinions; analysis of current methodology; theoretical concepts in mass communication.

8513.* SEMINAR: MASS COMMUNICATION RESEARCH. (4 cr per qtr; prereq 8510 or #) Schwartz
Research practicum; individual projects; problems in measurement of media content, attitudes, and opinions; current methodology; application of theoretical concepts in mass communication.

8516.* SEMINAR: COMMUNICATION ANALYSIS. (4 cr; prereq course in statistics, #) Carter, Lee, Soley, Tichenor
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.

8560 (formerly 8601).* SEMINAR: HISTORY OF MASS COMMUNICATION. (4 cr; prereq 5601, #, △) Dicken- Garcia, Roberts
Major historical literature in mass communication; development of a research project.

8580 (formerly 8801).* SEMINAR: PROBLEMS IN INTERNATIONAL COMMUNICATION RESEARCH. (4 cr; prereq 5801 or 5825 or #) Carter, Lee
Research strategies and designs relating to late 20th-century telecommunications and mass communication, with emphasis on comparative and cross-cultural analysis and Third World developmental concerns.

8620 (formerly 8211).* SEMINAR: ADVERTISING RESEARCH. (4 cr) Faber, Wackman
Advertising as persuasive communication. Application of research findings and techniques of related social sciences to the advertising decision-making process. Comparison of quantitative and qualitative techniques. Survey of new developments in creative media and market research.

8630 (formerly 8317).* SEMINAR IN VISUAL COMMUNICATION. (4 cr; prereq 5316 or #, △) Craig, Schwartz
Research in visual communication. Theoretical approaches, analysis of research methodologies.

8640 (formerly 8442).* 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 (formerly 8514).* SEMINAR: MASS COMMUNICATION THEORY. (4 cr; prereq 5531, #, △) Carter, Faber, Lee, Wackman
Research concepts and findings that offer promise for development of a general theory of mass communication. Emphasis on empirical studies that throw light on problems of professional journalists in trying to communicate more effectively through mass media.

8651 (formerly 8515).* SEMINAR: COMMUNICATION ANALYSIS. (4 cr; prereq statistics course, #) 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 (formerly 8531).* SEMINAR: PUBLIC OPINION AND PROPAGANDA. (4 cr; prereq 5531, #, △; offered when feasible) Carter, Tims
Theoretical bases of public opinion and propaganda, developing literature.

8660 (formerly 8602).* SEMINAR: HISTORY OF MASS COMMUNICATION. (4 cr; prereq 5601, #, △)
Research in history and development of U.S. mass media.

8661 (formerly 8603).* SEMINAR: HISTORY OF MASS COMMUNICATION. (4 cr; prereq 5601, #, △)
Documentary research in history and development of mass media in U.S.

8662 (formerly 8606).* SEMINAR: LITERARY ASPECTS OF JOURNALISM. (4 cr; prereq 5606, #, △) Roberts
Research in literary aspects of journalism exemplified in careers and works of English and American writers.

8663 (formerly 8611).* SEMINAR: DEVELOPMENT OF AMERICAN BROADCASTING. (4 cr; prereq 5611) Fang
Analysis of problems related to history and social, political, economic, and cultural patterns and characteristics of broadcasting in U.S.

8670, 8671, 8672 (formerly 8721, 8722, 8723).* COMMUNICATION AGENCIES AS SOCIAL INSTITUTIONS. (4 cr per qtr; prereq 5721 or equiv or #, △) Gillmor, Glasser, Tims, Ward
Influence and effects of mass communication, internal dynamics of media organizations, criticism and modes of reform. Theoretical frameworks for analysis.

8673 (formerly 8725).* SEMINAR: MEDIA MANAGEMENT. (4 cr; prereq #, △; 5725 or 5726 recommended) Wackman
Management issues in media organizations; relation to dynamics of organization structure, employees, markets, and economics/finances.

8677 (formerly 8776).* GOVERNMENT AND MASS COMMUNICATION: ADMINISTRATIVE LAW. (4 cr; prereq 5777 or #, △) Busterna, Gillmor, Glasser
Broadcast regulation, regulation of advertising, antitrust enforcement. Individual research projects examining administrative process.

8678 (formerly 8778).* GOVERNMENT AND MASS COMMUNICATION: CONSTITUTIONAL LAW. (4 cr; prereq 5777 or #, △) Gillmor, Glasser
Problems of constitutional and tort law affecting press and theories that underlie them.

8679 (formerly 8779).* GOVERNMENT AND MASS COMMUNICATION. (4 cr; prereq 5777, #, △; offered when feasible)
Research tutorial.

8680 (formerly 8824).* SEMINAR: INTERNATIONAL MASS COMMUNICATION. (4 cr; prereq 5801 or 5825 or 5826, reading knowledge of foreign language; offered when feasible)

8681, 8682 (formerly 8825, 8826).* SEMINAR: INTERNATIONAL MASS COMMUNICATION. (4 cr per qtr; prereq 8580 and 5801 or 5825 or #) Carter, Gunther, Lee
Main problems and currents of international mass communication. Focus on policy, conceptual, and research elements relevant to global development applications, including issues of freedom and constraint, media technology, and role of journalism in world affairs.

8683 (formerly 8828).* MASS COMMUNICATION PROBLEMS OF DEVELOPING COUNTRIES. (4 cr; prereq 8681 or 8682 or #) Carter, Lee
Analysis of factors—political, cultural, economic—affecting development of mass communication systems on behalf of Third World aspirations.

8684 (formerly 8831).* SEMINAR: INTERNATIONAL BROADCASTING AND WORLD AFFAIRS. (4 cr; prereq , 5801 or 5825 or #; offered when feasible)
Broadcast media and their relevance to diplomacy, regional and global development, and contemporary issues in transfer of news, information, and entertainment materials. Attempts by U.N., I.T.U., and other international and regional bodies to establish standards for satellite communications.

8970.* ADVANCED PROJECTS IN MASS COMMUNICATION. (1-4 cr per qtr [max 8 cr]; prereq grad major or minor in mass communication, #, △)
Individual research.

8990.* SPECIAL PROBLEMS IN MASS COMMUNICATION. (4 cr per qtr; prereq #, △)
Special topics for seminars.

Mathematics (Math)

Regents Professor: Lawrence Markus; James B. Serrin, Jr.

Professor: Richard McGehee, *head;* Eugene B. Fabes, *associate head;* Naresh Jain, *director of graduate studies;* Alfred Aeppli; Donald G. Aronson; John Baxter; Thomas Berger; Maury D. Bramson; John A. Eagon; Robert Ellis; Jerald L. Ericksen; Eugene B. Fabes; Avner Friedman; Bert Fristedt; Steven A. Gaal; Paul B. Garrett; J. Gil de Lamadrid; Jay Goldman; Lawrence F. Gray; Leon W. Green; Robert D. Gulliver, II; Robert M. Hardt; Morton Harris; Dennis Hejhal; Ettore F. Infante; Donald W. Kahn; Carlos E. Kenig; Harvey Keynes; David Kinderlehrer; Walter Littman; Warren S. Loud; Mitchell B. Luskin; Albert Marden; Charles McCarthy; William Messing; Norman G. Meyers; Willard Miller, Jr.; Wei-Ming Ni; Johannes C. C. Nitsche; Peter J. Olver; Steven Orey; William F. Pohl; Marian B. Pour-El; Karel Prikry; William E. Pruitt; Edgar Reich; Peter A. Rejto; J. Ian Richards; Joel Roberts; David Sattinger; George R. Sell; Yasutaka Sibuya; Steven I. Sperber; Dennis W. Stanton; Marvin L. Stein; David A. Storvick; Sidney Webster; Hans F. Weinberger; Dennis E. White

Associate Professor: Stephen B. Agard; Greg W. Anderson; George Brauer; Jack F. Conn; Paul H. Edelman; Mark Feshbach; David Frank; E. Gebhard Fuhrken; Lisl N. Gaal; Hillel Gershenson; Laurence Harper; Howard Jenkins; Max A. Jodeit, Jr.; James T. Joichi; William E. Lang; Chester L. Miracle; Richard Moeckel; Wayne Richter; Warren B. Stenberg; Charlotte T. Striebel; James E. Thompson

Assistant Professor: Bernardo Cockburn; Georgia Triantafillou

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

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 a three-quarter sequence in either analysis or abstract algebra, are required.

Students entering with a bachelor's degree are usually 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 strongly recommended (particularly for applicants seeking financial aid) but not required.

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, of which at least 8 credits must be in a related field outside of mathematics. 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-level mathematics sequence is required under each plan; additional 8xxx-level coursework may be required depending on the student's program. A final oral examination is required.

For further information, see the *Graduate Studies in Mathematics* publication.

Doctoral Degree Requirements—The written preliminary examination, given twice each year, covers basic analysis, basic algebra, and basic point set topology. Students may take this examination on entry and should ordinarily pass the examination during their second year. All teaching assistants and fellowship students are required to take this examination at each opportunity until they pass. 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 three times a year—in September, December, and June. It consists of four parts, weighted equally, that examine the following: real and complex analysis; algebra or topology or geometry; the thesis area; and the minor or supporting program. Students normally take this examination before their fourth year, how early 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 pre-

requisites, or one of the following sequences: 5282-5283-5284, 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—Contact the director of graduate studies, School of Mathematics, 127 Vincent Hall, University of Minnesota, 206 Church Street S.E., Minneapolis, MN 55455.

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 in math."

Since topics courses are all offered 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, means offered regularly, but not annually, and not necessarily every other year.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5005, 5006, 5007. THE DIVERSITY OF MATHEMATICS. (4 cr; prereq Elem Ed student, 1005-1006 or equiv and 10 more cr of univ math; does not carry grad cr in math)
Topics indicative of broad scope and aesthetic structure of mathematics, which can play an enrichment role in elementary schools. 5005: number theory, including prime numbers and congruences, and fractions and decimals. 5006: polyhedra, map coloring, analytic geometry, finite arithmetics and geometries, and projective geometry. 5007: theory of area, probability, mathematical games, combinatorics, and graph theory.

5056. THEORY OF INTEREST. (4 cr; prereq 1231 or equiv; does not carry grad cr in math)
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. ACTUARIAL SCIENCE PRINCIPLES—LIFE CONTINGENCIES I. (4 cr; prereq 1231, 1 qtr of probability or statistics; does not carry grad cr in math)
Single life functions: measurement of mortality, life annuity premiums, life insurance premiums, policy reserves, expense margins, and special topics.

5058. ACTUARIAL SCIENCE PRINCIPLES—LIFE CONTINGENCIES II. (4 cr; prereq 5057; does not carry grad cr in math)
Continuation of 5057. Multiple life functions: multiple-decrement function (tables) and tables with secondary decrements. Generalized models. Relationships involving compound contingent functions defined and used with forces of interest.

5081. FUNDAMENTAL TOPICS IN ANALYSIS. (4 cr; prereq 3531 or 3211 or 3213 or 3421; does not carry grad cr for math majors)
Limits; uses of a deep property of the real numbers; correct uses of term "infinity"; possibly other topics. Proofs by mathematical induction and by contradiction.

5082. FUNDAMENTALS OF ALGEBRA. (4 cr; prereq 3511 or 3142 or 3221 or equiv; does not carry grad cr in math)
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 3511 or 3211 and 3221 or 3142 or equiv; does not carry grad cr in math)
One non-Euclidean geometry, including attention to the axiomatic approach; some topic involving three or more dimensions; some use of transformations; possibly other topics. Proofs by mathematical induction and by contradiction.

5085. TOPICS IN THE FOUNDATIONS OF PRE-COLLEGE MATHEMATICS. (1-6 cr [no 5xxx-level cr for math majors]; prereq 3211 or equiv or #; does not carry grad cr in math)
Mathematical background for introducing new topics and techniques at pre-college level. Problem solving, discrete structures, numerical methods, linear algebra with geometry, geometry, topics in calculus, and probability/statistics.

5151. ELEMENTARY SET THEORY. (4 cr; prereq 3211 or equiv or #; does not carry grad cr in math)
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, §5162; prereq 3211 or equiv or #; does not carry grad cr in math)
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 3211 and 3142, or 3211 and 3221, or 3213 or 3421 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 3211 or equiv or #; does not carry grad cr in math)
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, §5262 or §5282 if content was linear algebra, §5264, §5284; prereq 3142 or 3221 or 3213 or 3421 or equiv or #; does not carry grad cr in math)
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, §5262 or §5282 if content was linear algebra, §5264, §5284; prereq 3142 or 3221 or 3213 or 3421 or equiv; does not carry grad cr in math)
Systems of linear equations, finite dimensional linear spaces, bases, linear transformations, matrices, determinants, eigenvalues, reduction to canonical forms, quadratic and bilinear forms, applications.

5244. GROUP THEORY. (4 cr per qtr, §5262, §5282; prereq 3142 or 3221 or 3213 or 3421 or equiv or #; does not carry grad cr in math)
Permutation groups, groups related to geometrical configuration; invariant subgroups, Jordan-Hölder composition theorem, Sylow groups, Abelian groups, elementary divisors, applications.

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.

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. DIFFERENTIAL GEOMETRY. (4 cr; prereq 3211 or 3421 or 3531 or equiv or #)
Plane and space curves, Frenet formulas, elementary theory of surfaces.

5376-5377. DIFFERENTIAL GEOMETRY. (4 cr per qtr; prereq 5375, 1 qtr linear algebra)
Differential forms. Advanced theory of surfaces, integral geometry, Riemannian geometry.

5404. VARIATIONAL PROBLEMS. (4 cr; prereq 3211 and 3066, or 3211 and 3221, or 3213 or 3421 or equiv or #; offered when feasible)
Introduction to the calculus of variations and its applications. Topics include fundamental theory, Euler-Lagrange equations, necessary and sufficient conditions, stability, isoperimetric problems, rudiments of the Mayer-Lagrange-Bolza problem, multiplier rule, direct methods, Rayleigh-Ritz method, eigenvalue problems, multiple integrals.

5427. APPLIED MATHEMATICS FOR THE LIFE SCIENCES. (4 cr; prereq 3066 and 3142, or 3211 and 3221, or 3213 or 3421 or equiv; offered when feasible; does not carry grad cr in math)
Mathematical tools useful in deterministic models arising in life sciences. Linear systems of difference and differential equations. Stability of nonlinear systems, including linearization techniques and Liapunov theory. Examples from demography, population ecology, and population genetics.

5428. MATHEMATICAL MODELS IN ECONOMICS AND THE SOCIAL, ACTUARIAL, AND MANAGEMENT SCIENCES. (4 cr; prereq 3211 and 3066 and 3142, or 3211 and 3221, or 3213 or 3421 or equiv or #)
Some mathematical models and associated mathematical techniques for describing behavior of and for optimizing various systems. How to find a model to fit a given situation.

5441. MATHEMATICAL THEORY OF FLUID FLOW. (4 cr; prereq 5568 or 5572 or equiv or #; offered when feasible)
General equations of fluid mechanics. Thermodynamics. Classical constitutive equations. Specialization to various subfields of fluid mechanics, including hydrostatics, barotropic perfect fluids, gas dynamics, and viscous flow theory. Examples of exact solutions.

5447-5448-5449. MATHEMATICAL THERMODYNAMICS. (4 cr per qtr; primarily for math majors interested in applications, engineers, scientists; prereq 3066 and 5601, or 5613, or 5567 and 5568, or #; offered when feasible)
5447-5448: A careful introduction to mathematical structures underlying classical thermodynamics. Concepts of heat, hotness, and material systems, rigorous formulation of laws of thermodynamics, general accumulation theorem, absolute temperature, Carnot cycles (and efficiency of heat engines). Applications to reversible and distributed systems, concept of entropy. 5449: Equilibrium of thermal systems. Gibbsian equilibrium theory and phase rule; applications to mixtures and phase transitions. Mechanical theory of equilibrium. Thermodynamics of irreversible processes; theory of quasi-ideal systems and continuous systems. Clausius-Duhem inequality.

5457-5458-5459. METHODS OF APPLIED MATHEMATICS. (4 cr per qtr; prereq 3211-3212-3213 or 3511-3521-3531 or equiv; does not carry grad cr in math)
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.

5473-5474-5475. ANALYSIS OF NUMERICAL METHODS. (4 cr per qtr; prereq 3211 and 3142 or 3213 or 3421 or equiv for 5473, 5473 for 5474, 5474 for 5475)
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 5567 or 5571 or equiv)
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. DIFFERENTIAL EQUATIONS WITH APPLICATIONS. (4 cr; prereq 3211 and 3066, or 3211 and 3221, or equiv or #; does not carry grad cr in math)
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. DIFFERENTIAL EQUATIONS WITH APPLICATIONS. (4 cr; prereq 5512; does not carry grad cr in math)
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 5512, or 3221 and 5601, or 3066 and 5601, or 3213 or 3421 or equiv; does not carry grad cr in math)
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.

5567. FOURIER SERIES AND BOUNDARY VALUE PROBLEMS. (4 cr, §5571; prereq 3211 and 3066, or 3211 and 3221, or 3213 or 3421 or equiv or #; does not carry grad cr in math)
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, §5572; prereq 3231 or 5602, or equiv vector analysis course)
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; does not carry grad cr in math)
Laplace transforms, Fourier transforms, inversion theorems; applications to differential equations.

5571-5572-5573. ELEMENTARY PARTIAL DIFFERENTIAL EQUATIONS. (4 cr per qtr, §5568 for 5572, 5573; prereq 5603 or 5613)
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.

5578-5579. COMPLEX ANALYSIS AND ITS APPLICATIONS. (4 cr per qtr, §5572; prereq 3231 or 5602 or 3531 or equiv course in vector analysis; offered when feasible)
Expanded version of 5568, with more material in both analytic function theory and applications to physics, engineering, and other areas of mathematics. Topics include additional material on conformal mappings, Riemann theta function, and fluid flows.

5601-5602. ADVANCED CALCULUS. (4 cr per qtr; prereq 3211 or equiv or #; does not carry grad cr in math)
5601: Differentiation of functions of several variables; vector algebra; curves in three dimensions; directional derivative and gradient, inverse transformation and implicit function theorems; change of variables in multiple integrals. 5602: Line and surface integrals; Stokes's theorem; convergence of infinite series; orthogonal functions; uniform convergence; integration and differentiation of series.

5606-5607-5608. ADVANCED CALCULUS: A RIGOROUS APPROACH. (4 cr; prereq 3211-3212-3213 or 3511-3521-3531 or 3411-3431)
Basic analysis course at 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 students planning grad work in mathematics, and as preparation for grad courses in analysis; prereq one soph-level sequence or #)
Theory of real numbers; elements of point set theory; limits; differentiation; multivariable analysis.

5679. PROBABILITY. (4 cr, §5681; prereq 3211 or equiv or #; does not carry grad cr in math)
Elementary principles of probability, total and compound probability, expectation, repeated trials, and topics chosen from the following: Stirling formula, the probability integral, geometrical probability, probability of causes, Bayes's theorem, errors of observation, principle of least squares.

5681-5682-5683. INTRODUCTION TO PROBABILITY. (4 cr per qtr; prereq 3531 or 3421 or two 5xxx math courses or Stat 5133 or #)
Logical development and various applications of probability. Probability spaces, random variables, central limit theorem; Markov chains.

5701. ENUMERATIVE COMBINATORICS. (4 cr; prereq 3211 or equiv, 3rd-yr standing, soph-level linear algebra is helpful)
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 3211 or equiv, 3rd-yr standing; soph-level linear algebra helpful)
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 or equiv, some knowledge of programming 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.

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, S^m_n-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, data base 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 (Lowenhein-Skolem theorems, compactness theorems, etc.); characterization of classes (EC, PC, etc.); preservation of properties under algebraic constructions; ultraproducts; special kinds of structures (homogeneous, saturated, etc.); applications to classical branches of mathematics.

8181-8182-8183. FORMAL LANGUAGES AND AUTOMATA. (3 cr per qtr; prereq 5162, ¶5163, ¶5164; offered when feasible)
Theory of computability, finite automata theory, algorithmic languages, formal aspects of the organization of abstract and actual machines.

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 and #; 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 when feasible)
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)
Abelian categories, injective and projective resolutions, homology, Ext and Tor, universal coefficient theorems, spectral sequences.

8211-8212. COMMUTATIVE ALGEBRA. (3 cr per qtr; prereq 8202 or #; offered when feasible)
Noetherian and Artinian rings, localization, flatness, completion, dimension, and depth.

8245-8246-8247. GROUP THEORY. (3 cr per qtr; prereq 8202 or #; offered when feasible)
Topics include the 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, and 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 #)
Axiomatic homology theory; various homology and cohomology theories; introduction to homotopy theory.

8321-8322-8323. HOMOTOPY THEORY. (3 cr per qtr; prereq 5342 or #; offered when feasible)
Review of singular homology and cohomology, homotopy of mappings, extension and retraction, classification of maps of the circle into the circle, fundamental groups, Hurewicz's theorem, fiber spaces, cross sections, homotopy groups, homotopy groups of special spaces, obstruction theory, homotopy groups of spheres, fundamental theorems of Morse theory.

8330-8331-8332. DIFFERENTIAL TOPOLOGY. (3 cr per qtr; prereq 5342 or #; offered when feasible)
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)
General theory of transformation groups, algebraic theory of minimal sets, structure theorems, flows induced by vector fields, symbolic flows.

8351-8352-8353. GLOBAL ANALYSIS. (3 cr per qtr; prereq 5284, 5342, 5614 or #; offered when feasible)
Smooth manifolds and their maps. Vector bundles, forms, and the global theory of differential operators. Introduction to infinite-dimensional manifolds.

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 and 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 covered vary from year to year.

8470-8471-8472. TOPICS IN THE MATHEMATICAL THEORY OF CONTINUUM MECHANICS. (1-3 cr; prereq 5573 or #)
Topics covered vary from year to year.

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.

8530-8531-8532. TOPICS IN CONTROL THEORY. (3 cr per qtr; prereq grad course in differential equations or control theory or #; offered alt yrs)
Summary of qualitative control theory for ordinary differential systems. Introduction to control of partial differential systems, differential-delay systems, and other functional systems. Introduction to game theory with recent developments in differential games.

8540-8541-8542. TOPICS IN DIFFERENTIAL AND DIFFERENCE EQUATIONS. (1-3 cr per qtr; 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)
Euler's equation, differentiability theorems, necessary conditions of Legendre and Weierstrass, isoperimetric problems. Theory of fields, Hamilton-Jacobi theory. Sufficiency theorems, direct methods, local behavior of extremals. Local and global properties of minimal surfaces, Plateau's problem.

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; H^p 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 and 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 #) Edelman, Joichi, White
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.

8680-8681-8682. ERGODIC THEORY. (3 cr per qtr; prereq 8602; offered when feasible)
Concepts of ergodic theory; mixing conditions; norm and almost everywhere ergodic theorems; entropy, recent developments.

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.

8735-8736-8737. RIEMANN SURFACES. (3 cr per qtr; prereq 8702 or #; offered when feasible)
Heuristic introduction. Abstract definition of Riemann surface. Examples. Topology of two-dimensional manifolds. Existence and properties of harmonic functions. Generalized Riemann mapping theorems and the fundamental polygon. Introduction to classification theory. Method of extremal length. Theory of differentials. Existence of meromorphic functions. Special case of closed surfaces.

8780-8781-8782. TOPICS IN SEVERAL COMPLEX VARIABLES. (1-3 cr per qtr; prereq #)

8790-8791-8792. TOPICS IN THE THEORY OF ANALYTIC FUNCTIONS. (1-3 cr per qtr; prereq 8702 or #)

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.

8880-8881-8882. TOPICS IN OPERATOR THEORY. (1-3 cr per qtr; prereq 8702, 8602 or #)
Linear ordinary differential equations, initial and boundary value problems; linear integral equations, semigroup theory, dynamical systems. Functional analytic methods and necessary Banach space and measure theory material.

8990-8991-8992. READING AND RESEARCH. (Cr ar)

Mathematics Education

See Curriculum and Instruction.

Mechanical Engineering and Industrial Engineering

Regents' Professor: Ernst R. G. Eckert (emeritus)

Professor: Richard J. Goldstein, *head;* Darrell A. Frohrib, *director of graduate studies;* Sant Ram Arora; Perry L. Blackshear; Arthur G. Erdman; Edward A. Fletcher; Warren E. Ibele; David B. Kittelson; Tarald O. Kvalseth; Jack L. Lewis; Benjamin Y. H. Liu; Virgil A. Marple; Thomas E. Murphy; Katsuhiko Ogata; Suhas V. Patankar; Emil Pfender; Subbiah Ramalingam; James W. Ramsey; Donald R. Riley; Ephraim M. Sparrow

Associate Professor: Max Donath; Barney E. Klamecki; Thomas H. Kuehn; Peter H. McMurry; David Y. H. Pui; Charles J. Scott; Terrence W. Simon; Patrick J. Starr; Kim A. Stelson; Kumar K. Tamma

Assistant Professor: Diana D. Brehob; Thomas R. Chase; Norman A. Decker; Kevin J. Dooley; Steven L. Girshick; Homayoon Kazerooni; Hae Ok Lee; Nicholas J. Zabaras

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.

The *Productivity Center* facilities are organized into four laboratories: the Computer Graphics and Computer Aided Design Lab, the Robotics and Sensors Lab, the Intelligent Manufacturing Machines and Systems Lab, and the Computer Aided Manufacturing/Manufacturing Sciences Lab. Computational facilities include a VAX 11/780, a wide variety of minicomputers and microcomputers both for instruction and research, plus access to the University Cyber and DEC VAX 8600 mainframes and the Minnesota Supercomputer Center supercomputers through high-speed network communication links. Graphics support is provided by Apollo Silicon Graphics, IBM PC/AT and RT/PC, and Evans and Sutherland PS300 engineering workstations. A Lambda LMII lisp machine provides advanced support for artificial intelligence and expert systems related research.

Prerequisites for Admission—An undergraduate degree in engineering or in a closely related scientific field such as physics, chemistry, or mathematics, is re-

quired. Unusually well-qualified students may be admitted directly to the Ph.D. program with a baccalaureate degree.

Special Application Requirements—Athough test scores are not required, they 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.

Master's Degree Requirements—For the M.S. degree, students are required to complete two credits of graduate seminars. The final examination is oral. For the M.M.E. and M.I.E. degree, 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—Contact the director of graduate studies, Mechanical and Industrial Engineering, 125 Mechanical Engineering, University of Minnesota, 111 Church Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Mechanical Engineering (ME)

Graduate Credit Courses for Nonmajors

5190. ADVANCED ENGINEERING PROBLEMS. (2-4 cr; open to upper division students; prereq approved deptl 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 division mechanical engineering major, 3201-3203-3205 and 3303 and 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; 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, computer programming desirable, IT or grad student)
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 utilizing 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 3rd-yr ME courses and FORTRAN programming; 3 lect and 1 rec hrs per wk)
Application of computer-aided design techniques to engineering design. Engineering design projects/case studies utilizing 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.

5230. ACOUSTICS AND VIBRATION LABORATORY. (2 cr; prereq ME upper div student, 3701, 3702, 3201)
Transducers and signal conditioning for acoustic and vibration measurement; sinusoidal, impulse, and stochastic identification techniques; modal analyzers, comparison of analytical and experimental modal results.

5231. MECHATRONICS LABORATORY. (2 cr; prereq ME upper div student, 3701, 3702, 3201)
Computer control of servomechanisms; motor and mechanical drive component types and selection; power electronics; microprocessors and programmable controllers; digital control; position, force, and velocity measurement; performance prediction and testing techniques.

5232. FLUID POWER CONTROL LABORATORY. (2 cr; prereq ME upper div student, 3701, 3702, 3201, AEM 3200)
Selection of components for fluid power control systems; closed-loop control system design for force, velocity, and position control; performance prediction and testing techniques.

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.* COMPUTER-AIDED MANUFACTURING: ROBOTICS. (4 cr; prereq 5260 and 5283 or equiv, IT major)
Analysis and design of computer-controlled systems used in the manufacturing environment. Numerical control (NC) systems design. Robotics; multijointed manipulator dynamics and control. Sensor feedback and adaptive control.

5272.* COMPUTER-AIDED MANUFACTURING: AUTOMATION. (4 cr; prereq 5271 or equiv, IT major)
Continuation of 5271. Additional topics include automatic inspection and assembly techniques; mathematics of image processing as applied to inspection and robot tracking problem; group technology, parts classification, and manufacturing cell.

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. Controlability and observability. Introduction to optimal control and adaptive control.

5285. CONTROL SYSTEMS LABORATORY. (2 cr; prereq IT major, 5283 or equiv)
Experiments designed to 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.

8225. FINITE ELEMENT ANALYSIS: LARGE STRAIN APPLICATION. (4 cr; prereq 5225 or equiv, IT grad)
Finite element analysis of elasticity and plasticity with large strains, material nonlinearity, and incompressibility. Such topics as fracture mechanics, composite materials, mechanics of rotating body, metal forming. Student projects involve program development and/or utilization of general purpose finite element codes.

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).

8243.* PHOTOELASTICITY. (3 cr; prereq 5207)
Stress by photoelasticity. Stress patterns. Frozen stresses. Solution of individual problems.

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.

8282.* FEEDBACK CONTROL SYSTEMS. (3 cr; prereq 5284, Math 5572 or ¶Math 5572)
Stability analysis of nonlinear control systems. Optimization of multistage decision processes by dynamic programming techniques. Optimal control of deterministic and stochastic systems. Optimal filtering and estimation. Selected topics associated with recent advances in control theory.

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.

5266. MATERIAL FINISHING PROCESSES. (4 cr; prereq 5260, IT or grad student; 3 lect and 1 rec hrs per wk)
Theory and practice of metal removal and finishing including mechanical, chemical, and electrolytical methods. Techniques of surface preparation, plating, abrasive and chemical cleansing, coatings and films.

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

5330. HEAT TRANSFER LABORATORY. (2 cr; prereq 5342, ME upper div student)
Measurement and analysis of various modes of heat transfer: conduction, natural and forced convection, radiation. Heat transfer analog, temperature measurement, study of heat transfer in representative engineering systems.

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., furnances and ovens, HVAC systems, solar energy utilization, 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, etc. Isentropic flow in variable area passages. One-dimensional discontinuities. Flow with wall friction, heat transfer, 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)
Heat transfer in laminar and turbulent boundary layer and duct flow. Free convection. Condensation and evaporation. Convective mass transfer.

8332.* RADIATION. (3 cr; prereq 5342)
Heat radiation of black bodies and nonblack bodies. Radiation between surfaces and through participating media.

8333.* ADVANCED THEORY OF HEAT TRANSFER. (3 cr; prereq 5342)
Analytical treatment of problems of convection that reflect present knowledge. Boundary layer and pipe flow solutions and associated mathematical techniques. Heat exchangers and techniques for enhancing heat transfer.

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.

8350.* ADVANCED THERMODYNAMICS OF FLUID FLOW. (3 cr; prereq 5344, 8310 or #)
Mechanism of thermodynamic actions in fluids. Irreversible effects related to viscosity, heat transfer, diffusion, and chemical reaction. Flow of reactive gas mixtures. Reaction rates and their effects.

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.

8353. COMPUTATION OF BOUNDARY LAYER FLOWS. (3 cr; prereq 8351 or #)
Finite-difference methods for solution of boundary layer equations. Use of a computer program for two-dimensional boundary layers. Wall boundary layers, jets and wakes, flows in pipes, annuli, nozzles and diffusers.

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 meterallurgy; 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

5430. INTERNAL COMBUSTION ENGINE PERFORMANCE LABORATORY. (2 cr; prereq CE 3400 or AEM 3200, 3701, 3702, 5460, ME upper div; formerly ME 5703, 5704, 5705 lab sects P-1, P-2)
Measurement of performance and emissions from both gasoline and diesel internal combustion engines for range of engine operating conditions.

5432. STEAM POWER LABORATORY. (2 cr; prereq CE 3400 or AEM 3200, 3303, 3701, 3702, ME upper div; formerly ME 5703, 5704, 5705 lab sects P-5, P-6)
Analysis of thermodynamic variables that affect performance of steam turbine-vapor power cycle as function of cycle and configuration changes.

5433. COMPRESSOR, COMBUSTOR, AND TURBINE LABORATORY. (2 cr; prereq CE 3400 or AEM 3200, 3303, 3701, 3702, ME upper div; formerly ME 5703, 5704, 5705 lab sects P-3, P-4)
Measurement of efficiency of three types of compressors and two types of turbines. Analysis of combuster-driven turbines for exhaust composition and combustion efficiency.

5442.* VAPOR CYCLE POWER SYSTEMS. (3-5 cr [1-2 cr term paper option]; prereq 3303, IT or grad student; 3 lect hrs per wk)
Vapor cycle analysis, regeneration, reheat, compound cycle modifications, combined gas turbine-vapor cycle systems, binary systems. New energy sources—e.g., solar, geothermal, nuclear.

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. Combustion thermodynamics

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. (3-5 cr [1-2 cr term paper option]; prereq 5460, IT or grad student; 3 lect hrs per wk)
Hydrocarbon fuels, octane and cetane ratings, additives and deposits; lubrication systems, lubricants, additives for control of friction; air and liquid coolings; engine design problems.

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 student or grad, 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.

8442.* ADVANCED POWER PLANTS. (3 cr; prereq 5442 or equiv)
Individual projects dealing with various aspects of advanced vapor cycles and associated energy sources.

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.

8450.* DYNAMICS OF HIGH SPEED ENGINES. (3 cr; prereq 3205, 5460) Murphy
Inertia forces; balancing high speed engines; engine torque analysis; torsional vibration. Conferences, assigned readings, and problems.

8453.* ADVANCED GAS TURBINES AND JET PROPULSION. (3 cr; prereq 5462)
Gas turbines and ramjets for aircraft; performance, control, nozzles, azial and centrifugal compressors, and turbines; cooling, lubrication, and construction. Conferences, assigned readings, and problems.

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.

5607. CONTAMINATION CONTROL ENGINEERING. (4 cr; prereq 3303 and CE 3400 or equiv, IT or grad student)
Ventilation, hoods, duct system design, fans, clean rooms; noise transmission and control in HVAC systems; control of gaseous emissions by absorption, adsorption, combustion.

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.

5612. ENVIRONMENTAL ENGINEERING. (4 cr; prereq upper div IT or grad student; 4 lect hrs per wk)
Basic principles of engineering assessment and control of emissions to air and water, noise measurement and control, handling and disposal of solid waste.

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.

5630. THERMAL ENVIRONMENTAL ENGINEERING SENIOR LABORATORY. (2 cr; prereq ME upper div student, 3701, 3702, 5603 or ¶5603; formerly 5703, 5704, 5705 lab sects E-1, E-2)
Experiments on such topics as psychometrics, refrigeration, air-conditioning, and solar energy as related to refrigeration and building heating and cooling.

8600.* PSYCHOMETRICS AND AIR CONDITIONING. (3 cr; prereq 5603; 3 lect hrs per wk)
Moist air properties, psychometry 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. (3 cr; prereq 5613, 5614 or #)
Kinetic theory applications to aerosol systems, including free molecules and transition regime treatments of condensation, thermophoresis, diffusiophoresis, photophoresis, and electrical charge transport; analytical and numerical solutions to the coagulation equation; homogeneous nucleation theory; particle sampling and transport; filtration.

General

5402. ECOLOGY, TECHNOLOGY, AND SOCIETY. (4 cr, §SSci 3402; prereq IT or grad student; 4 lect hrs per wk)
Examination of dilemmas resulting from conflicts between finite limits and population and industrial growth; underlying causes in terms of current technology, values, economics, institutions, and political structures; possible directions for resolution. Faculty from various disciplines participate.

5403. ECOLOGY, TECHNOLOGY, AND SOCIETY. (4 cr, §SSci 5403; prereq IT or grad student; 3 lect hrs per wk)
Military technology related to problems of life support, major dilemmas of economic growth and control of technology, ethical problems faced by engineers, factors in transition to a sustainable society.

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.

5721. PROPULSIVE SYSTEMS FOR SURFACE TRANSPORTATION. (4 cr; prereq 3301 recommended, IT or grad student)
Characteristics of electrical and mechanical propulsive devices and energy storage systems available for use in various types of surface transport vehicles viewed against a background of information related to worldwide energy sources, environmental implications of transport propulsive devices, power requirements, and thermodynamic constraints.

5741-5742. INDUSTRIAL ASSIGNMENT AND DESIGN PROJECT. (4 cr per qtr; prereq 3742 for 5741, 5741 for 5742)
Solution of system design problems requiring development of criteria, evaluation of alternatives, and generation of preliminary design. Final report emphasizes design communication and describes design decision process, analysis and final recommendations.

8485-8486-8487. BIOMEDICAL ENGINEERING SEMINAR. (1-3 cr per qtr) Institute of Technology and Medical School faculties
(Same as Surg 8204-8205-8206) Lectures, demonstrations, and individual research activities designed to introduce graduate students and faculty of mechanical engineering and surgery to techniques and goals of the two disciplines.

8770-8771-8772. MECHANICAL ENGINEERING RESEARCH. (Cr ar; prereq △)

8773-8774-8775. GRADUATE SEMINAR. (1 cr per qtr; for grad students and staff members)
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 are treated 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 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.

5180, 5181. APPLIED INDUSTRIAL ENGINEERING. (3-5 cr per qtr [1-2 cr term paper option]; prereq 3000, 5010, 5020, 5030, 5040, △)
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; 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 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 from quarter to quarter.

5480. MAN-MACHINE SYSTEMS. (4 cr; prereq 5070 or #, IT or grad student; 3 lect and 1 rec-lab hrs per wk)
Applications of mathematical methods for development of quantitative descriptions and models of human performance with relevance to engineering design of man-machine systems. Information processing, control, and decision making.

5531.* INDUSTRIAL SAMPLING TECHNIQUES. (4 cr; prereq 5030, ME 3900, IT or grad student; 3 lect and 1 rec hrs per wk)
In-depth coverage of industrial sampling plans. Single, double, and multiple sampling plans; sequential, continuous, and variable sampling plans; life testing plans; administrative and economic considerations.

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; prereq sr or grad in IT or equiv)
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)
Linear programming and the simplex method, geometry of linear programming, duality theory and its simplifications, variants of the simplex algorithm, decomposition principle, game theory and network flows.

8430.* NONLINEAR PROGRAMMING. (3 cr; prereq 5040 or #; offered when feasible)
Theory of convex sets and functions, Kuhn-Tucker theorems, duality theorems, quadratic programming, complementary pivot theory, pivotal methods of nonlinear programming: feasible direction, gradient and penalty methods of search.

8440.* DYNAMIC PROGRAMMING. (3 cr; prereq 5505 or #; offered when feasible)
Functional equations and principle of optimality, theory of dynamic programming, computational aspects of dynamic programming, discrete deterministic problems with nonsequential and sequential optimization, discrete problems with random future, discrete dynamic problems in finite Markov chains.

8450.* QUEUING THEORY. (3 cr; prereq 5442 or #; offered when feasible)
Discrete and continuous time Markov chains, stationary stochastic processes, Markovian queues, renewal processes, scheduling problems.

8460.* STOCHASTIC PROGRAMMING. (3 cr; prereq 8420, 8430 or #; offered when feasible)
Markov decisions, chance-constrained linear and nonlinear programming, maximum principle—discrete and continuous version. Application of stochastic programming to design of production systems and distribution networks, traffic controls; budgeting and investments.

8470.* ADVANCED INVENTORY AND PRODUCTION CONTROL. (3 cr; prereq 5361 or #; offered when feasible)
Design of production facilities, inventory policies for single and multiple items, multiechelon inventory systems, scheduling problems, role and design of information systems in production.

8773-8774-8775. GRADUATE SEMINAR. (1 cr per qtr; S-N grading only)
Presentation and discussion of recent developments in industrial engineering and operations research.

Mechanics

See Aerospace Engineering and Mechanics.

Medicinal Chemistry (MedC)

Professor: Yusuf J. Abul-Hajj, *head;* Patrick E. Hanna, *director of graduate studies;* Herbert T. Nagasawa; Philip S. Portoghese; Wayne T. Shier; Emil J. Staba; Robert Vince

Associate Professor: Rodney L. Johnson

Assistant Professor: Simon M. N. Efange; Terry P. Lybrand; Rory P. Remmel

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; and pharmaceutical cell systems (plant, animal, and microbial).

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 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.

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 (12 credits), biochemistry (12 credits), and medicinal chemistry (16-18 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.

Minor Requirements for Students Majoring in Other Fields—Requirements include an introductory course (5600), advanced medicinal chemistry courses (8114, 8116, 8500, 8600, and 8700).

For Further Information—Contact the director of graduate studies, Department of Medicinal Chemistry, College of Pharmacy, Health Sciences Unit F, University of Minnesota, 308 Harvard Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5200. THE NEW DRUG DEVELOPMENT PROCESS. (1 cr)
New drug development process in U.S. pharmaceutical industry.

5320. 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.

5330. THERAPEUTIC AGENTS II. (2 cr, §MChP 5330; prereq BioC 5001)
See 5320 for description.

5340. THERAPEUTIC AGENTS III. (3 cr, §MChP 5340; prereq BioC 5001)
See 5320 for description.

5350. THERAPEUTIC AGENTS IV. (4 cr, §MChP 5350; prereq BioC 5001)
See 5320 for description.

5495. VISTAS IN MEDICINAL CHEMISTRY RESEARCH. (1 cr) Staff
Selected topics of contemporary interest in pharmaceutical sciences.

5600. GENERAL PRINCIPLES OF MEDICINAL CHEMISTRY. (4 cr; prereq Phcl 1009, BioC 5001 or #) Portoghese, staff
General principles of drug design and molecular bases of recognition at receptors.

5810s. MEDICINAL PLANTS. (2 cr; prereq #) Staba
Survey of biologic, biochemical, and economic features of natural drugs and their constituents, emphasizing drugs from higher plants.

5812w. MEDICINAL PLANT TISSUE CULTURE SYSTEMS. (2 cr, §Phcg 5812; prereq #; offered alt yrs) Staba
Cell, tissue, and organ plant *in vitro* systems employed to produce medicinals. Emphasis on multiliter systems and production methods and basic research required to make them effective systems of production.

8100.* MEDICINAL CHEMISTRY SEMINAR. (Cr ar; required of all majors in medicinal chemistry) Staff

8114f. NATURAL TOXINS. (2 cr, §Phcg 8114; prereq #; offered alt yrs) Shier
Structures and mechanisms of action of natural toxins of plant, animal, and microbial origin. Roles of natural toxins as drugs; as experimental probes in biochemistry, pharmacology, and pathology; and in establishment of animal models of human disease.

8116f. STEROID DRUGS. (2 cr, §Phcg 8116; prereq #; offered alt yrs) Abul-Hajj
Natural sources, chemistry, biosynthesis, actions, production, and therapeutic uses.

8200. SELECTED TOPICS. (1 cr per qtr) Staff
In-depth discussion of selected topics in medicinal chemistry.

8206w. OPIOID TOPICS. (1 cr; prereq #) Portoghese
Topics in opiate and opioid-related research. Offered jointly with Department of Pharmacology.

8300f. PHARMACEUTICAL CELL SYSTEMS. (4 cr, §Phcg 8300; prereq #; offered alt yrs) Staff
Laboratory exercises demonstrating uses of cellular techniques in production, biotransformation, and assay of antibiotics, steroids, alkaloids, growth regulators, and other useful compounds by microorganisms, tissue cultures, and extracellular enzyme preparations.

8500w. DESIGN OF CHEMOTHERAPEUTIC AGENTS. (3 cr; prereq MedC 5600 or #; offered alt yrs) Vince
Modern aspects of drug design, with emphasis of 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. (2 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) Johnson, staff
Current approaches to rational design of drugs.

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.

Microbial Ecology

Regents' Professor: Eville Gorham (ecology and behavioral biology)

Professor: Martin Dworkin (microbiology); Arnold Fredrickson (chemical engineering): Greg Germaine (dentistry, microbiology); Richard Hanson (microbiology); David McLaughlin (botany); Robert Megard (ecology and behavioral biology); Jean Molina (soil science); Philip Regal (ecology and behavioral biology); Palmer Rogers (microbiology); Edwin Schmidt (soil science, microbiology); Elwin Stewart (plant pathology); David Tilman (ecology and behavioral biology)

Assistant Professor: Randall Hicks (biology)

Course of Study—Minor in microbial ecology, applicable to either master's or doctoral programs.

Curriculum—Microbial ecology is an area of interdisciplinary research concerned with the relationships of microoganisms 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 is designed to encourage interdisciplinary interaction, communication, and synthesis.

Prerequisities for Admission—To be admitted to the minor program, a student must be admitted to the Graduate School and enrolled in a master's or doctoral program, should have broad training in the biological sciences, and must be accepted by the director of graduate studies of the microbial ecology minor. 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.

Special Application Requirements—Consult the director of graduate studies.

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 5106) 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 that are specific to the minor program.

For Further Information—Contact the director of graduate studies, Microbial Ecology Minor Program, 109 Zoology Building, University of Minnesota, 318 Church St. SE, Minneapolis, MN 55455.

Core Courses

EBB 5052. THEORETICAL POPULATION ECOLOGY

MicB 5106. ADVANCED GENERAL MICROBIOLOGY LABORATORY

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

CE 8506. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS

EBB 5031. EVOLUTION

EBB 5065. THEORETICAL EVOLUTIONARY ECOLOGY

EBB 5601. LIMNOLOGY

EBB 5608. ECOSYSTEMS: FORM AND FUNCTION

EBB 8602. ADVANCED LIMNOLOGY

MicB 5322. PHYSIOLOGY OF BACTERIA LABORATORY

PlPa 5105. INTRODUCTION TO THE STUDY OF FUNGI

PlPa 5106. MYCOLOGY: ASCOMYCETES—FUNGI IMPERFECTI

PlPa 8111. GENETICS OF PATHOGENS AND PLANT DISEASE

Soil 5515. SOIL DEVELOPMENT, CLASSIFICATION, AND GEOGRAPHY

Soil 8632. SOIL MICROBIOLOGY

Microbial Engineering

Professor: Yusuf Abul-Hajj (pharmacognosy); Edward Cussler (chemical engineering); Martin Dworkin (microbiology); Richard Estensen (laboratory medicine and pathology); David Fan (genetics, microbiology); Anthony Faras (microbiology); Arnold Fredrickson (chemical engineering); Richard Hanson (microbiology); Theodore Labuza (food science and nutrition); Larry McKay (food science and nutrition); Palmer Rogers (microbiology); Irwin Rubenstein (genetics and cell biology); Charles Schachtele (microbiology, dentistry); Wayne Shier (pharmacognosy); John Staba (pharmacognosy)

Associate Professor: Michael Flickinger (biochemistry), *director of graduate studies;* James Fuchs (biochemistry); Beulah Gray (microbiology); Bernard Reilly (microbiology, dentistry); Janet Schottel (biochemistry); James Zissler (microbiology)

Assistant Professor: Perry Hackett (genetics and cell biology); Susan Harlander (food science and nutrition); Wei-Shou Hu (chemical engineering); Friedrich Srienc (chemical engineering, materials science and engineering); Robert Vessella (microbiology, surgery)

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 designed to combine a depth of understanding of basic principles in basic 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. Applicants are encouraged to 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 basic laboratory course in advanced microbiology, molecular biology, or biofermentation. 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 will 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 languge 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—Contact the director of graduate studies, M.S. Program in Microbial Engineering, Institute for Advanced Studies in Biological Process Technology, 240 Gortner Laboratory, University of Minnesota, 1479 Gortner Avenue, St. Paul, MN 55108.

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 5002. TOPICS IN BIOCHEMISTRY. (3 cr; prereq Biol 5001)

BioC 5751-5752-5753. GENERAL BIOCHEMISTRY. (4 cr per qtr, §MdBc 5751-5752-5753; prereq 3 qtrs organic chemistry, 2 qtrs physical chemistry, 1 qtr biochemistry or #) Staff

BioC 8225. TRACER TECHNIQUES. (1-3 cr; prereq 5002 or 5751 or 5745 or MdBc 5750, #)

Biol 5003. GENETICS. (4 cr, §GCB 3022, §5022, prereq 5001)

ChEn 5001. COMPUTATIONAL METHODS IN CHEMICAL ENGINEERING AND MATERIALS SCIENCE. (4 cr; prereq chem engr or mat sci major)

ChEn 5101-5102-5103. PRINCIPLES OF CHEMICAL ENGINEERING. (4 cr per qtr; prereq 5001 or ¶5001, IT student)

ChEn 5104. UNIT OPERATIONS AND SEPARATION PROCESSES. (4 cr; prereq 5101)

ChEn 5751-5752-5753. BIOCHEMICAL ENGINEERING I, II, III. (3 cr per qtr; prereq #)

ChEn 5756. BIOCHEMICAL ENGINEERING LABORATORY. (2 cr; prereq 5751 or 5752)

FScN 5120. FOOD MICROBIOLOGY. (5 cr; prereq MicB 5105 or VPB 3103)

FScN 5123. MICROBIOLOGY OF FOOD FERMENTATIONS. (2 cr; prereq 5120 or #)

FScN 5135. FOOD ENGINEERING UNIT OPERATIONS. (5 cr; prereq 1102 or ¶1102, Math 1142, Phys 1042, Phys 1046)

FScN 5136. UNIT OPERATIONS LABORATORY. (2 cr; prereq 5135)

FScN 5555. FREEZING AND DEHYDRATION OF FOODS. (5 cr; prereq 3110, 5120, 5135, or #)

FScN 8323. MICROBIAL STARTER CULTURES. (3 cr; prereq 5123, Biol 5001 or #)

GCB 5031-5032. ADVANCED GENETICS. (4 cr per qtr; prereq 3022 or Biol 5003 and Biol 5001 or BioC 5751 or #)

MicB 5106. ADVANCED GENERAL MICROBIOLOGY LABORATORY. (3 cr; prereq 5105 or equiv)

MicB 5125. LABORATORY IN RECOMBINANT DNA TECHNOLOGY. (4 cr, §Biol 5125; prereq #)

MicB 5218. IMMUNOLOGY. (3 cr; prereq Biol 5001)

MicB 5232. MEDICAL MICROBIOLOGY. (3 cr; prereq 5105 or 3103 or 8110 or Biol 5013 and 5216 or 5218)

MicB 5321. PHYSIOLOGY OF BACTERIA. (3 cr; prereq 3103 or 5105 or Biol 5103 or VPB 3013, Biol 5001; 3 cr genetics)

MicB 5352. APPLIED MICROBIOLOGY. (4 cr; prereq 5321 or #)

MicB 5424. BIOLOGY OF VIRUSES. (4 cr; prereq 5321 or Biol 5001 or #)

MicB 5992. PRACTICUM: TEACHING. (1 cr; prereq #)

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 #)

MicB 8121. ADVANCED IMMUNOLOGY LABORATORY: MONOCLONAL ANTIBODY APPLICATIONS. (2 cr; prereq 5216 or equiv, #)

MicB 8216. FRONTIERS OF IMMUNOLOGY I: IMMUNOBIOLOGY, IMMUNOGENETICS. (3 cr; §Path 8216; prereq Biol 5001 or equiv, #)

MicB 8217. FRONTIERS OF IMMUNOLOGY II: MOLECULAR IMMUNOLOGY. (3 cr; §Path 8217; prereq Biol 5001 or equiv)

MicB 8218. FRONTIERS OF IMMUNOLOGY III: CLINICAL IMMUNOLOGY. (4 cr; §Path 8218; prereq 8216, 8217)

MicB 8910. SEMINAR. (1 cr; prereq #)

Phcg 8300. PHARMACEUTICAL CELL SYSTEMS. (4 cr; prereq #; offered alt yrs)

Microbiology (MicB)

Professor: Ashley T. Haase, *head;* Peter G. W. Plagemann, *director of graduate studies;* Arthur G. Johnson, *chair, Department of Microbiology, UMD*[1]; Dwight L. Anderson; P. Patrick Cleary; Martin Dworkin; John W. Eaton; David P. Fan; Anthony J. Faras; Gregory R. Germaine; Richard Hanson; Alan B. Hooper; Russell C. Johnson; M. Colin Jordan; Paul T. Magee; Larry L. McKay; Paul Quie; Palmer Rogers; Walter Sauerbier; Charles F. Schachtele

Associate Professor: Russell F. Bey; Michael C. Flickinger; Beulah H. Gray; Tucker W. LeBien; Omelan A. Lukasewycz[1]; Harry T. Orr; Bernard E. Reilly; Patrick Schlievert; Janet Schottel; Richard J. Ziegler[1]; James F. Zissler

Assistant Professor: Alice Adams[1]; Robert J. Brooker; Robert E. Click; Kathleen F. Conklin; Thomas Fitzgerald[1]; Donna Fontana; Florence K. Gleason; Dale S. Gregerson; Ronald R. W. Jemmerson; R. Scott McIvor; Robert D. Nelson; Richard W. Peluso; Stewart Scherer; Robert L. Vessella, Jr.; Lawrence P. Wackett; Carol L. Wells

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]

[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.*

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, 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.

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, a one- to two-page essay outlining a research problem and proposing its solution, 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, since the core curriculum begins in fall. Applications should be submitted by February 1; those received after that date will be 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 year 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 nine months prior to the completion of 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—Contact the Department of Microbiology, 1460 Mayo, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5105f,w,s.[1] **BIOLOGY OF MICROORGANISMS.** (5 cr, §3103, §Biol 5013; prereq 5 cr in biological sciences, Biol 5001 or #) Hanson
Lectures, demonstrations, and laboratory exercises in taxonomy, anatomy, physiology, biochemistry, and ecology of microbes. Some emphasis on molecular structure in relation to bacterial function.

5106f. ADVANCED GENERAL MICROBIOLOGY LABORATORY. (3 cr; prereq 5105 or equiv) Dworkin
Isolation from natural sources of a variety of microorganisms such as *Clostridium*, yeast, *Caulobacter*, *Myxobacteria*, *Leptospira*, photosynthetic bacteria, *Bdellovibrio*, luminescent bacteria, and others. Laboratory only.

5125s. LABORATORY IN RECOMBINANT DNA TECHNOLOGY. (4 cr, §Biol 5125; prereq #) Staff
Introduction to basic recombinant DNA techniques. Methods for growing, isolating, and purifying recombinant DNAs and cloning vectors.

5201f. MICROBIOLOGY FOR DENTAL STUDENTS. (7 cr) Anderson, Liljemark, Reilly
Nature and diversity of microoganisms; 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.

[1]*Microscope required. Students may obtain use of microscope by purchasing two $3 microscope cards from the bursar.*

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 laboratory.

5216f. IMMUNOLOGY. (4 cr; prereq Biol 5001) Gray
Nature of antigens and antibodies; chemical basis of serologic specificity; qualitative and quantitative aspects of antigen-antibody reactions; theories of antibody production; cellular antigens and blood grouping; nature of complement and its role in immunologic phenomena; mechanisms of hypersensitivity; hypersensitivity-like states and immunologic diseases; transplantation and tumor immunity; host-parasite interactions. Includes laboratory.

5218f. IMMUNOLOGY. (3 cr; Biol 5001) Gray
Same as 5216 without laboratory.

5225w. MICROBIOLOGY FOR MEDICAL STUDENTS. (3 cr; prereq microbiology grad student 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 diseases.

5226s. MICROBIOLOGY FOR MEDICAL STUDENTS. (3 cr; prereq microbiology grad student or #) Schlievert, staff
Continuation of 5225.

5232w. MEDICAL MICROBIOLOGY. (3 cr; not open to med students; prereq 5105 or 3103 or 8110 or Biol 5013 and 5216 or 5218) Cleary
Pathogenic bacteria and fungi; mechanisms of pathogenicity and virulence; properties of microoganisms and their animal hosts that influence the outcome of host-parasite relations analyzed from genetic and metabolic view.

5233f.[1] MICROORGANISMS AND DISEASE. (7 cr; prereq 10 cr in chemistry and 5 cr in biological sciences or #; not open to microbiology majors) Johnson
Lectures, demonstrations, and laboratory instruction on nature of microorganisms, immunology, medical bacteriology, virology, mycology, parasitology, and principles of disease control.

5234w.[1] MEDICAL MICROBIOLOGY LABORATORY. (2 cr; prereq 5232 or ¶5232) Cleary
Exercises designed to demonstrate the principles and techniques employed in the study of interactions between microorganisms and humans leading to a diseased state.

5235f. MICROORGANISMS AND DISEASE. (4 cr; prereq 10 cr in chemistry and 5 cr in biological sciences or #; not open to microbiology majors) Johnson
Same as 5233 without laboratory.

5321w. PHYSIOLOGY OF BACTERIA. (3 cr; prereq 3103 or 5105 or Biol 5013 or VPB 3103; Biol 5001; 10 cr organic chemistry; 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.

5322w. PHYSIOLOGY OF BACTERIA LABORATORY. (2 cr; prereq 5321 or ¶5321 and a lab course in basic bacteriology) Rogers
Techniques employed in study of bacterial physiology and metabolism.

5352s. APPLIED MICROBIOLOGY. (4 cr; prereq 5321 or #) Flickinger, Hanson
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.

5355s. GENETIC AND MOLECULAR ASPECTS OF BIOTECHNOLOGY. (3 cr; prereq 5105 or equiv, 5321; offered when feasible)
Principles and practices of techniques and procedures employed in new biotechnology. Genetic engineering, recombinant DNA technology, and production of monoclonal antibodies.

5424s. BIOLOGY OF VIRUSES. (4 cr; prereq 5321 or Biol 5001 or #) 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. Includes laboratory.

5900f,w,s. TOPICS IN MICROBIOLOGY. (1 cr; open to microbiology undergrad majors; S-N only) Rogers
Seminars on research programs, historical perspectives, significant emerging fields, professional societies and publications, and career opportunities.

5992f,w,s,su. PRACTICUM: TEACHING. (1 cr; prereq #) Staff
Supervised experience in laboratory instruction: development of skills in effective use of instructional materials, tests and measurement.

[1]*Microscope required. Students may obtain use of microscope by purchasing two $3 microscope cards from the bursar.*

8110f. STRUCTURE, FUNCTION, AND METABOLISM OF BACTERIA. (3 cr; prereq beginning microbiol, 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.

8112f. MICROBIAL GENETICS. (3 cr; prereq #) Scherer, Zissler
Lecture and discussion in molecular genetics.

8121f. ADVANCED IMMUNOLOGY LABORATORY: MONOCLONAL ANTIBODY APPLICATIONS. (2 cr; prereq 5216 or equiv, #) Vessella
Familiarizes students with theory, generation, and application of monoclonal antibodies. Emphasis on "hands on" laboratory with supporting lectures. Students completing course will be able to design and perform experimental protocols using monoclonal antibodies.

8125. MICROBIAL DEVELOPMENT. (3 cr; prereq coursework in microbiol and cell biol and biochem or #) Fontana
Cell-cell interactions that regulate development of biological systems.

8216f. FRONTIERS OF IMMUNOLOGY I: IMMUNOBIOLOGY, IMMUNOGENETICS. (3 cr, §Path 8216; prereq Biol 5001 or equiv, #) Segall
Overview of B-cell/T-cell interactions, major histocompatibility complex, cell surface markers, B-cell development and responses, negative regulatory mechanism, T-cell responses, tolerance, PMNs, and macrophages.

8217. FRONTIERS OF IMMUNOLOGY II: MOLECULAR IMMUNOLOGY. (3 cr, §Path 8217; 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.

8218. FRONTIERS OF IMMUNOLOGY III: CLINICAL IMMUNOLOGY. (4 cr, §Path 8218; prereq 8216, 8217) Gray
Antibody-mediated hypersensitivity, cellular hypersensitivity, autoimmunity, transplantation, tumor immunology, immunocytology, immune deficiencies.

8242f,w,s. DIAGNOSTIC MICROBIOLOGY. (Cr ar; prereq grad student in microbiology, #) Staff
Laboratory procedures for isolation and identification of microorganisms from patients. Work is carried out in diagnostic microbiology laboratories of the hospital.

8421. VIROLOGY AND TUMOR BIOLOGY. (3 cr; prereq undergrad biochem, #) Peluso
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 #) Staff
Graduate students with requisite preliminary training may elect research project outside their thesis work.

Mineral Engineering

Professor: Charles Fairhurst, *head;* Gust Bitsianes; Steven L. Crouch; Andrzej Drescher; Malcolm T. Hepworth; Iwao Iwasaki; Kenneth J. Reid; Anthony M. Starfield; Ioannis Vardoulakis

Associate Professor: Karl A. Smith; Raymond L. Sterling

Assistant Professor: Randal J. Barnes; Joseph F. Labuz; Vaughan R. Voller

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.S.Min.E. (Plan A and Plan B), M.Min.E., and Ph.D.

Curriculum—The program is administered in the Department of Civil and Mineral 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—Contact the secretary for graduate studies, Civil and Mineral Engineering Building, University of Minnesota, 500 Pillsbury Drive S.E., Minneapolis, MN 55455.

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 Geo-Engineering in this bulletin.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Mineral Engineering (MinE)

5600. MINERAL EXPLORATION AND EXPLOITATION. (4 cr; prereq 3rd yr, IT student or grad IT major; 3 lect hrs per wk)
Mineral distribution and demand; nongeologic ore determinants; mineral law, taxation, liquidation value; options and basis; ore guides; drilling, sampling, and confining theory; concepts of risk elimination.

5610. MINERAL EVALUATION. (4 cr; prereq 5600, Stat 3091; 3 lect and 2 rec hrs per wk)
Statistical and geostatistical methods of evaluating ore reserves. Feasibility studies, including direct costs, taxes, depreciation, depletion, present worth, rate of return, and project financing.

5619.* ENGINEERING FIELD STUDY. (3 cr; prereq sr or grad mineral or geological engineering major or #, IT student or grad IT major; offered 2 wks during summer)
Mining and petroleum operations; mine and petroleum plants and metallurgical plants; research and engineering offices in selected regions.

5620. UNDERGROUND MINING METHODS. (4 cr; prereq 5600, IT student or grad IT major; 4 lect and 2 rec hrs per wk)
Description of mining methods and principles of underground ore extraction. Handling materials underground, rail transport, conveyors, load-haul-dump operations. Mine ventilation, drainage, and services.

5630. SURFACE MINING ENGINEERING. (4 cr; prereq 5620, IT student or grad IT major; 4 lect hrs per wk)
Surface mining hydraulics and dredging; open pit and strip mining; in-situ leaching; in-situ retorting (oil shale, coal gasification); design (manual and computer aided) for economic optimization; production scheduling; unit operations and choice of equipment; cost estimation.

5640. MINERAL ECONOMICS. (4 cr; prereq 5610 or #, IT student or grad IT major; 4 lect hrs per wk)
Elementary principles of economics and applications to mineral industries; developed and undeveloped areas; marginal ore production; marketing of raw materials.

5642. THE MINERAL INDUSTRIES. (4 cr; prereq 5613 or #, IT student or grad IT major)
Minerals and developing economies, modern industrial economics, and international trade; gold and silver as monetary metals. Problems in analyzing resources: mineral supply; secondary (scrap) supply; depletion, exhaustibility, and conservation. Quantitative economic analysis: interindustry; projecting and forecasting; computer applications; marketing; mineral financing.

5650. MINERAL ENGINEERING DESIGN I. (4 cr; prereq 5720, 5722 or #, IT student or grad IT major; 10 design hrs per wk)
Systems approach to selected aspects of a mining project—exploration, mining, mineral processing, metals extraction. Final bound report of an in-depth engineering feasibility study required.

5652. MINERAL ENGINEERING DESIGN II. (4 cr; prereq 5650 or #, IT student or grad IT major)
For description, see 5650.

5660.* SPECIAL MINERAL ENGINEERING PROBLEMS. (Cr and hrs ar; prereq IT student or grad IT major)
Literature survey of research work on mining problems.

5680. MATERIALS HANDLING. (4 cr; prereq CE 3400 or #; 3 lect and 1 rec hrs per wk)
Engineering principles used in design of ore handling and transport systems; application in design of power transmission systems; ore handling, crushing and hoisting; other mine transportation systems.

5700. MINERAL ECONOMICS: SYSTEMS ANALYSIS FOR MINERAL ENGINEERS. (4 cr; prereq #, IT student or grad IT major)
Introduction to systems analysis, operations research techniques, modeling and simulation. Applications to mineral engineering. Life cycle concept of mining.

5710. ENVIRONMENTAL ASPECTS OF MINERAL ENGINEERING. (4 cr; prereq 5613 and 5820 or #, IT student or grad IT major; 3 lect hrs and one 2-hr lab per wk)
Recognizing and minimizing the environmental problems posed by mining and metallurgical operations. Both the immediate working environment and the larger ecological impacts are considered.

5720. MINERAL PLANT ENGINEERING I. (4 cr; prereq CE 5612 or #, IT student or grad IT major)
Basic engineering principles in design and selection of mine, petroleum, and mill plant equipment. Calculations involving compressed air, pumping, transmission of gases and fluids, and power systems (mechanical, hydraulic, pneumatic, and electrical).

5722. MINERAL PLANT ENGINEERING II. (4 cr; prereq 5720 or #, IT student or grad IT major)
Basic engineering principles in design and selection of mine plant equipment such as hoists, conveyors, and railroad systems. Calculations involving power transmission, drilling, hoisting, and transportation of crushed ore.

5920. METALLURGICAL PROCESSES. (2 cr; prereq #, IT student or grad IT major)
Unit processes of extractive metallurgy illustrate known technologies for producing metal from ore. Ferrous and nonferrous applications and recent innovations.

5940. SPECIAL PROBLEMS: EXTRACTIVE METALLURGICAL ENGINEERING. (Cr ar; prereq IT sr)
Laboratory investigation of problems in extractive metallurgy.

8470-8471-8472.* RESEARCH PROBLEMS. (Cr ar; prereq #)

8601-8602-8603.* SEMINAR: MINERAL ENGINEERING. (Cr ar; prereq #)

8620. ADVANCED ENGINEERING DESIGN. (Cr ar; prereq #)

8640. ADVANCED MINERAL ECONOMICS. (3 cr; prereq 5642 or #)

8641.* SELECTED MINERALS IN NATIONAL AND WORLD AFFAIRS. (3 or 4 cr; prereq 5642)
Economic study of energy-related minerals; fetilizer-related minerals; capital and energy-intensive metals—aluminum, copper, steel.

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.

5101. CHEMICAL METALLURGY II. (4 cr; prereq MetE/MatS 5100 or #; 3 lect hrs and 1 rec hr per wk)
ΔGo-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.

5201. ORE MICROSCOPY. (3 cr; prereq Geo 3401 or # and Δ; 2 lect and 2 lab hrs per wk)
Introduction to polarized light microscopy in the identification and study of ore minerals, their textures and associated gangue. Elementary optics, optical properties of minerals. Application of microscopy to discovery of mineralogical and textural factors that exercise fundamental control over beneficiation processes.

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 laboratory 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.

5940. SPECIAL PROBLEMS IN EXTRACTIVE METALLURGICAL ENGINEERING. (1-6 cr)
Laboratory investigation of problems in extractive metallurgy.

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.

8001. APPLIED PROCESS METALLURGY II. (3 cr; prereq #)
Modern developments in bulk liquid metal processing and waste metal recycling. Critical analysis of ingot and continuous casting of ferrous and nonferrous metals. Evaluation of design criteria for shaped castings; running, risering, gating, and chilling design concepts.

8830.* ELECTRIC AND MAGNETIC SEPARATION OF MINERALS. (4 cr; prereq #; offered alt yrs)
General review of electrostatics and magnetostatics as related to electric and magnetic separation of solids. Laboratory methods for determining electric and magnetic properties of solids. Theory and operation of various electric and magnetic separators currently used in industry.

8838. OPTIMIZATION AND CONTROL TECHNIQUES IN MINERAL PROCESSING I. (3 cr; prereq IT grad standing or #; 2 lect hrs and one 3-hr tutorial lab per wk; offered alt yrs)
General mathematical model of comminution and its application to rod mills, ball mills, and cone crushers. Mathematical model of hydraulic classification and its application to hydrocyclones. Use of models in simulation of multistage closed comminution circuits. Recognition of physical constraints during simulation. Deficiencies of models. Control of comminution circuits including digital computer control.

8839. OPTIMIZATION AND CONTROL TECHNIQUES IN MINERAL PROCESSING II. (3 cr; prereq 8838 or #; 2 lect hrs and one 3-hr tutorial lab per wk; offered alt yrs)
Kinetic model of flotation. Distribution of flotation rate constants and importance of entrainment. Simulation and control of flotation circuits. Dynamics of operation of comminution and flotation circuits.

8842. SURFACE CHEMISTRY OF MINERAL SUSPENSIONS. (3 cr)
Thermodynamics and kinetics of surface reactions as applied to flotation systems. Electrical double layer theory, theory of flocculation and dispersion of mineral suspensions, kinetics of electrode processes, theory of semiconductor—electrolyte interfaces.

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.

8932.* PHYSICAL CHEMISTRY OF HIGH TEMPERATURE METALLURGICAL REACTIONS II. (3 cr; prereq 8930)
Liquid slag state and slag constitution theories. Slag-metal distribution equilibria. Phosphorus and sulfur problems in iron and steelmaking.

8934.* PHYSICAL CHEMISTRY OF HIGH TEMPERATURE METALLURGICAL REACTIONS III. (3 cr; prereq 8932)
Kinetics and rates of reaction in iron and steelmaking. Mass transport processes. Applications to metallurgical systems.

Molecular Biology

Curriculum—Molecular biology is the study, at a molecular level, of the organization, maintenance, and expression of the genetic information of the cell. The principles and practices of molecular biology cut across many traditional areas of

biology, including biochemistry, genetics, cell biology, and microbiology. A cross-programmatic admissions and fellowship program has been established for Ph.D. students with interests in this area. Students who enter the Graduate School through this route will receive a non-service fellowship during their first year. They will take courses in molecular biology and related fields and receive laboratory research training. After the first year, students will select an adviser from among participating faculty and enter the graduate program of that adviser. Students will complete requirements and receive their degree in the selected graduate program, but will also participate in molecular biology training throughout their graduate studies.

Faculty currently participating in this cross-programmatic effort, and the graduate degree programs with which they are affiliated, include:

Professor: Dwight L. Anderson (genetics, microbiology); Fritz H. Bach (genetics, pathobiology); Robert M. Brambl (cell and developmental biology, genetics, plant pathology, plant physiology); P. Patrick Cleary (microbiology); Anthony J. Faras (genetics, microbiology); James A. Fuchs (biochemistry, genetics); Burle G. Gengenbach (agronomy, genetics, plant breeding, plant physiology); Richard S. Hanson (microbiology); Larry L. McKay (food science, genetics, microbiology); Peter G. W. Plagemann (cell and developmental biology, microbiology); Irwin Rubenstein (cell and developmental biology, genetics, plant physiology); Michael J. Simmons (genetics); D. Peter Snustad (genetics)

Associate Professor: Howard C. Towle (biochemistry, cell and developmental biology, genetics), *coordinator;* Martin Blumenfeld (cell and developmental biology, genetics); Perry B. Hackett (cell and developmental biology, genetics); Victoria Iwanij (cell and developmental biology, genetics); Paul A. LeFebvre (cell and developmental biology, genetics); Dennis M. Livingston (biochemistry, genetics); Harry T. Orr (genetics, microbiology, pathobiology); Patrick M. Schlievert (microbiology); Janet L. Schottel (biochemistry, genetics, microbiology); Carolyn D. Silflow (botany, cell and developmental biology, genetics, plant physiology); Brian G. Van Ness (pathobiology)

Assistant Professor: Judy G. Berman (botany, genetics); David A. Bernlohr (biochemistry); Anath Das (biochemistry); J. Stephen Gantt (botany, genetics, plant physiology); Kevin S. Guise (animal physiology, animal science, genetics); David C. LaPorte (biochemistry, genetics); R. Scott McIvor (genetics, microbiology, pathobiology); Michael P. Murtaugh (veterinary biology, veterinary microbiology); Michel M. Sanders (biochemistry); Stewart Scherer (microbiology); William J. Sharrock (biochemistry, cell and developmental biology); Jocelyn E. Shaw (cell and developmental biology, genetics); Eric A. Wong (animal physiology, animal science, genetics)

Prerequisites for Admission—Prospective students should have completed courses in general and organic chemistry, calculus, physics, genetics, and biochemistry. In addition, courses in quantitative analysis and physical chemistry are recommended. For students of demonstrated ability, background deficiencies may be made up during the first year.

Special Application Requirements—Applicants should submit three letters of recommendation from persons familiar with their academic and research capabilities, scores from the General (Aptitude) and Subject (Advanced) Tests of the Graduate Record Examination, and a statement of interest and goals. Recommended date for receipt of completed applications is February 1. Completed files are reviewed between February and June. Graduate studies typically begin in summer session or fall term.

Requirements—All students who enter through this plan must complete the Advanced Molecular Biology course series (BioC/GCB/MdBc 8213 and 8214) during their graduate studies. In addition, students are expected to participate in research seminars, laboratory rotations, and journal clubs in molecular biology.

For Further Information—Students interested in entering the Graduate School through this cross-programmatic molecular biology program should contact the coordinator, Molecular Biology, 4-225 Millard Hall, University of Minnesota, 435 Delaware Street S.E., Minneapolis, MN 55455. Students may apply directly to this plan by designating molecular biology on the Graduate School application form. In addition, students may also wish to consider applying directly to individual graduate programs listed above that correspond to their interests.

Museum Studies

Professor: Donald E. Gilbertson (Bell Museum of Natural History), *director of graduate studies;* Joanne B. Eicher (design, housing, and apparel); Eugene D. Gennaro (curriculum and instruction); Marion J. Nelson (art history); 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); Charles W. Haxthausen (art history)

Assistant Professor: Marla C. Berns (design, housing, and apparel); Kerry J. Freedman (curriculum and instruction); Lyndel I. King (University Art Museum)

Adjunct Assistant Professor: Louis B. Casagrande (design, housing, and apparel); Michael P. Conforti (art history); Robert Jacobson (art history); George Keyes (art history)

Course of Study—Minor in museum studies, applicable to either master's or 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 minor program is contingent upon prior admission to the Graduate School and to a master's or doctoral program in a degree-granting department. The minor will be available beginning fall quarter 1989. 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, 5 of these required credits are for the introduction to museum studies core seminar.

Language Requirements—None specific to the minor program.

For Further Information and a List of Courses—Contact the director of graduate studies, Museum Studies Minor, 300 Bell Museum, University of Minnesota, 10 Church Street S.E., Minneapolis, MN 55455.

Music

Regents' Professor: Dominick Argento

Professor: Karen L. Wolff, *director;* Everett L. Sutton, *director of graduate studies*; David B. Baldwin; Frank Bencriscutto; Paul Fetler; Paul W. Freed; James A. Hepokoski; Donna Jackson; Thomas S. Lancaster; Richard Leppert; Richard L. Massmann; Tanya Remenikova; Geneva H. Southall; Lloyd Ultan; Almita Vamos; Roland Vamos

Associate Professor: John E. Anderson; Alexander Braginsky; Reginald T. Buckner; Stanley P. Engebretson; Charles E. Furman; Alan L. Kagan; Young-Nam Kim; Alex Lubet; Susan McClary; Duncan R. McNab; Gwendolyn C. Perun; Stephen W. Schultz; Rebecca P. Shockley; D. Clifton Ware, Jr.; Lawrence Weller

Assistant Professor: Dean W. Billmeyer; Mark P. Bjork; Michael Cherlin; David A. Damschroder; Katherine Holum; Barry E. Kopetz; John Tartaglia[1]

Instructor: Jane G. Burris; Ferald B. Capps[1]; James L. Clute[1]; Marvin D. Dahlgren[1]; David W. Eagle; Elaine K. Eagle; Lea Foli[1]; Ruben G. Haugen; Robert W. Jamieson[1]; David B. Kamminga[1]; Barbara G. Kierig; Rosalind L. Laskin; Manuel Laureano[1]; James P. McGuire; Frances G. Miller; John W. Miller, Jr.[1]; Jeffrey W. Van

Teaching Specialist: Gary A. Bordner[2]; Christopher Brown

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.M., D.M.A., and Ph.D.

Curriculum—*Master of arts degree:* Emphases are offered in musicology, ethnomusicology, theory, composition, music education, and music therapy. For the *master of music degree,* emphases are offered in piano, harpsichord, organ, voice, violin, viola, cello, double bass, flute, oboe, clarinet, saxophone, bassoon, horn, trumpet, trombone, baritone, tuba, percussion,

[1]*Minnesota Orchestra*
[2]*St. Paul Chamber Orchestra*

harp, guitar, choral conducting, and church music. For the *doctor of musical arts degree,* emphases are offered in piano, organ, voice, clarinet, trumpet, violin, and cello. For the *doctor of philosophy degree,* emphases are offered in musicology, ethnomusicology, theory and composition, and music education/music therapy. (There is also a music education concentration within the curriculum and instruction emphasis of the Ph.D. major in education.)

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 ethnomusicology, theory and composition, applied music and music education.

Special Application Requirements—Three letters of recommendation and scores for the Graduate Record Examination General Test and Subject Test in music are required for all degrees. In addition, examples of original works (i.e., compositions, arrangements, transcriptions and/or theses, articles or term papers) must be submitted for M.A. and Ph.D. applicants. A minimum TOEFL score of 500 is required of applicants whose primary language is not English.

For programs with emphasis in music education, scores from the Miller Analogies Test are required. For the M.M. and D.M.A. programs, a performance audition is required. Taped performances may be submitted in lieu of an in-person audition by applicants living more than 200 miles from Minneapolis. In the case of admission based on a taped recording, the appropriate level of study, including the possibility of remedial work, will be determined by an in-person audition which must be taken before registration.

Diagnostic Tests—The Music Theory Placement Test is administered to all entering students. Graduate students in music must demonstrate proficiency in music theory and ear training to include the first four quarters of the undergraduate sequence plus 20th century theory. An audition is required for registration in all applied music courses. The piano proficiency test must be taken by students in musicology degree programs in their first quarter of study.

Master's Degree Requirements—For the *master of arts degree,* Plan A, an original composition may be offered instead of the usual research thesis. For Plan B, the required 44 credits must include 20 credits in the major field plus 8 credits of Plan B projects and 8 credits in a related field. An original composition may be offered instead of the Plan B project. A final oral examination is required for both plans. For the *master of music degree,* students must complete a program consisting of at least 44 credits. In solo performance areas, one recital is required. In the choral conducting area, a conducting recital with supporting paper is required. Individual programs must be approved by the adviser, the School of Music graduate studies committee, and the Graduate School. A final oral examination is required.

Doctoral Degree Requirements—For the *doctor of musical arts degree,* students must complete a program that includes 48 credits in applied music, 30 credits in other areas of music with emphasis on the literature and pedagogy of the major performing medium, and a supporting program of 12 credits outside music. Four recitals (which may include two master's level recitals) and two performances of an ensemble nature are required. A supporting paper of limited scope, demonstrating the ability to conduct scholarly investigation, is also required. Students take preliminary written, preliminary oral, and final oral examinations. For the *doctor of philosophy degree,* students, in consultation with the adviser, develop a program of study in the major that prepares them for the examinations. An original composition for full orchestra may be substituted for the thesis.

Language Requirements—For the M.M. degree and the M.A. in music education degree, none. For the M.A. in music degree, a reading knowledge of French or German is required; substitution may be made with approval from the School of Music when a different language is needed for an individual research project. For the Ph.D. degree, either two foreign languages, or one foreign language and a special research technique or collateral field of knowledge, are required. When two languages are offered, French, Italian, and German are acceptable. For the D.M.A. degree, language requirements are at the discretion of the adviser and the school.

For Further Information—Contact the director of graduate studies, School of Music, 100B Ferguson Hall, University of Minnesota, 2106 4th Street South, Minneapolis, MN 55455.

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 will determine the mode(s) for which a student may register. Students should consult the School of Music, 100 Ferguson Hall, regarding the examination as well as the mode and level of music appropriate for fulfilling specific requirements for their degree programs.

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 8323
(2 or 4 cr; prereq audition, △)

MusA 8401 to 8723
(2 or 4 cr [max 12 cr]; prereq music major, △)

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

INSTRUMENT	*ELECTIVE*	*PRINCIPAL*	*MAJOR*	*SECONDARY REQUIRED*	*SECONDARY ELECTIVE*	*PRINCIPAL BEYOND REQUIREMENT*	*MAJOR BEYOND REQUIREMENT*
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

Music (Mus)

Pedagogy, Literature, and Conducting

5016. TRUMPET PEDAGOGY. (2 cr; prereq 12 cr lower div trumpet lessons)
Principles. Discussion of literature, history, method, and current teaching aids.

5321-5322-5323. SUZUKI VIOLIN PEDAGOGY. (2 cr per qtr; prereq undergrad or grad string major with violin as principal performing instrument or #)
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 5321-5322-5323 or equiv, audition to demonstrate ability beyond material in course)
Intensive examination of techniques of Shinichi Suzuki for intermediate and advanced violin students in Western society. Discussion, playing experience, observation of children's lessons in MacPhail Center Suzuki Program, and practical teaching experience.

5341. JAZZ PEDAGOGY. (2 cr; prereq #)
Teaching methods of jazz improvisation (vocal and instrumental), arranging, jazz history, bibliographies.

5351f-5352w-5353s. PIANO PEDAGOGY I. (2 cr per qtr; prereq 12 cr in MusA 1201 or MusA 1301 or #; offered alt yrs)
Demonstration and discussion of teaching techniques, methods, and materials for group and individual instruction at elementary and early intermediate levels.

5354f-5355w-5356s. PIANO PEDAGOGY II. (2 cr per qtr; prereq 5351-5352-5353 or #; offered alt yrs)
Demonstration and discussion of teaching techniques, methods, and materials for group and individual instruction at intermediate and early advanced levels. Application of principle and techniques in directed teaching setting.

5357f-5358w-5359s. GRADUATE PIANO SEMINAR. (2 cr per qtr; prereq #; offered alt yrs)
Recognition and discussion of problems in piano study, instruction and performance. Terminology, repertory, evolution of piano construction, performance practice from baroque to contemporary literature.

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 #) Remenikova
Principles of cello pedagogy. Private teaching at beginning, intermediate, and advanced levels. Discussion of problems, materials, theory, and methods.

5370. VOCAL PERFORMANCE SEMINAR. (2 cr; prereq 18 cr applied voice and #)
Vocal performance in seminar setting. Performance problems—stage deportment, interpretation, vocal technique, and lyric diction.

5371f-5372w-5373s. DICTION FOR SINGERS. (2 cr per qtr; prereq 12 cr of 1204 or #)
Introduction to International Phonetic Association alphabet and principles utilized in a singing pronunciation of English, Italian, German, and French. 5371: English and Italian. 5372: German. 5373: French.

5375-5376. VOCAL PEDAGOGY. (4 cr per qtr; prereq 18 cr applied voice, MuEd 3431 or #) Ware
Anatomical study of vocal mechanism. Principles and techniques of vocal production. Survey of teaching methods and application of knowledge in directed teaching situation.

5377. THE ADOLESCENT SINGING VOICE. (3 cr; prereq upper division clearance in voice for voice majors or 6 cr of applied voice for non-voice majors)
Principles of voice in teaching adolescent singers. Directed teaching, required readings, and study of relevant repertoire.

5378. USE AND CARE OF THE HUMAN VOICE. (1 cr) Ware
Physiology and anatomy of human voice, psychology, acoustics, general and specific health care, and therapeutic techniques.

5384, 5385. CHORAL CONDUCTING. (4 cr per qtr; prereq #; offered alt yrs) Lancaster
Choral conducting—hand techniques, sound control, articulation, breath control, intonation.

5387. INSTRUMENTAL CONDUCTING. (4 cr; prereq #) Massmann
Basic conducting techniques; role of conductor.

5388. ADVANCED INSTRUMENTAL CONDUCTING. (4 cr; prereq 5387 or #) Massmann
Score study, instrumentation, performing practices.

5399f,w,s. PERFORMANCE IN CONDUCTING. (4 cr; prereq 5388 or 5385, #) Lancaster
Preparation and conducting, with documentation of an ensemble program.

5452. SERVICE PLAYING AND IMPROVISATION. (2 cr; prereq 3533, #) Billmeyer
Hymn-playing at the organ. Arranging anthem accompaniments for organ and conducting from the console. Techniques for improvisation at the organ.

5467-5468-5469. STAGE MOVEMENT AND ACTING FOR SINGERS. (4 cr per qtr; prereq audition, #) Sutton
Basic techniques of stage movement and acting styles, application to various forms of music theatre.

5741, 5742. VOCAL LITERATURE. (4 cr per qtr; prereq 12 cr in 1104 or 1204 or 1304 or #; offered alt yrs)
Literature and pedagogy: performance of representative songs from major and minor composers. Vocal techniques from major schools of singing as they relate to song performance.

5744f, 5745w, 5746s. PIANO LITERATURE. (2 cr per qtr; prereq 12 cr in 1101 or 1201 or 1301 or #; offered alt yrs)
History of keyboard literature suitable for piano performances from end of 16th century to present; background and development. Performance illustrations by instructor, recordings.

5747, 5748, 5749. ORGAN LITERATURE. (2 cr per qtr; prereq 1606, 3533, jr or sr or grad in organ or church music or musicology or #) Billmeyer
Organ literature from 14th century to present. Influence of organ design from various periods and national schools on literature, performance.

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.

8537. SCORE STUDY (CHORAL). (4 cr; prereq grad and #) 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.

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.

8754. CHORAL LITERATURE: RENAISSANCE THROUGH BAROQUE ERAS. (4 cr; prereq grad and #) Lancaster
Sacred and secular choral works of Renaissance and baroque eras.

8755. CHORAL LITERATURE: CLASSICAL ERA THROUGH THE TWENTIETH CENTURY. (4 cr; prereq grad and #) Lancaster
Sacred and secular choral works of classical era through 20th century.

Ensembles, Directed Studies, Music Business

5331. JAZZ IMPROVISATION IV. (2 cr; prereq 3331, 3332, 3333 or audition) Buckner
Analysis of and improvisation on advanced tunes from post-bebop literature (ballads, Latin, swing, rock); application of harmony beyond 7th chords, quartal harmonies; development of knowledge of American standards.

5332. JAZZ IMPROVISATION V. (2 cr; prereq 5331 or audition) Buckner
Analysis of and improvisation on advanced tunes from post-bebop 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) Buckner
Analysis of and improvisation on advanced tunes from post-bebop literature; application of advanced harmony; development of ability to execute 5/4, 7/4, and other multi-metered tunes, ballads, and transcribed solos.

5340f,w,s. JAZZ ENSEMBLE. (1 cr per qtr [max 6 cr]; prereq audition, #) Bencriscutto
A 20-member performing organization covering significant jazz compositions and arrangements written specifically for this medium.

5343. MUSIC BUSINESS. (2 cr; prereq sr Mus major or grad student or business student interested in music) Buckner
Historical developments in and principles of music business (songwriting, publishing, copyright, agents, managers, contracts, record industry, music merchandising, arts administration, career planning and development) as it relates to musicians in composition, performance, scholarship, and teaching.

5347. ORCHESTRAL REPERTOIRE FOR WINDS AND PERCUSSION. (1 cr; prereq #)
Style and interpretation of standard orchestral repertoire.

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 #) Schultz
Practice and performance of standard and contemporary compositions for percussion ensembles in various combinations.

5410f,w,s. BAND. (1 cr per qtr; prereq #) Bencriscutto, Kopetz
Concert Band Ensemble; Symphony Band Ensemble; Symphony Bands I and II; Marching Band. Concert Band and Symphony Band perform standard and contemporary repertoire. Marching Band performs at University functions.

5420f,w,s. ORCHESTRA. (1 cr per qtr; prereq #) Massmann
Symphonic repertory through performance. Players from all colleges are invited to participate. Performance schedules include major choral works with the University Chorus, guest and student soloists.

5430f,w,s. UNIVERSITY CHORUS. (1 cr per qtr; prereq #)
Sec. 1—Women's Chorus: Performance of concert music for women's voices, with music from 16th to 20th centuries. Sec. 2—Varsity Men's Chorus: Performance of concert music for men's voices, with music from 16th to 20th centuries. Sec. 3—University Symphonic Chorus: Large oratorio chorus that performs major symphonic works with University Symphony Orchestra, Minneapolis Civic Orchestra, and others; membership open to all University students and individuals from community, by audition. Sec. 4—Conducting Class Ensemble: Participation in laboratory ensemble for conducting class.

5440f,w,s. ENSEMBLE. (1 cr per qtr; prereq #)
Performance of chamber music of major and minor composers; sonatas, trios, quartets, quintets, other forms. Combinations of vocal and instrumental chamber ensemble materials.

5450f,w,s. COLLEGIUM MUSICUM. (1 cr per qtr; prereq #) McClary
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. (2 cr per qtr; prereq #) Lancaster
Mixed chorus of 16 to 20 voices. Performances each quarter of works for small chorus.

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 #, △, 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 △)

Music Theory and Composition

5511. ADVANCED EAR-TRAINING I. (3 cr; prereq 3513 or #)
Dictation of melodic, harmonic, and rhythmic materials in a variety of styles. Introduction to contemporary sonorities.

5512. ADVANCED EAR-TRAINING II. (3 cr; prereq 3513 or #)
Dictation of melodic, harmonic, rhythmic, and contrapuntal materials. Emphasis on 20th-century tone combinations, meters, and rhythms. Tonal, polytonal, and atonal exercises. Training in tonal memory.

5521f-5522w-5523s. ADVANCED KEYBOARD HARMONY. (2 cr per qtr; prereq 3533, 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 MUSIC, 1890-1945. (4 cr; prereq 3535)
Representative works of Early Modern period.

5533. ANALYSIS OF MUSIC, 1945-PRESENT. (4 cr; prereq 3535)
Procedures and techniques of analysis applied to music composed since ca. 1945.

5540f,w,s. JAZZ COMPOSITION AND ARRANGING. (2 cr per qtr; prereq 3533, #) Bencriscutto
Original creative writing in jazz style or with strong jazz influence for any medium of musical expression, guided in individual sessions with instructor.

5541f-5542w-5543s. ADVANCED COUNTERPOINT. (2 cr per qtr; prereq #) Fetler
Practice in technique of writing three- and four-voice fugues; contrapuntal devices and problems; analysis of polyphonic works of various periods from Ars Nova to the present day.

5550. COMPOSITION. (2 cr per qtr; prereq 3535 or equiv, #, 3 qtrs 3550 or grad student) Argento, Fetler, Lubet, Ultan
Original work in various forms.

5560. ELECTRONIC MUSIC LABORATORY. (2 cr; prereq 5791 or #) Ultan
Electronic music techniques and compositional methods. Performance in combination with instruments and voices.

5561f-5562w-5563s. ORCHESTRATION. (2 cr per qtr; prereq 3533) Argento
Scoring instruments of the orchestra for ensemble combinations and full orchestra.

5564. BAND ARRANGING. (4 cr; prereq 3533, 5563 or MuEd 3512 or #) Schultz
Current scoring techniques for wind and percussion instruments. Scoring for band. Creative arrangements for marching or concert band.

5571. INTRODUCTION TO SCHENKERIAN ANALYSIS. (4 cr; prereq 3534) Damschroder
Theory and analysis of tonal music using principles developed by Heinrich Schenker. Emphasis on concepts and notation, application to excerpts and short pieces from 18th and 19th centuries.

5572. CHROMATICISM IN LATE-TONAL MUSIC. (4 cr; prereq 3512, 3534, #) Damschroder
Exploration of late-tonal chromatic practice through analysis of selected repertory, 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.

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 materials) directed toward development of skills in use of digital equipment for composition, teaching, and performance.

5971. MUSIC TRANSCRIPTION FOR WINDS. (2 cr; prereq 3533) Baldwin
Transcription of three works with score and parts copied in ink. Principles of music manuscript and examination of example of transcription.

8550. COMPOSITION. (3 cr per qtr [max 18 cr]; prereq completion of undergrad major sequence in music theory and composition, #) Argento, Fetler, Lubet, Ultan

8558. THEORY SEMINAR. (4 cr; prereq #)
Study of recent research in music theory.

8570. SEMINAR IN COMPOSITION. (4 cr per qtr [max 12 cr]; prereq grad student and #) Ultan
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).

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) Ultan
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, 1606, 3533 or #) McClary
Ornamentation, phrasing, articulation, and improvisation in music of period 1550-1759. Instruction books of period; analysis of performance of baroque music in baroque style.

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.

5451. HYMNOLOGY. (2 cr; prereq 1606, 3533, #) Billmeyer
Hymns of various historical periods and denominations, related literature of church. Modern hymnals of major church denominations.

5510. EARLY MUSIC PERFORMANCE PRACTICES. (1 cr; prereq 1606, 3533, #)
Editing, arranging, and performance of music composed before 1600 according to historically authentic practices.

5601f, 5602w, 5603s. HISTORY OF OPERA. (3 cr per qtr; prereq 9 cr in history of music, of art, of theatre, or of Europe from 1600 or #) Argento
Origins of opera; development as musicodramatic form through analysis of libretto and music of representative masterpieces. 5601: Late Renaissance, baroque, classical. 5602: Romantic. 5603: Contemporary periods.

5634f. BAROQUE VOCAL MUSIC. (4 cr; prereq 1606; offered alt yrs) McClary
Dramatic conventions in opera, oratorio, cantata.

5635w. BAROQUE INSTRUMENTAL MUSIC. (4 cr; prereq 1606; offered alt yrs) McClary
Transition from modality to tonality and development of instrumental genres; sacred music in Italy and Germany.

5637f, 5638w, 5639s. MUSIC IN GALANT AND CLASSIC PERIODS. (4 cr per qtr; prereq 1606 or #; offered alt yrs)
5637: Learned and galant styles, symphony, Haydn. 5638: Concerto, opera, Mozart. 5639: Keyboard and chamber music, Beethoven.

5641f. ROMANTIC CONCERT MUSIC. (4 cr; prereq 1606 or #; offered alt yrs)
Romanticism, concert music, and orchestral concert.

5642w. ROMANTIC SOLO MUSIC. (4 cr; prereq 1606 or #; offered alt yrs)
The artist, solo music, and solo concerts.

5643s. ROMANTIC CHAMBER MUSIC. (4 cr; prereq 1606 or #; offered alt yrs)
Chamber music, theory, and education.

5662. HEINRICH SCHÜTZ: LIFE AND WORKS. (4 cr; prereq 8 cr music history or history of art or German literature or political history to 1700 or #) McClary
Political events in 17th-century Germany, Europe; Protestant hymn, psalm literature. Musical elaborations in works of Schütz. Madrigals, monodies, sacred concerti and cantatas, passions.

5665. RABINDRANATH TAGORE: MUSIC AND POETRY. (4 cr) Kagan
Life, philosophy, works. Influences: Europe's, India's classical and folk traditions. His poetic forms and themes. Influence on Bengali literature. Songs, operas, with bilingual texts.

5666. STRAVINSKY. (4 cr; prereq 12 cr music history, 3535) 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 1606, 3533) McClary
Analysis of chamber compositions of Beethoven, particularly quartets. His use of chamber sonorities and classical forms, changes in style, and aesthetic problems.

5701, 5702. AMERICAN MUSIC. (4 cr per qtr; prereq 1606 or 8 cr American history or American studies or #; offered when feasible)
From colonial times to present. American Indian music; sacred music in America. Puritan New England to present; jazz; music education; symphony orchestra; contemporary music.

5708. THE BLACK COMPOSER: CONTRIBUTIONS TO WESTERN MUSIC AND CULTURE. (4 cr, §Afro 5201; prereq upper div or grad) Southall
Music achievements of Black Americans in classical music.

5757, 5758. HISTORY OF THE SYMPHONY. (4 cr per qtr; prereq 1606, 3533) McClary
The symphony from its beginnings to the present. Representative compositions; readings from relevant primary and secondary source materials. 5757: From Pergolesi to Liszt. 5758: From Brahms to present.

5804. FOLK AND TRADITIONAL MUSIC: CROSS-CULTURAL SURVEY. (4 cr) Kagan
Music of peoples of world in topical and geographic format. Music styles, behavior, and concepts in various societies and cultures. Field recordings and filmed performances.

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 1606 or #) Holum
Introduction to use of basic bibliographies and indexes, reference works, periodicals and historical editions; techniques for preparing an annotated bibliography.

5861. INTRODUCTION TO ETHNOMUSICOLOGY. (4 cr; prereq #; offered alt yrs) Kagan
Scope, aims, methods, and resources of research in ethnomusicology. Preliterate, folk, and high-art music of world; style, form, usage, and function. Musical typology and comparative studies.

5863. MUSICAL INSTRUMENTS OF THE WORLD. (4 cr; offered alt yrs) Kagan
Organology; classification; comparative study of musical instruments in all cultures: history, distribution, structure, technology, acoustics. Instruments in literature, myths, iconography.

5864. AMERICAN FIDDLE TRADITIONS. (4 cr; prereq #)
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 MIDDLE AGES. (4 cr; prereq 1606; offered alt yrs) Jackson
Growth and development of Western musical style from earliest records to Machaut; Gregorian chant and accretions to liturgy; chivalric song traditions in Spain, France, and Germany; organum, clausula, and motet.

8632w-8633s. THE MUSIC OF HUMANISM: ARS NOVA AND RENAISSANCE. (4 cr per qtr) Jackson
Stylistic achievements in history of part-music, 1350-1600: French, Italian, English, German song forms; Franco- Flemish mass and motet, diffusion of Franco-Flemish style; mannerism and musical depiction of text; rise of instrumental music; stylistic analysis.

8647w. CONTEMPORARY MUSICAL STYLES. (4 cr; prereq undergrad degree in music; offered alt yrs) Jackson
Critical analysis of major compositions and historical documents.

8661. SEMINAR: EDITING LASSO'S MUSIC FOR PERFORMANCE. (4 cr; prereq undergrad degree in music) Jackson

8844f. SEMINAR: ADVANCED RESEARCH IN MUSIC. (4 cr; prereq undergrad degree in music; offered alt yrs) Jackson
History and aims of musicology; methods and materials of historical musicology; locating and questioning historical documents; the analytical bibliography; textual criticism and editorial methods; varieties of history and music history; patterns in musical historiography.

8845w. SEMINAR: ADVANCED RESEARCH IN MUSIC. (4 cr; prereq undergrad degree in music) McClary
Systematic approaches to music research. Reading and discussion of important studies in musical behavior; sociology of music, aesthetics; and applications of linguistics, structuralism, and semiotics to music. Bibliographical tools for interdisciplinary research.

8847-8848. NOTATION OF POLYPHONIC MUSIC. (4 cr per qtr; prereq #; offered alt yrs) Jackson
8847: White mensural notation of 15th and 16th centuries. Transcribing and editing for historically authentic performance. 8848: Modal, pre-Franconian, Franconian, French, and Italian notations from 12th and 14th centuries.

8851. HISTORY OF MUSIC THEORY THROUGH 1600. (4 cr; prereq undergrad degree in music)
Examination of important treatises and writings on notation, compositional procedure, and acoustics in Western music, from Greek antiquity to 1600. Modal theory and practice in 16th-century polyphony. Approaches to analysis of early music.

8864-8865. RESEARCH IN ETHNOMUSICOLOGY. (4 cr per qtr; 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

See Curriculum and Instruction and Music.

Neurology (Neur)

Professor: Arthur C. Klassen, *interim head*; Kenneth F. Swaiman, *director of graduate studies*; William R. Kennedy; Joo Ho Sung; Fernando Torres; David D. Webster

Associate Professor: Khurshed A. Ansari; Gary Birnbaum; David S. Knopman; Myoung C. Lee; Ilo E. Leppik; Robert I. Roelofs

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

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

Prerequisites for Admission—Candidates must have an M.D. degree from an approved medical school. In addition, they must have completed either one year of clinical experience that satisfies entrance into the neurology residency program or a neurology residency program.

Master's Degree Requirements—Each program is planned to meet individual interests and needs. Areas of study usually include physiology, anatomy, pathology, or other laboratory areas. The final examination is oral.

Doctoral Degree Requirements—Individual programs are designed by students and their advisers, with approval of the director of graduate studies. The minor may be elected in a number of nonclinical areas, including physiology, anatomy, pathology, or other laboratory areas. Advanced courses in these areas are required.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Department of Neurology, Box 295 UMHC, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5125. NEUROIMMUNOLOGY RESEARCH. (Cr ar; prereq bachelor's degree and some coursework in immunology)
Fundamental concepts and exposure to laboratory investigations in neuroimmunology. Project involving human or animal neurologic disease. Design and execution of experiments. Requires attendance at journal clubs and meetings—three month minimum.

8200f,w,s,su. CLINICAL NEUROLOGY. (Cr ar) Klassen and staff

8201f,w,s,su. CLINICAL PEDIATRIC NEUROLOGY. (Cr ar) Swaiman and staff

8202f,w,s,su. RESEARCH IN NEUROLOGY. (Cr ar) Klassen and staff

8203f,w,s,su. APPLIED ELECTROENCEPHALOGRAPHY. (Cr ar) Torres

8204f,w,s,su. APPLIED ELECTROMYOGRAPHY. (Cr ar) Kennedy

8205f,w,s,su. APPLIED NEUROPATHOLOGY. (Cr ar) Sung

8220. NEUROPHARMACOLOGY. (1 cr; offered every 3rd yr) Staff

8221w,s. NEUROCHEMICAL ASPECTS OF SELECTED CLINICAL DISORDERS. (2 cr; offered every 3rd yr) Swaiman and staff

8222f,w. APPLIED NEUROPHYSIOLOGY. (2 cr; offered every 3rd yr)

8226s. NEUROMUSCULAR DISEASES. (1 cr; offered every 3rd yr) Kennedy

8227s. NEUROLOGICAL SPEECH DISORDERS. (1 cr; offered every 3rd yr) Staff

8229. CLINICAL CORRELATIVE NEUROANATOMY. (1 cr) Roelofs

8233f,w,s. NEUROLOGICAL CLINICAL PATHOLOGICAL CONFERENCE. (1 cr) Klassen and staff

8234f,w,s. NEUROPSYCHOLOGY CONFERENCE. (1 cr) Meier

8235w. ADVANCED NEUROPSYCHOLOGY. (2 cr) Meier

8236f,w,s,su. RESEARCH IN NEUROPATHOLOGY. (Cr ar) Sung

8244w. NEUROEPIDEMIOLOGY. (1 cr; offered every 3rd yr) Loewenson

8701. NEUROOPHTHALMOLOGY. (2 cr; offered every 3rd yr)

8702. NEURORADIOLOGY. (1 cr, §Rad 8110; offered alt yrs)

8703f,w. ADVANCED NEUROPATHOLOGY. (2 cr, §Path 8701; offered alt yrs) Sung

8704f,w,s. SURVEY OF NEUROPATHOLOGY. (1 cr, §Path 8702) Sung and staff

8705f,w,s,su. NEUROLOGICAL-NEUROSURGICAL CONFERENCE. (1 cr, §Rad 0124)

Neuroscience (NSc)

Professor: Robert P. Elde (cell biology and neuroanatomy), *director of graduate studies*; Frank H. Barnwell (ecology and behavioral biology); Alvin J. Beitz (veterinary biology); Gary Birnbaum (neurology); Dwight A. Burkhardt (psychology); Bianca Conti-Tronconi (biochemistry); Boyd K. Hartman (psychiatry); William S. Herman (genetics and cell biology); William R. Kennedy (neurology); James F. Koerner (biochemistry); Alice A. Larson (veterinary biology); Gordon E. Legge (psychology); Paul C. Letourneau (cell biology and neuroanatomy); Allen S. Levine (food science and nutrition); Charles F. Louis (veterinary biology); Bernard L. Mirkin (pediatrics, phamacology); David A. Nelson (otolaryngology); J. Bruce Overmier (psychology); Richard E. Phillips (ecology and behavioral biology); Richard E. Poppele (physiology); Richard L. Purple (physiology); John R. Sheppard (genetics and cell biology); John F. Soechting (physiology); Sheldon B. Sparber (pharmacology); Akira E. Takemori (pharmacology); David Thomas (biochemistry); Travis Thompson (psychology); Neal F. Viemeister (psychology)

Associate Professor: John H. Anderson (otolaryngology); Marilyn E. Carroll (psychiatry); Timothy J. Ebner (neurosurgery); Glen J. Giesler (cell biology and neuroanatomy); William G. Iacono (psychology); Charles K. Knox (physiology); Steve C. McLoon (cell biology and neuroanatomy); Charles A. Nelson (child development); Mary Jo Nissen (psychology); Harry T. Orr (laboratory medicine and pathology); Mario A. Ruggero (otolaryngology); Virginia S. Seybold (cell biology and neuroanatomy); George L. Wilcox (pharmacology)

Assistant Professor: David R. Brown (veterinary biology); Patricia L. Faris (psychiatry); Jurgen F. Fohlmeister (physiology); William H. Frey III (psychiatry); Rita B. Messing (pharmacology)

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

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 four courses: Neurochemical Communication (5460), Systems Neuroscience (CBN 5111 and Phsl 5112), 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 (totaling at least 16 credits) and a minor field of study 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 PubH 5400) 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. Applicants are required to take the Graduate Record Examination General test and Subject test appropriate to their field of emphasis.

Degree Requirements—Elective courses are selected from the following list and should total at least 16 credit hours. Because thesis work is expected to include statistical analysis of data, a course in statistics, such as PubH 5400, is *required*. Proficiency in at least one computer programming language is highly recommended.

The written preliminary examination is administered to students upon completion of the required courses at the end of the first year. Upon completion of most of the elective and minor courses, students will 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 will be 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—Contact the director of graduate studies in neuroscience, Neuroscience Program, 4-166 Jackson Hall, University of Minnesota, 421 Church Street S.E., Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Required Courses

5460f. NEUROCHEMICAL COMMUNICATION. (4 cr, §MdBc 5460, §VB 5460; prereq biochem)
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.

5550. ITASCA CELL AND MOLECULAR NEUROBIOLOGY LABORATORY. (6 cr; prereq NSc grad student or Δ; A-F only)
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 #) 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, §Anat 8210; prereq Anat 5111, Phsl 5112 or #; offered even yrs) McLoon
Nervous system development. General mechanism and experimental approaches.

CBN 5111. HUMAN NEUROSCIENCE A. (4 cr; prereq regis med fr or grad and #; 5111-Phsl 5112†) Elde
Structure and function of nervous system, including organs of special sense.

Phsl 5112. HUMAN NEUROSCIENCE B. (3 cr; prereq regis med fr or grad; Anat 5111-Phsl 5112†)

Elective Courses

5017. ANALYSIS OF BEHAVIOR I. (4 cr, §Psy 5017; prereq Psy 3011 [except for honors and grad students])
Systematic formulation of topics of psychology based on operant analysis.

5031. PERCEPTION. (4 cr, §Psy 5031; prereq Psy 3051 or Psy 3031 or #)
Data and principles of visual perception: color vision, pattern vision, form and space perception, abnormal vision, physiological optics, and methods of study.

5034. SENSORY PSYCHOBIOLOGY. (4 cr, §Psy 5034; prereq Psy 3031 [except for grad students] or #)
Analysis of properties and biological mechanisms of sensory perception in humans and animals. Color vision, visual sensitivity and adaptation, electrical activity of eye and brain.

5045. MOLECULAR PRINCIPLES OF BEHAVIOR. (3 cr, §GCB 5045; prereq BioC 5002 or #)
Relationships between biochemistry and behavior. Emphasis on diseases of human behavior, e.g., psychoses, alcoholism, epilepsy. Simple biological systems used to study behavior.

5062. NEUROPSYCHOLOGY OF MOTIVATION AND LEARNING. (4 cr, §Psy 5062; prereq Psy 5061 or #)
Brain mechanisms of aggression, fear, pain, hunger, thirst, reproductive behavior, learning, and discrimination processes.

5102. VETERINARY NEUROBIOLOGY. (3 cr, §VB 5102; prereq #) Beitz
Structural and functional organization of central nervous system of domestic animals.

5149. BEHAVIORAL GENETICS. (4 cr, §EBB 5149; prereq Biol 5003 or GCB 3022/5022 or equiv) Merrell
Application of genetic principles to study of behavior, primarily animal behavior.

5211. BIOLOGY OF NERVE CELLS. (3-4 cr, §Anat 5211; prereq GCB 5049 and Phsl 3053 or Phsl 3056 or Phsl 5110 or GCB 5114 or VB 5312 or #) Quick and staff
Anatomical basis of nerve cell function. Emphasis on excitable membranes, interactions among neurons and other cells, and current topics and technology.

5323. MECHANISMS OF ANIMAL BEHAVIOR. (5 cr, §EBB 5323; prereq Biol 3011 or 1 qtr animal physiology)
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. (4 cr, §VB 5400; prereq VB 5308 or #) Larson
General principles of drug action, drug disposition, and drug use in domestic animals. Pharmacology of autonomic drugs, inhalation anesthetic agents, narcotic analgesic drugs, tranquilizing agents, gastrointestinal drugs, inorganic ions, and preparations used in fluid and electrolyte therapy. Veterinary applications.

5444. MUSCLE CONTRACTION. (3 cr, §MdBc 5444, §Phsl 5444, §VB 5444; prereq undergrad biochem or physiology courses, #) Donaldson, Louis, Poppele, Thomas
Introduction to physiology, biochemical regulation, and physical chemistry of muscle contraction.

5950. SPECIAL TOPICS: CELLULAR REGULATION. (3 cr; prereq △) Herman

8031. SEMINAR: VISUAL PERCEPTION. (3 cr, §Psy 8031; prereq Psy 5031 or #) Legge
Physiological, psychophysical, and cognitive determinants of visual perception.

8035. VISION. (3 cr, §Psy 8035; prereq Psy 8034) Burkhardt
Topics in contemporary vision research include neuroelectric activity, color, binocular and spatial vision, adaptation.

8037. PSYCHOPHYSICS AND AUDITION. (3 cr, §Psy 8037; prereq Psy 8034 or #) Viemeister
Modern and classical psychophysics. Psychophysical and physiological correlates of audition. Theories of hearing.

8064. BEHAVIORAL PHARMACOLOGY. (3 cr, §Psy 8064; prereq Psy 5017 or #) Pickens
Analysis of behavioral effects of drugs.

8081. NEUROETHOLOGY. (3 cr, §AnSc 8081, §EBB 8081; prereq EBB 5312, Psy 5061 or #; offered alt yrs) Phillips
Current concepts of neurological and neurochemical basis of animal behavior, including reception, coding, transmission and storage of information, levels of integration; central control of input and output; spontaneity; development and learning.

8114. BIOPHYSICS OF NERVE CELLS. (3 cr, §Phsl 8114; prereq #; offered alt yrs) Fohlmeister
Hodgkin-Huxley model, cable theory and dendritic trees, propagated action potential, impulse initiation, theories of membrane transport, ion channel gating, gating currents, single channel gating, gating and shot noise in excitable membranes.

8115. MATHEMATICAL NEUROPHYSIOLOGY. (4 cr, §Phsl 8115; prereq calculus through differential equations, Stat 8501 or #; offered alt yrs) Knox
Analysis of nerve impulse trains; interval distributions, auto- and cross-correlation functions. Shot noise processes, applications of information theory. Models of neurons, including McCullock-Pitts, random walk, and 'leaky integrator' models. Neural networks; randomly connected nets, discrete and cellular space models. Computer simulation techniques.

8136. EXPERIMENTAL COMPARATIVE VETERINARY NEUROLOGY. (3 cr, §VB 8136; prereq VB 8135, #) Beitz, Fletcher
Principles, methods, and laboratory exercises in investigating central nervous system of domestic animals.

8141su. NEUROANATOMICAL METHODS. (2 cr, §Anat 8141; prereq #; offered alt yrs) Elde and staff
Introduction to contemporary morphological techniques applicable to investigation of nervous system. Theoretical basis of these techniques, practical aspects of use. Laboratory.

8170s. CELL JUNCTION STRUCTURE AND PHYSIOLOGY. (4 cr, §Anat 8170; prereq GCB 5048 and GCB 5114 or #; offered even yrs) Sheridan
Structure, biochemistry, and function of intercellular junctions in animal systems. Emphasis on gap and tight junctions. Lecture/discussion on basic concepts; student seminars on applications to specialized tissues.

8207. SEMINAR: PSYCHOPHARMACOLOGY. (3 cr on completion of 3 qtrs, §Phcl 8207; prereq #) Meisch, Pickens, Sparber
Topics on behavioral aspects of drug action.

8208. NEUROPSYCHOPHARMACOLOGY. (3 cr, §Phcl 8208; prereq Phcl 5111, Psy 5018, Psy 5062 or #; offered alt yrs) Sparber, Wilcox
Current methodologies used to study relationships between drugs and biochemical, behavioral, and neurophysiological consequences. Functional biogenic amine, peptidergic, and other pathways; how specific manipulations result in altered neuronal function and behavior; feedback, mechanisms, induction and inhibition. Tolerance to and/or dependence on stimulants, hallucinogens, depressants, and opiates.

8216. SELECTED TOPICS: NEUROPHYSIOLOGY. (Cr ar, §Phsl 8216; prereq Anat 5111, Phsl 5112 or equiv, #) Poppele and staff
Advanced seminar.

8217. PROPERTIES OF RECEPTOR SYSTEMS. (3 cr, §Phsl 8217; prereq #; offered alt yrs) Poppele
Physiological role of receptors as information gathering and relay devices; behavior of specific receptor organs and their functional components.

8218. PHYSIOLOGY OF VISUAL SYSTEMS. (3 cr, §Phsl 8218; 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.

8219. SPINAL CORD PHYSIOLOGY AND MOTOR CONTROL. (3 cr, §Phsl 8219; prereq #; offered alt yrs) Soechting
Physiological basis of motor control considered at different functional levels (spinal cord, brain stem, thalamus and basal ganglions, cerebral cortex and cerebellum) in terms of cellular mechanisms, input-output relations, and modelling.

8221. NEUROBIOLOGY OF PAIN AND ANALGESIA. (3 cr, §Anat 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, §Anat 8222; prereq #; offered in alt sequence with 8221 and 8223) Seybold
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.

8223. NEUROBIOLOGY OF ENDOCRINE REGULATION. (3 cr, §Anat 8223; prereq #; offered in alt sequence with 8221 and 8222) Elde
Neural systems involved in regulation of endocrine function. The hypothalamic-pituitary-target organ axes.

8247. PHYSIOLOGY OF HEARING. (3 cr, §Otol 8247; prereq #) Ruggero
Structure and function of mammalian auditory systems. Cochlear anatomy; basilar membrane mechanics, cochlear potentials, and the anatomy and neurophysiology of auditor nerve and nuclei.

8324. READINGS IN NEUROBIOLOGY. (1 cr per qtr, §NSu 8324; prereq Phsl 8104, #) Ebner
Survey of major topics in neurobiology.

8460f. NEUROCHEMICAL COMMUNICATION. (1 cr, §GCB 8460, §MdBc 8460, §Phcl 8460, §VB 8460; prereq 5460 or ¶5460, biochem)
Biochemistry of neuronal signaling and manipulation by pharmacological agents, in context of current research papers. Information about most systems (e.g., autonomic and central nervous systems) in context of specific transmitter systems wherever practical. Research-oriented paper or grant application on area discussed in 5460.

Neurosurgery (NSu)

Professor: Shelley N. Chou, *head, director of graduate studies*; Edward L. Seljeskog

Associate Professor: Timothy J. Ebner; Donald L. Erickson; Stephen J. Haines; Robert E. Maxwell; Gaylan L. Rockswold

Assistant Professor: Dennis A. Turner

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 emphasis in basic neurobiology and clinical trials of newer modalities of therapeutic measures.

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 experience. Final selection is made via the national Neurologi cal Surgery Matching Program.

Master's Degree Requirements—At least five academic years are required, of which 36 months must be in clinical neurosurgery, 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—Contact the Department of Neurosurgery, Box 96 UMHC, University of Minnesota Hospitals, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address).

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

8305. NEUROSURGICAL DIAGNOSIS. (4 cr) Chou, and 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) Chou and staff
The neurosurgical fellow acts as house surgeon at University and affiliated hospitals.

8311. OPERATIVE NEUROSURGERY. (4 cr) Chou and 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) Chou and staff
Problems in experimental or clinical neurosurgical sciences.

8318. NEURORADIOLOGICAL CONFERENCE. (1 cr) Chou, Seljeskog, and staff
Review of X-rays and case histories on neurosurgical service.

8320. NEUROSURGICAL CONFERENCE. (2 cr) Chou, Seljeskog, and staff
In-depth review of selected topics in basic or clinical neurosurgery.

8322su,w. SEMINAR: NEUROSURGERY-OPHTHALMOLOGY—PART I. (1 cr) Staff
Review and discussion of topics in neuroophthalmology.

8323f,s. SEMINAR: NEUROSURGERY-OPHTHALMOLOGY—PART II. (1 cr; prereq 8322) Staff

8324. READINGS IN NEUROBIOLOGY. (2 cr; prereq Phsl 8104, consent of Medical School) Ebner
Survey of major topics in neurobiology. Specific papers in each area serve as basis for discussion.

8325. ADVANCED READINGS IN NEUROBIOLOGY. (2 cr; prereq 8324) Ebner
(Continuation of 8324) In-depth discussion of fewer topics.

8330. NEUROSURGERY LITERATURE SEMINAR. (2 cr) Staff
Review and discussion of current literature relating to neurosurgery and the neurosciences.

Nursing (Nurs)

Professor: Ellen T. Fahy, *dean*; Sue K. Donaldson; Verona C. Gordon; Floris E. King; Elaine R. Mansfield; Mark E. Nesbit; Margaret A. Newman; A. Marilyn Sime; Mariah Snyder; Albert I. Wertheimer

Associate Professor: Diane K. Kjervik, *director of graduate studies;* Sheila A. Corcoran; Patricia Crisham; Sandra R. Edwardson; Ellen C. Egan; Bernadine M. Feldman; Sara S. Rode; Muriel B. Ryden; Patricia S. Tomlinson

Assistant Professor: Kenneth R. Burns; Kathleen G. Dineen; Laura J. Duckett; Cynthia R. Gross; Marilyne R. Gustafson; Ruth D. Lindquist; Kathleen Sodergren

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, childbearing-childrearing family nursing, medical-surgical nursing, and nurse midwifery. The Ph.D. program is designed to prepare creative and productive scholars in nursing. Students select one area of research from among the following: 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 of study 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. Students may be required to make up deficiencies in areas covered by the placement examinations after admission.

Special Application Requirements—For the M.S. degree, 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 deadline for the M.S. program is January 25 for summer, fall, or winter admission and October 1 for winter, spring, or summer admission; for the Ph.D. program, 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, a course in nursing research methodology, and 4 credits of 8050 for the Plan B project. For more information, see the School of Nursing publication *Graduate Studies in Nursing*. A final oral examination is required for both plans.

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 21 to 28 credits in a minor field is required.

Language Requirement—None.

For Further Information—Contact the director of graduate studies, School of Nursing, 6-101 Health Sciences Unit F, University of Minnesota, 308 Harvard Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Theoretical and Ethical Foundations of the Discipline

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 U.S. and worldwide.

5902. NURSING AND THE POLITICS OF HEALTH. (3 cr; prereq grad student, #) Fahy
Relationship of changing social policy to health services and impact on funding for nursing education, research, and service.

8010. STRUCTURE OF THE DISCIPLINE OF NURSING. (3 cr; prereq △) Egan, Sime, Sodergren
Exploration of purposes, characteristics, and kinds of structures with emphasis on theories, models, and conceptual frameworks.

8011. MORAL AND ETHICAL POSITIONS IN NURSING. (3 cr; prereq △) Corcoran, 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) 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, △) 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, △) Crisham
Interaction between research and theory in moral judgment and behavior, applied ethics, and nursing.

8800. PHENOMENON OF HEALTH. (3 cr; prereq △) Newman
Examination of assumptions and scientific perspectives of differing views of health; articulation and evaluation of holistic view of person-environment and health.

8900. THEORETICAL FOUNDATIONS OF HEALTH-RELATED BEHAVIORS. (3 cr; prereq #) Sime, 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

8014. RESEARCH IN NURSING. (3 cr; prereq inferential statistics, △) Feldman, King, Rode, Sime
Exploration of research process and research methodologies appropriate to nursing. Analysis of research reports.

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.

8064. CLINICAL REASONING IN NURSING. (4 cr; prereq 8014, #) Corcoran
Comparison of selected models of decision making used to study clinical reasoning in nursing. Formulation of research proposals.

8114. ADVANCED NURSING RESEARCH. (4 cr; prereq 8014 or equiv, advanced inferential and nonparametric statistics, computer science, △) King
Testing and validating methods of study unique to nursing science.

8210. THEORY DEVELOPMENT IN NURSING. (3 cr; prereq 8110, #) Egan, Newman
Examination of strategies for theory development; synthesis of theoretical formulations in nursing, utilizing a selected strategy.

Nursing Knowledge Underlying Clinical and Functional Specialization

Clinical Specialization

5801. GERONTOLOGICAL NURSING SEMINAR. (2 cr; prereq #; offered when feasible)
Theories of aging, age-related issues with impact on health care of aging persons; designing nursing interventions specific to elderly clients.

8030. NURSING INTERVENTION MODELS. (4-8 cr [8 cr must be completed before cr is granted]; prereq 8011 or ¶8011, 8012, #) Dineen, Gordon, Lindquist, Tomlinson
Developing, providing, and evaluating nursing intervention with a specified client population. Students register for a section that focuses on a desired population.

8060. ADVANCED CLINICAL NURSING. (3-9 cr; prereq △, #)
Hypothesis generation and testing in general nursing to develop creative and critical approaches to nursing.

8313. CARE OF THE CHILDBEARING FAMILY IN RISK. (4-6 cr; prereq physiology, #) Dineen
Problems encountered during perinatal period with emphasis on nursing care of mothers with medical complications.

8314. NURSE-MIDWIFERY MANAGEMENT DURING CHILDBEARING. (9 or 10 cr; prereq #) Dineen
For students wanting to complete requirements for nurse-midwifery certification. Emphasis on labor and delivery management with opportunity to improve skills throughout childbearing period.

8411. KNOWLEDGE DEVELOPMENT UNDERLYING NURSING THERAPY. (4-6 cr; prereq advanced course in relevant science, #) Burns
Development of nursing practice for a specified client population. Focus on one element or aspect of an intervention model to expand knowledge in that area. Relevant research literature evaluated.

8421. PSYCHIATRIC-MENTAL HEALTH NURSING: GROUP DYNAMICS AND LEADERSHIP SKILLS. (3 cr; prereq 8030, #) Kjervik
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, #) Kjervik
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, #) Rode, Tomlinson
Maintenance, promotion, improvement, and restoration of health in the childbearing-childrearing family unit. Theoretical concepts related to women, children and families, and family development.

Functional Specialization

5901. FINANCIAL MANAGEMENT OF NURSING SERVICES. (3 cr; prereq #; offered when feasible)
Theories of managerial and financial accounting and of health care economics as they relate to behavior of health care costs and achievement of goals and objectives for hospital nursing services.

8451. TEACHING-LEARNING PROCESS IN NURSING. (4 cr; prereq 8030, ¶course in learning theory and #) Corcoran, 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 8030, #) Edwardson
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

5722. AN INTRODUCTION TO THE NURSE AS A LEADER FOR CHANGE THROUGH PARTICIPATION IN THE LEGISLATIVE PROCESS. (3-5 cr; prereq two of the following: 5611, 5612, 5613, 5614, or grad student, or #; offered when feasible)
Seminars and active participation in legislative process, emphasizing development of health care bills from idea to statute, preparation and presentation of testimony, individual and group impact on legislative process and development of rules and regulations.

8063. NURSING CONSULTATION. (3 cr)
Study and practice in consultation in nursing care.

8315. NURSE-MIDWIFERY MANAGEMENT: INTRAPARTAL AND POSTPARTAL. (8-10 cr; prereq 8314) Dineen
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.

8415. NURSE CLINICIAN ROLE DEVELOPMENT. (6-9 cr; prereq course dealing with the health care delivery system, #) Burns, Snyder
Selection and development of a role, either nurse clinician-specialist or nurse clinician-generalist. Aspects of the role may include patient care, consultation, staff development, research, coordination, and collaboration.

8425. PSYCHIATRIC-MENTAL HEALTH NURSING: ROLE DEVELOPMENT. (6 cr; prereq #) Gordon
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.

8435. CHILDBEARING-CHILDREARING FAMILY NURSING: ROLE DEVELOPMENT. (6-9 cr; prereq 8431, #) Rode, Tomlinson
Development, synthesis, and utilization of intervention models as applied to a child and his or her family and to a childbearing family unit.

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)
Some aspects inherent in American society (alienation, productivity, roles, youth emphasis) and their impact on health care institutions; nurse's effects upon individuals involved with these institutions.

8601. CLINICAL NURSING LEADERSHIP I. (6 cr; prereq 8600)
Clinical practice involving extension of patient assessment to various health care institutions; individual employee assessment and work with and through others to achieve patient care goals. Consultation and evaluation processes, individual counseling, and group dynamics used to create more positive approaches to care of individuals.

8702. NURSING ADMINISTRATION II. (6 cr; prereq 8701, #) Edwardson
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

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: Paul B. Addis (food science and nutrition); C. Eugene Allen (animal science, 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); Joan Gordon (food science and nutrition); Robert M. Jordan (animal science); Theodore P. Labuza (food science and nutrition); Arthur S. Leon (physiological hygiene); Allen S. Levine (food science and nutrition); Jay C. Meiske (animal science); Donald E. Otterby (animal science); Patricia B. Swan (food science and nutrition); Shirley W. Thenen (food science and nutrition); John F. Van Pilsum (biochemistry, medical sciences); Paul E. Waibel (animal science)

Associate Professor: Dennis A. Savaiano (food science and nutrition), *director of graduate studies;* Elaine Asp (food science and nutrition); Judith E. Brown (human development and nutrition); Margot P. Cleary (Hormel Institute); Steven G. Cornelius (animal science); John H. Himes (human development and nutrition); James E. Pettigrew (animal science); John D. Potter (epidemiology); Joanne L. Slavin (food science and nutrition); Marshall D. Stern (animal science)

Assistant Professor: Linda J. Brady (food science and nutrition); I. Marilyn Buzzard (human development and nutrition); Mary C. Gannon (food science and nutrition); Sally Weisdorf (pediatric gastroenterology)

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—Five subspecialty areas are offered in the doctoral degree program: animal nutrition, applied human nutrition, clinical nutrition, nutritional biochemistry, and nutritional epidemiology. Thesis work can be conducted on humans or on experimental or farm animals. Research projects 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. For the nutritional biochemistry subspecialty area, a course in quantitative analysis is required. 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, embryology, 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 for all students include FScN courses 5622, 5623, 8101 (twice), 8622, 8623, 8624 (or AnSc 8421), and 8625; two courses in research methods; and one course in epidemiology. 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—Contact the director of graduate studies, Nutrition, Department of Food Science and Nutrition, University of Minnesota, 1334 Eckles Avenue, St. Paul, MN 55108.

Note—The following courses are commonly selected for major and minor programs; other courses are also available.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

AnSc 8420s.* ENERGY IN ANIMAL NUTRITION. (3 cr; prereq #, BioC 5002 recommended; offered odd-numbered yrs) Staff
Role; sources and their classification; measurements of energy intake, utilization, and loss; expressions of energy value; interrelationships with other nutrients; and fate of energy in intermediary metabolism.

AnSc 8421s.* PROTEIN AND AMINO ACID NUTRITION. (3 cr; prereq BioC 5002 or equiv or #, BioC 5743 recommended; offered even-numbered yrs) Coon
Role; sources, how determined; measurements of protein quality; fate and use of ingested protein and amino acids; and interrelationships with other nutrients.

AnSc 8440w.* RUMINANT NUTRITION. (4 cr; prereq BioC 5002 or #, MicB 5321 recommended; offered odd- numbered yrs) Stern
Development, physiology, and function of the rumen; role of rumen microflora in digestion and synthesis; and factors influencing these phenomena.

AnSc 8441w. RESEARCH TECHNIQUES IN RUMINANT NUTRITION. (4 cr; prereq 8440 or #, MicB 5321 recommended; offered even yrs) Stern
Techniques for measuring rumen fermentation and digestion in gastrointestinal tract, including batch culture fermentation, *in situ* digestion, continuous culture fermentation, ruminal and intestinal cannulation, and blood sampling techniques.

AnSc 8740w. CONCEPTS AND DEVELOPMENTS IN RUMINANT NUTRITION. (2 cr; prereq #) Stern
Review and critical evaluation of recent research reports of relevance to ruminant nutrition.

AnSc 8741s. CONCEPTS AND DEVELOPMENTS IN AVIAN NUTRITION. (2 cr; prereq #; offered even-numbered yrs) Coon, Waibel
Review and evaluation of recent research reports, current concepts, and ongoing research in poultry nutrition.

AnSc 8742s. CONCEPTS AND DEVELOPMENTS IN SWINE NUTRITION. (2 cr; prereq #; offered even-numbered yrs) Cornelius, Pettigrew
Review and evaluation of scientific literature pertinent to swine and small animal nutrition.

BioC 5751f-5752w-5753s. GENERAL BIOCHEMISTRY. (4 cr per qtr, §MdBc 5751-5752-5753; prereq 3 qtrs organic chemistry, 2 qtrs physical chemistry, 1 qtr biochemistry or #) Staff
Comprehensive discussion of structure, function, metabolism, and metabolic regulation of components in biological systems.

BioC 8225s. TRACER TECHNIQUES. (1-3 cr; prereq 5002 or 5751 or 5745 or MdBc 5750, #)
Laboratory work on application of radioisotopes to study of metabolic processes.

FScN 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 regarding nutrition, food additives, food safety, food fads, health foods, environmental contamination, consumer movement, naturally occurring food toxicants, processed foods, synthetic foods, organically grown foods.

FScN 5612. EXPERIMENTAL NUTRITION. (4 cr; prereq 5622 or ¶5622, BioC 5024 or #) Staff
Principles and methods of diet formulation, dietary manipulation, energy and nitrogen balance, and body composition analyses in experimental animal models. Use and evaluation of methods and intepretation of results.

FScN 5622. MACRO-NUTRIENT METABOLISM. (5 cr; prereq 3600, Biol 5001, Phsl 3051 or #) 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 3600, Biol 5001, Phsl 3051 or #) Thenen
Nutritional/biochemical and physiological function of essential vitamins and minerals in humans and experimental animal models.

FScN 5624. A METABOLIC APPROACH TO CLINICAL NUTRITION. (4 cr; prereq 5622, 5623)
Focus on individual human in clinical setting. Interaction of calorie deprivation, metabolic demands of illness, and nutritional implications of medical treatment.

FScN 5643. SEMINAR: WORLD FOOD SUPPLY PROBLEMS. (3 cr, §AgEc 5790, §Agro 5200, §Soc 5675, §LACS 5280; prereq sr or grad student, #) Savaiano
Multidisciplinary approach to social, economic, and technical problems of feeding world's growing population.

FScN 8101. RESEARCH SEMINAR. (1 cr; S-N only; prereq #) 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 BioC 5002 or #; offered when feasible) Csallany
Evaluation of current research and other topics relevant to lipid chemistry in food, animal, and plant tissues, biological fluids, and micoorganisms, with emphasis on free radicals, autoxidation, oxidative deterioration, and antioxidant reactions.

FScN 8621. INDEPENDENT STUDY: NUTRITION. (1-9 cr; prereq #) Staff
Independent study and written reports in nutrition.

FScN 8622. CARBOHYDRATE AND LIPID METABOLISM. (3 cr; prereq 5622, 5623, or equiv, #)
Selected aspects of regulation of carbohydrate and lipid metabolism, emphasizing current methodology and literature.

FScN 8623. ADVANCED VITAMIN NUTRITION. (3 cr; prereq 5622, 5623, or equiv, #)
Advanced concepts and current literature in vitamin biochemistry, metabolism, bioavailabilty, and requirements.

FScN 8624. ADVANCED PROTEIN AND AMINO ACID METABOLISM. (3 cr; prereq 5622, 5623, or equiv, #)
Advanced concepts and current literature in protein and amino acid biochemistry, metabolism, digestion, and requirements.

FScN 8625. ADVANCED MINERAL NUTRITION. (3 cr; prereq 5622, 5623, or equiv, #)
Advanced concepts and current literature in mineral biochemistry, metabolism, bioavailability, and requirements.

FScN 8627. HUMAN NUTRITION AND AGING. (2 cr; prereq 5623) Thenen
Critical examination of nutrient interactions with aging process at physiologic and biochemical levels.

MdBc 8219s. BIOCHEMISTRY OF SPECIALIZED TISSUES. (3 cr; prereq 5753 or 5100; offered alt yrs) Van Pilsum
Biochemical and physiological functions and metabolism of adipose, nervous, muscle, liver, kidney, and other tissues in mammals.

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 basic courses in microbiol and stat, preferably biostat) Burke, Snowdon, Sprafka
Basic epidemiologic principles applicable to infectious and noninfectious disease; host-agent-environment complex; factors underlying spread of infectious disease; laboratory applications of statistical and epidemiologic methods.

PubH 5340. EPIDEMIOLOGY II: STRATEGIES AND METHODS. (4 cr; prereq 5330 or #) Prineas
Measures of disease occurrence; strategies and design principles of etiology and evaluative studies. Measurement problems, interactions, sensitivity and precision, validity, and the need for data specification and control of variables.

PubH 5380. APPLIED HUMAN NUTRITION. (4 cr; prereq biochem or equiv) Leon
Bioenergetics, physical activity, and health; assessment of nutritional intake, and clinical and biochemical assessment; food composition and requirements; food additives; food-drug interactions; physiological effects of starvation and dieting; anorexia nervosa; relationship of blood lipids and diet to coronary heart disease and cancer.

PubH 5386. PUBLIC HEALTH ASPECTS OF CARDIOVASCULAR DISEASES. (3 cr; prereq basic epid, biostat) Grimm, Luepker
Evaluation of population studies and trials on cardiovascular diseases; modifiable risk factors for coronary heart disease; prevention of 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 CHILD NUTRITION. (3 cr; prereq 3xxx-level nutrition course or equiv or #) Brown
Nutrient functions and requirements throughout pregnancy, lactation, infancy, and childhood.

PubH 5903. NUTRITIONAL ASSESSMENT. (1-3 cr; prereq 3xxx-level nutrition course or equiv or #) Buzzard, Himes
Methods used to assess nutritional status of populations and individuals throughout various stages of life cycle.

PubH 5914. NUTRITION INTERVENTION. (3 cr; prereq nutrition course or #) Mullis
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-level nutrition course or equiv or #) Krinke, Mullis
Review of current literature and research on nutrient needs and factors affecting nutritional status of adults and the elderly.

Obstetrics and Gynecology (Obst)

Professor: Takashi Okagaki, *director of graduate studies*; Harry Foreman (emeritus); Benjamin S. Leung; Konald A. Prem; George E. Tagatz; Leo B. Twiggs; Bruce A. Work

Associate Professor: Leon L. Adcock; Julius C. Butler; Stephen H. Cruikshank; Preston P. Williams

Assistant Professor: Doris C. Brooker; John E. Savage

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—Contact the director of graduate studies, Department of Obstetrics and Gynecology, Box 395 Mayo, University of Minnesota Medical School, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address).

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; 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
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
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.

FPAd 5243. TOPICS IN FAMILY PLANNING. (3-12 cr; prereq #) Foreman
Flexible course for meeting individual needs and interests, including thesis preparation, research projects, and field training.

Ophthalmology (Oph)

Professor: Donald J. Doughman, *head;* William Knobloch, *director of graduate studies*; Jonathan D. Wirtschafter

Associate Professor: J. Douglas Cameron; Herbert L. Cantrill; Robert D. Letson; Richard L. Lindstrom; William B. Rathbun

Assistant Professor: J. Daniel Nelson; C. Gail Summers

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

Degrees Offered—M.S. and M.S. Ophthal. (Plan A only).

Curriculum—The program normally requires four years to complete. Clinical training is provided at the University Hospitals, Hennepin County Medical Center, St. Paul-Ramsey Medical Center, and Veterans Administration Medical Center in the Twin Cities. All fellows spend a brief time in the laboratory becoming familiar with the research problems of the field. Additional training is available for those who wish to prepare for teaching and research careers. Individuals who wish to earn a Ph.D. are encouraged to complete a doctoral program in one of the basic science fields, doing their research on an ophthalmologic problem appropriate to their major subject.

Prerequisites for Admission—Applicants must hold an M.D. degree from an approved medical school.

Special Application Requirements—Applicants must forward to the department information concerning their educational and professional background, National Board scores, undergraduate and medical school transcripts, a dean's letter, two or three letters of recommendation, a brief narrative statement regarding their interest in ophthalmology and

their career goals, and a list of the publications or research projects in which they have been involved.

Master's Degree Requirements—The coursework listed is required of all graduate students whether they are working toward a degree or not. Oph 8101 and 8131 are offered on a continuing basis throughout the three-year residency program; the remainder of the courses (with the exception of Oph 8106 and 8142) are offered once during the three-year program. Minor fields are completed in one of the basic science disciplines by special arrangement with the department involved. Recommended are such fields as physiology, biophysics, biochemistry, and microbiology. A final oral examination is required.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Ophthalmology, Box 493 UMHC, University of Minnesota. 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address).

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

8101f,w,s,su. CLINICAL OPHTHALMOLOGY. (8 cr) Doughman and staff

8103. PEDIATRIC OPHTHALMOLOGY, STRABISMUS, AND HEREDITARY DISORDERS. (3 cr; prereq grad physician or grad student in vet science) Letson

8106. STRABISMUS MANAGEMENT. (1 cr; prereq MD or vet med grad student)

8110. OPTICS, REFRACTION, AND CONTACT LENS. (3 cr) Tani

8111. INTRAOCULAR INFLAMMATION, UVEITIS, OCULAR TUMORS. (3 cr; prereq MD or vet med grad student)

8112. RETINA AND VITREOUS. (3 cr; prereq MD or vet med grad student)

8113. BASIC AND CLINICAL NEURO-OPHTHALMOLOGY. (3 cr; prereq MD or vet med grad student)

8116. GLAUCOMA, LENS, AND ANTERIOR SEGMENT TRAUMA. (3 cr; prereq MD or vet med grad student)

8117. ORBIT, PLASTICS, AND TRAUMA. (3 cr; prereq MD or vet med grad student)

8118. GENERAL MEDICAL PROBLEMS. (3 cr; prereq MD or vet med grad student)

8119. CLINICAL PATHOLOGICAL CORRELATIONS IN OPHTHALMOLOGY. (1 cr; prereq MD or vet med grad student)

8120. SCOPE OF OPHTHALMIC PATHOLOGY. (2 cr; prereq MD or vet med grad student)

8125, 8126. DISEASES OF THE CORNEA AND EXTERNAL EYE. (3 cr; prereq MD or vet med grad student)

8131f,w,s,su. PRACTICAL OCULAR SURGERY. (3 cr) Doughman and 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)

Oral Biology (OBio)

Regents' Professor: Robert J. Gorlin

Professor: Burton L. Shapiro, *chair*; Gregory R. Germaine, *director of graduate studies;* William H. Douglas; William F. Liljemark; Harold H. Messer; Charles F. Schachtele; Quenton T. Smith; Carl J. Witkop

Associate Professor: Robert J. Feigal; Mark C. Herzberg; Robert H. Ophaug; Larry F. Wolff

Assistant Professor: Ralph DeLong; Joel D. Rudney

Instructor: Elizabeth D. Rekow

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, and mechanisms of microbial infection and immunity, are emphasized in advanced coursework and research. Individual programs are planned 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 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 should submit three letters of recommendation from persons familiar with their academic and research experience. 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. Students must maintain a cumulative GPA of at least 3.00 in both the major and the minor. A designated minor in a related discipline is required. The Plan B program involves three papers, at least one of which includes a laboratory study. A final oral examination is required for both plans.

Doctoral Degree Requirements—There are no minimum credit requirements for the Ph.D. program, except for the minor program. Coursework is selected to give the student a broad background in oral biology plus advanced work more directly related to the student's research interests. A designated minor is required. The written preliminary 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 in connection with OBio 8030 (which will be 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—Contact the director of graduate studies, Department of Oral Biology, 17-226 Moos Health Sciences Tower, University of Minnesota, 515 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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) Staff
Basic concepts of cell biology and human biology for dental specialist and/or oral research trainees.

8018s. BIOLOGY OF MINERALIZED AND OTHER CONNECTIVE TISSUES. (3 cr; offered spring of odd yrs) Messer, Smith
Lectures and discussions on developmental biology of connective tissues, morphologic and biochemical composition of connective tissue components, structure and biosynthesis of connective tissue components, normal and pathologic mineralization and changes in connective tissue during aging, wound healing, and various disease processes.

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, Rekow, staff
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*) Germaine
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 SSI 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 SSI 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 participation in discussion of current topics in oral biology.

8101, 8102, 8103. TOPICS IN CARIOLOGY. (1-2 cr; prereq #) Messer, 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.

Orthopedic Surgery (OrSu)

Professor: Roby C. Thompson, *head;* David S. Bradford; James H. House

Associate Professor: Theodore R. Oegema

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

Degree Offered—M.S.Orth.Surg. (Plan A only).

Curriculum—Four-year fellowships are offered to graduate students. Graduate work is carried on at University Hospitals, Gillette Children's Hospital, Shriners Hospital for Crippled Children, Abbott-Northwestern Hospital, and other Twin Cities hospitals.

Prerequisites for Admission—Applicants must hold the M.D. degree from an approved medical school.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Department of Orthopedic Surgery, Box 189 Mayo, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address)

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

8401. ORTHOPEDIC CONFERENCE. (3 cr) Staff
Review of X-rays and case histories of patients on orthopedic inpatient or outpatient service.

8403. FRACTURES. (5 cr) Staff
The orthopedic fellow acts as house surgeon on fracture service at Hennepin County Medical Center.

8404. FRACTURES. (5 cr) Staff
The orthopedic fellow acts as house surgeon on fracture service at St. Paul-Ramsey Medical Center.

8405. ORTHOPEDIC DIAGNOSIS. (3 cr) Staff
The orthopedic fellow assists in instruction of clinical clerks and interns and studies problems in diagnosis in Outpatient Department at University Hospitals.

8407. PEDIATRIC ORTHOPEDICS. (5 cr) Staff
The orthopedic fellow acts as house surgeon at Gillette Children's Hospital.

8408. ORTHOPEDIC PROBLEMS AND MANAGEMENT. (5 cr) Staff
The orthopedic fellow acts as house surgeon at University and Veterans Administration Medical Center.

8409. ORTHOPEDIC PROBLEMS AND MANAGEMENT. (5 cr) Bradford and staff
The orthopedic fellow acts as house surgeon on spine service at Abbott-Northwestern Hospital.

8410. ORTHOPEDIC PATHOLOGY. (2 cr) Staff
Seminar for systematic review of pathology of ossified tissues and soft tissues of extremities.

8411. ORTHOPEDIC OPERATIVE SURGERY. (5 cr) Staff
The orthopedic fellow acts as first assistant at operations at University Hospitals and later may be permitted to operate.

8412. ORTHOPEDIC ANATOMY. (2 cr) House and staff
The orthopedic fellow dissects upper and lower extremities and aids in instruction of medical students in anatomy of extremities.

8416. ORTHOPEDIC RESEARCH. (5 cr) Bradford
Problems in experimental or clinical surgery at University Hospitals.

Otolaryngology (Otol)

Professor: Arndt J. Duvall, III, *head*; Frank M. Lassman, *director of graduate studies*; Earl R. Harford; S. K. Juhn; David A. Nelson; W. Dixon Ward

Clinical Professor: Jerome A. Hilger; Albert Hohmann; Michael M. Paparella

Associate Professor: George L. Adams; John H. Anderson; Lawrence R. Boies, Jr.; Robert H. Maisel; Tetsuo Morizono; Kurt Pollak; Mario Ruggero; Peter A. Santi

Clinical Associate Professor: John D. Banovetz; Stephen L. Liston

Assistant Professor: James I. Cohen

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

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

Curriculum—The graduate degree programs are designed to 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 time in basic research directed toward preparation of an acceptable thesis for a master's or doctoral degree.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Department of Otolaryngology, Box 396 UMHC, University of Minnesota, Harvard Street at East River Road, Minneapolis, MN 55455 (mailing address).

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5970. DIRECTED STUDIES. (Cr ar [may be repeated for cr]; prereq #) Staff
Directed readings and preparation of reports on selected topics.

8220. RESEARCH IN OTOLARYNGOLOGY. (18 cr) Staff

8230. CLINICAL OTORHINOLARYNGOLOGY. (6 cr) Boies, Duvall, Maisel, Pollak, staff
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) Boies, Duvall, Maisel, Pollak, staff
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, Duvall, Hilger, Maisel
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) Duvall, Hilger, Pollak, staff
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) Duvall, staff
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) Duvall, staff
Instruction, didactic and practical, in laryngoscopy, esophagoscopy, bronchoscopy, and mediastinoscopy. General management principles stressed.

8238. PATHOLOGY OF THE EAR, NOSE, AND THROAT. (2 cr) Staff
Gross pathology and histopathology of diseases of the ear, nose, throat, and related regions.

8239. OTONEUROLOGY. (2 cr) Anderson
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, Maisel, Pollak, staff
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) Lassman, Harford, and 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) Lassman, 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, staff
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 #) Ruggero
Basic functional mechanisms of the auditory system, peripheral and central.

8248. READINGS IN AUDITORY PHYSIOLOGY. (1-3 cr; prereq #) Ruggero
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 #) Staff
Review of current research papers concerning cochler anatomy and pathology.

Parasitology

See Veterinary Parasitology under Veterinary Medicine.

Pathobiology (Path)

Regents' Professor: Alfred Michael; James G. White

Professor: Ellis S. Benson, *head;* Khalil Ahmed; Miguel M. Azar; Fritz H. Bach; Henry H. Balfour, Jr.; David M. Brown; Richard D. Brunning; Agustin P.

Dalmasso; Louis P. Dehner; John W. Eaton; Richard D. Estensen; Leo T. Furcht; Nelson D. Goldberg; Leonard Greenberg; Franz Halberg; Erhard Haus; Harry S. Jacob; Arthur G. Johnson[1]; John Kersey; Catherine Limas; Andreas Rosenberg; Burton L. Shapiro; John R. Sheppard; Michael W. Steffes; Lee W. Wattenberg

Associate Professor: Tucker W. LeBien, *director of graduate studies;* Diane Arthur; Larry D. Bowers; John H. Eckfeldt; William J. M. Hrushesky; Danuta Malejka-Giganti; Harry T. Orr; Gundu Rao; Stephen Rich; Walter Runge; Michael Y. Tsai; Daniel Vallera; Brian G. VanNess; Michael J. Wilson; Walid Yasmineh

Assistant Professor: Ralph J. Butkowski; Aristidis S. Charonis; Douglas J. Christie; Connie Clark; Berengere de Martinville; Patricia L. Faris; Vincent F. Garry; Said A. Goueli; Bo Hedlund; James B. McCarthy; R. Scott McIvor; James O'Leary; Miriam Segall; Effie C. Tsilibary

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 designed for qualified postbaccaulaureate 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. An internal supporting program in immunology is available.

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 foward to the Department of Laboratory Medicine and Pathology three letters of recommendation, scores from the General (Aptitude) Test of the Graduate Record Examination, and a brief autobiographical sketch including reasons for seeking a degree in pathobiology, career objectives, and areas of special interest. A minimum TOEFL score of 600 is required of applicants whose native language is not English.

Students are admitted for 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 5110, 8108, 8109, 8110, and two additional 3-credit courses in pathobiology are required for the minor.

For Further Information—Contact the director of graduate studies, Pathobiology Program, Department of Laboratory Medicine and Pathology, Box 198, University of Minnesota Medical School, 420 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5101. GENERAL PATHOLOGY. (1-6 cr [grade at end of summer]; prereq pathobiology grad, #)

5109. SEMINAR: SELECTED TOPICS IN PATHOBIOLOGY. (1 cr; prereq #)
Current thesis topics and other aspects of pathobiology.

5110. SEMINAR: PATHOLOGY. (1 cr; prereq #)
Staff

5115. BASIC TRANSMISSION ELECTRON MICROSCOPY. (4 cr; prereq Path grad, #)
Introduction to principles of basic electron microscopy. Laboratory emphasis on sample preparation, microscope use, image interpretation, photographic techniques.

5141. PROBLEMS IN EXPERIMENTAL AND CLINICAL CHRONOBIOLOGY. (Cr and hrs ar)
Halberg

[1]*University of Minnesota, Duluth*

8100. FLUORESCENT TECHNIQUES IN PATHOBIOLOGY AND PROTEIN CHEMISTRY. (3 cr; prereq MdBc 5100 and MdBc 5101 or equiv, Chem 3301 and Chem 3302 or equiv, 8108 and 8109 and 8110 or #)
Theoretical background and practical detail for understanding, interpreting, and applying advanced and novel techniques for analysis of fluorescence in cell biology, protein and membrane chemistry, immunology, and related fields. Lectures and laboratory.

8108f. PATHOBIOLOGY I. (3 cr, 8108-8109-8110; prereq MdBc 5100, MdBc 5101 or ¶MdBc 5100, ¶MdBc 5101, Anat 5103, Anat 5104 or ¶Anat 5103, ¶Anat 5104 or #) LeBien and staff
In-depth examination of cell injury and death, thrombosis, immunopathology, growth control and carcinogenesis, cytogenetics and inborn errors of metabolism, and acute and chronic inflammation. Morphology, cell biology, and biochemistry emphasized. Discussion of examples of abnormal function leading to disease based on most recent advances in each area.

8109w. PATHOBIOLOGY II. (3 cr, 8108-8109-8110; prereq MdBc 5100, MdBc 5101 or ¶MdBc 5100, ¶MdBc 5101, Anat 5103, Anat 5104 or ¶Anat 5103, ¶Anat 5104 or #) LeBien and staff
For description, see 8108.

8110s. PATHOBIOLOGY III. (3 cr, 8108-8109-8110; prereq 8108, 8109) LeBien and staff
For description, see 8108.

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 #) 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.

8140. RESEARCH TOPICS AND METHODS IN PATHOBIOLOGY. (2 cr; prereq regis grad or #) Staff
Current department research disciplines and related methodologies. Discussion and laboratory in immunology, cell biology, molecular biology, biochemistry, carcinogenesis, and other areas.

8201. RESEARCH. (Cr and hrs ar; grad students with necessary preliminary training may elect research, either as majors or minors in pathobiology) Benson, staff

8216. FRONTIERS OF IMMUNOLOGY I: IMMUNOBIOLOGY, IMMUNOGENETICS. (3 cr, §Micro 8216; prereq Biol 5001, MdBc 5100, MdBc 5101 or equiv)
Overview of B-cell/T-cell interactions, major histocompatibility complex, cell surface markers, B-cell development and responses, negative regulatory mechanism, T-cell responses, tolerance, PMNs, and macrophages.

8217. FRONTIERS OF IMMUNOLOGY II: MOLECULAR IMMUNOLOGY. (3 cr, §Micro 8217; 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.

8218. FRONTIERS OF IMMUNOLOGY III: CLINICAL IMMUNOLOGY. (4 cr, §Micro 8218; prereq 8216, 8217)
Antibody-mediated hypersensitivity, cellular hypersensitivity, autoimmunity, transplantation, tumor immunology, immunocytology, immune deficiencies.

8237. LABORATORY IN OPTICAL TRANSFORMS OF ELECTRON MICROGRAPHS. (2-5 cr; prereq Anat 8135, 8136, 8137 or equiv, BioC 5523, Chem 5574 or equiv, #) Runge
Practical application of the optical diffractometer to electron micrographs, including independent research or thesis-related material.

8272. IMMUNOBIOLOGY. (2 cr; prereq #; offered when feasible) Azar
Review of basic research outlines in immunobiology. Methodology, experimental outline, and significance. Group discussions.

8275. NORMAL AND ABNORMAL LYMPHOCYTE DIFFERENTIATION. (2 cr; prereq 8109, MicB 5218, #) LeBien
Methodology, utilization, and theory behind hybridomas and monoclonal antibodies. B cell hybridomas (murine and human) and T cell hybridomas (murine and human)—past, present, future. Lectures and group discussions.

8300. CURRENT TOPICS IN MEDICAL GENETICS. (2 cr; prereq # or △) Eaton, Hirsch
Current developments in medical genetics and concepts of pathogenesis of genetic diseases.

Pediatrics (Ped)

Regents' Professor: Alfred F. Michael, *head;* James G. White

Professor: C. Carlyle Clawson, *director of graduate studies*; David M. Brown; Patricia Ferrieri; Alfred J. Fish; G. Scott Giebink; Edward L. Kaplan; William Krivit; Russell V. Lucas, Jr.; Sheldon M. Mauer; Bernard L. Mirkin; James H. Moller; Mark E. Nesbit; Paul G. Quie; Richard B. Raile; Harvey L. Sharp; Kenneth F. Swaiman; Robert W. ten Bensel; Robert A. Ustrom; Homer D. Venters; Robert L. Vernier; Warren J. Warwick

Associate Professor: Amos Deinard; Rolf R. Engel
Assistant Professor: Bruce R. Blazar

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

Degree Offered—M.S.Ped. (Plan A only).

Curriculum—The Department of Pediatrics offers broad opportunities for graduate training in the general field of pediatrics as well as in its subspecialties. The program permits candidates to complete the requirements for the specialty of pediatrics. Qualified candidates who wish to pursue careers in teaching and research or to continue graduate work in certain subspecialties may extend their clinical program to include further training in a clinical subspecialty and related basic sciences.

Prerequisites for Admission—Applicants must hold an M.D. degree from an approved medical school and have completed one year of post-M.D. clinical pediatric training in an accredited pediatric residency program.

Special Application Requirements—At the time of application, candidates for the master's degree usually will be in the process of completing or will have completed their initial three years of clinical pediatrics residency required for specialty board certification. Application to the master's degree program and the Graduate School must be made in conjunction with an application for post-residency subspecialty pediatric clinical fellowship training. Details of the application process may be obtained from the director of graduate studies.

Master's Degree Requirements—Candidates must (1) be eligible for certification by the American Board of Pediatrics, which requires three years of clinical pediatric training beyond the M.D. degree; (2) complete an additional two to three years of clinical subspecialty, training coursework, and thesis project work; (3) Pass oral and written final examinations. The specific clinical subspecialty field in pediatrics, chosen as the candi date's area of major emphasis, may have additional special requirements. Contact the director of graduate studies for further information.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Department of Pediatrics, Box 391 Mayo, University of Minnesota Health Sciences, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address).

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

8202f,w,s,su. PEDIATRIC CLINICS. (Cr ar; prereq #) Krivit and staff

8204f,w,s,su. RESIDENCY IN PEDIATRICS. (Cr ar; prereq #) Krivit and 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 grad students who have completed at least 11.2years of 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.

8208f,w,s,su. PEDIATRIC RESEARCH. (Cr ar; prereq #) Staff

Pharmaceutics (Phm)

Professor: Ronald J. Sawchuk, *director of graduate studies*; Gilbert S. Banker; Yueh-Erh Rahman; Edward G. Rippie

Associate Professor: David Angaran; James C. Cloyd; Darwin E. Zaske

Assistant Professor: Walid M. Awni; Raj G. Suryanarayanan; Cheryl L. Zimmerman

Adjunct Assistant Professor: Keith K. Chan

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 available in physical pharmacy, biopharmaceutics and pharmacokinetics. Minor fields of particular value include chemistry, chemical engineering, mechanical engineering, biochemistry, biometry, and pharmacology.

Prerequisites for Admission—A degree from a recognized college of pharmacy and an exceptional scholastic record are required. Individuals from other academic fields, however, 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, a statement of career goals is required.

Master's Degree Requirements—Required components of the program include advanced courses in pharmaceutics and chemistry. A complete list of degree program requirements may be obtained from the director of graduate studies. An oral final examination is required for both plans.

Doctoral Degree Requirements—Required components of the program include advanced courses in pharmaceutics, 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—Contact the director of graduate studies, Department of Pharmaceutics, 9-105 Health Sciences Unit F, University of Minnesota, 308 Harvard Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Phmc 5680. PHARMACOKINETICS. (4 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.

5696.* PREPARATION OF PARENTERAL PRODUCTS. (3 cr; prereq #) Staff
Principles and procedures involved in manufacture of parenteral products.

5699.* SPECIAL PROBLEMS IN PHARMACEUTICS. (Cr ar; prereq #) Staff
Problems in formulation, production, and evaluation of pharmaceutical products.

8100.* SEMINAR: PHARMACEUTICS. (1 cr; required of majors in pharmaceutics) Staff

8101. READINGS IN PHARMACEUTICS. (1 cr; prereq #) Staff
Current literature.

8105. PHARMACOKINETICS RESEARCH SEMINAR. (2 cr; prereq Phm grad student specializing in pharmacokinetics) Sawchuk, Zimmerman
Advanced topics in animal and human pharmacokinetics.

8200.* RESEARCH PROBLEMS. (Cr ar; prereq #) Staff
Experimental investigation of problems in pharmaceutics.

8410. STABILIZATION OF PHARMACEUTICALS. (3 cr; prereq survey course in physical chemistry or #; offered alt yrs) Staff
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 1231 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) Zimmerman
Nonlinear pharmacokinetics (concentration- and time-dependent), drug metabolite kinetics, kinetics of pharmacological response, population kinetics.

8430. DRUG TRANSPORT. (3 cr; prereq survey course in physical chemistry or #; offered alt yrs) Wiedmann
Theory of diffusional transport of drug molecules with applications to pharmaceutical dosage forms.

8440. PHYSICAL PHARMACY. (4 cr; prereq Phmc 5680 and survey course in physical chemistry or #; 4 hrs per wk; offered when demand warrants) Rippie
Application of physical chemical relationships between drugs and their formulations for optimization of bioavailability.

8441. PHYSICAL PHARMACY. (4 cr; prereq Phmc 5680 and survey course in physical chemistry or #; offered alt yrs) Suryanarayanan
Physical and physical chemical properties of drugs in solid state form as related to their bioavailability.

8442. PHYSICAL PHARMACY LABORATORY. (1 cr; prereq Phmc 5680, ¶8441, and a survey course in physical chemistry or #; offered when demand warrants) Rippie
Laboratory 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) Agyilirah, Banker
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.

Pharmacology (Phcl)

Professor: Horace H. Loh, *head;* Akira E. Takemori, *director of graduate studies;* Lloyd Beck[1]; Bianca M. Conti-Tronconi; Richard M. Eisenberg[1]; Robert P. Elde; Nelson D. Goldberg; Patrick E. Hanna; Jordan L. Holtzman; Alice A. Larson; Nancy M. Lee; Jack W. Miller; Bernard L. Mirkin; Herbert T. Nagasawa; Philip S. Portoghese; Michael A. Raftery; Norman E. Sladek; Sheldon B. Sparber; Ben G. Zimmerman

Associate Professor: James F. Cumming; Earl W. Dunham; Thomas P. Green; Donald B. Hunninghake; Edward T. Knych[1]; Ping-Yee Law; Robert F. O'Dea; Aloysius J. Quebbemann; Jean F. L. Regal[1]; Virginia S. Seybold; Alan R. Sinaiko; George L. Wilcox

Assistant Professor: John R. Babson; Rita B. Messing; George J. Trachte[1]; Kendall B. Wallace[1]; Timothy F. Walseth

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

Degrees Offered—M.S.[2] under special circumstances (Plan A only) and Ph.D.

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, 8204, 8211, 8214, and 8217. Prerequisite courses include physiology and biochemistry. Additional requirements are courses in histology, 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 14 credits must be completed in Phcl 5111 or the equivalent, 8204, and 8211. The remaining credits can be completed in other advanced pharmacology courses.

[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 director of graduate studies on the Twin Cities campus, or the program director or Graduate School office on the Duluth campus.*

For Further Information—Contact the director of graduate studies, Department of Pharmacology, 3-260 Millard Hall, University of Minnesota, 435 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5110. PHARMACOLOGY. (5 cr; prereq regis med or #) Hunninghake, staff
Lectures and laboratories on general principles of pharmacology and major classes of drugs.

5111. PHARMACOLOGY. (4 cr; prereq 5110 or #) Hunninghake, staff
Continuation of 5110.

8110w. ADVANCED PHARMACOLOGY. (2 cr; prereq BioC 5752, Phsl 8111 and ¶5111 or #) Walseth, staff
Supplement to 5110/5111. Contemporary research concepts and experimental approaches in different areas of investigative pharmacology.

8204. SEMINAR: SELECTED TOPICS IN PHARMACOLOGY. (3 cr on completion of 3 qtrs; prereq 5111 or #) Wilcox, staff

8206w. OPIOID TOPICS. (1 cr; prereq #) Takemori
Special topics in opiate and opioid-related research.

8207. SEMINAR: PSYCHOPHARMACOLOGY. (1 cr; prereq #) Sparber, staff
Selected topics on behavioral aspects of drug action.

8208s. NEUROPSYCHOPHARMACOLOGY. (3 cr; 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.

8209. CURRENT RESEARCH IN DRUG METABOLISM. (1 cr; prereq #) Holtzman
Seminar dealing with current advances in fields of drug metabolism and disposition of pharmacological agents. Bioactivation of drugs and environmental agents leading to toxicity and carcinogenesis a primary focus.

8210s. PHARMACOLOGY OF IMMUNOSUPPRESSIVE DRUGS. (1 cr; prereq #) Sladek
Discussions focusing on current developments in field. Journal articles, contemporary methodology, new concepts, and local research projects covered.

8211f. PHYSIOLOGICAL DISPOSITION OF DRUGS. (2 cr; prereq BioC 5752 or equiv or #) Quebbemann, staff
Principles underlying pharmacokinetics, biotransformation, and excretion of drugs.

8212. REGULATION OF CELL FUNCTION AND METABOLISM. (1 cr; prereq #) O'Dea, staff
Current advances in the fundamental processes underlying control of cellular events, including processes related to cyclic nucleotides, calcium, phospholipid and lipid metabolism, and cellular events such as contraction, secretion, motility and proliferation.

8213. RENAL HANDLING OF DRUGS AND ORGANIC SUBSTANCES. (1 cr; prereq #) Quebbemann
Papers from current literature presented and discussed by participants.

8214s. TOXICOLOGY. (2 cr; prereq MdBc 5101 or #) Babson, staff
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 per qtr; prereq #) O'Dea, staff
Contemporary research problems, investigative approaches and methodologies in experimental pharmacology. Cardiovascular, renal, endocrine, and autonomic pharmacology; neuropharmacology; psychopharmacology; chemotherapy; toxicology.

8219s. ADVANCED TOXICOLOGY. (1 cr; prereq 8214 or #; offered alt yrs) Babson
Lectures on the biochemical mechanisms of intoxication by selected compounds.

Philosophy (Phil)

Professor: Marcia M. Eaton, *chair;* Michael Root, *director of graduate studies*; Arthur L. Caplan; Norman O. Dahl; Ronald N. Giere; Keith Gunderson; William H. Hanson; Geoffrey P. Hellman; Jasper Hopkins; Douglas E. Lewis; H. E. Mason; Rolf E. Sartorius; C. Wade Savage; Burnham Terrell; John R. Wallace

Associate Professor: C. Anthony Anderson; John M. Dolan; Sandra L. Peterson; Naomi B. Scheman

Assistant Professor: Margaret Morrison; Joseph I. Owens

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 15. 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. Students decide, in consultation with their adviser, whether language study will be included in their programs.

For Further Information—Further details about the program are presented in the publication *Department Degree Programs: M.A. and Ph.D.*, available from the Department of Philosophy. Contact the director of graduate studies, Department of Philosophy, 355 Ford Hall, University of Minnesota, 224 Church Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5003. AMERICAN PHILOSOPHY. (4 cr; prereq 1002 or 1 qtr history of philosophy or #; offered when feasible)
Selected American philosophers; e.g., Edwards, Peirce, James, Dewey, Lewis.

5004. SOCRATIC DIALOGUES. (4 cr; prereq 3001 or #; offered when feasible) Dahl, Hopkins, Lewis, Peterson
Early Socratic dialogues of Plato with emphasis on Socratic method and paradoxes.

5005. PLATO. (4 cr; prereq 3001 or #; offered alt yrs) Hopkins, Peterson
Analysis of major dialogues.

5008. ARISTOTLE. (4 cr; prereq 1 qtr history of philosophy or #; offered alt yrs) Dahl, Peterson
Selected passages from major works.

5012. PLATO AND ARISTOTLE. (4 cr; prereq 3001 or #; offered when feasible) Dahl, Peterson
Comparative presentation of metaphysical and epistemological views; problem of universals.

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.

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, Scheman
The *Ethics*.

5036. LEIBNIZ. (4 cr; prereq 3003 or #; offered when feasible) Dahl
Selected philosophical writings.

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
Philosophical works.

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, Mason
Selected passages from major works.

5054. KIERKEGAARD. (4 cr; prereq 1 qtr history of philosophy or #; offered when feasible) Mason
Major philosophical works.

5055. SOCIAL AND POLITICAL PHILOSOPHY OF KARL MARX. (4 cr; prereq 3004 or #; offered when feasible) Owens
Central topics in Marx's social and political philosophy; philosophy of history, alienation, emancipation, critique of ethical and political ideas, death of the state. Marx's criticism of traditional epistemology and methodology; and epistemological and methodological assumptions.

5068. LATER PHILOSOPHY OF WITTGENSTEIN. (4 cr; prereq 5231 or 3003 or #; offered alt yrs) Mason, Scheman
Philosophical Investigations.

5076. THOREAU. (4 cr; prereq 4 cr in philosophy or #; offered when feasible) Dolan
Walden and selected essays.

5101. METAPHYSICS. (4 cr; prereq 1 qtr history of philosophy or #; offered alt yrs) Anderson, Dolan, Owens
Philosophical theories concerning nature of reality.

5105. EPISTEMOLOGY. (4 cr; prereq 1001 or #; offered alt yrs) Anderson, Dolan, Savage
Theories of origin, development, reliability, justification, and scope of knowledge.

5201. SYMBOLIC LOGIC I. (5 cr; prereq 1001 or #) Anderson, Dahl, Dolan, Hanson
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 #) Anderson, Dahl, Dolan, Hanson
Further study of first-order predicate logic: identity, axiomatic development. Various metatheorems: soundness, consistency, and completeness.

5203. SYMBOLIC LOGIC III. (4 cr; prereq 5202; offered alt yrs) Anderson, Hanson, Hellman
Axiomatic development of first-order predicate logic and first-order number theory; proofs of limitative results such as undecidability of predicate logic and incompleteness of number theory. Significance of limitative results.

5211. MODAL LOGIC. (4 cr; prereq 5202 or Math 5162 or #; offered alt yrs) Anderson, 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) Anderson, 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) Anderson, 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) Anderson, Dolan, Mason, Owens, Peterson, Root
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) Anderson, Dolan, Hellman, Mason, Owens, Peterson, Root
Detailed study of topics surveyed in 5231 or other topics central to the philosophy of language.

5301. HISTORY OF ETHICS: BRITISH MORALISTS. (4 cr; prereq 1003 or 1 qtr history of philosophy or #; offered alt yrs)
Ethical theory in Great Britain from 17th through 19th centuries.

5302. HISTORY OF ETHICS: SELECTED CLASSICAL MORALISTS. (4 cr; prereq 1003 or 1 qtr history of philosophy or #; offered alt yrs) Dahl, Peterson
Moral philosophy outside of British tradition (see 5301). Specific topics announced in the *Class Schedule.*

5311. ETHICAL THEORY. (4 cr; prereq 1003 or #; offered alt yrs) 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, Scheman
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) Mason
Philosophical accounts of the concept and principles of justice.

5324. ETHICS AND EDUCATION. (2-4 cr; prereq 8 cr philosophy or education or #; offered when feasible) Scheman
Recent studies relating ethical theory and philosophy of education; theories of moral development and moral education.

5414. POLITICAL PHILOSOPHY. (4 cr; prereq 1004 or #; offered alt yrs) Dolan, Hellman
Central concepts and principal theories of political philosophy.

5415. PHILOSOPHY OF LAW. (4 cr; prereq 1003 or 1004 or 3302 or social science major or #; offered when feasible)
Analytical accounts of law and legal obligation.

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; prereq 8 cr in philosophy; offered alt yrs) Anderson, Hopkins, Owens
Grounds and sanctions of religion according to various philosophies.

5601. PHILOSOPHY OF SCIENCE: CONFIRMATION AND THEORY TESTING. (4 cr; prereq 1001 or 3601 or #) Giere, Hanson, Morrison, Savage
Principles of scientific method; contemporary approaches to scientific inference.

5602. PHILOSOPHY OF SCIENCE: THEORIES AND EXPLANATION. (4 cr; prereq 3601 or 5601 or #) Giere, Hellman, Morrison, Savage
Major contemporary views about structure of scientific theories and nature of scientific explanation.

5603. PHILOSOPHY OF SCIENCE: SCIENTIFIC CHANGE. (4 cr; prereq 3601 or 5601 or history of science course or #) Giere, Morrison
Major contemporary views about growth of scientific knowledge.

5604. PHILOSOPHY OF SCIENCE: DETERMINISM AND CAUSATION. (4 cr; prereq 1001 or #; offered when feasible) Hellman, Morrison
Attempts to analyze concepts of determinism and causation, their importance for science and human affairs.

5605. PHILOSOPHY OF SCIENCE: TIME AND SPACE. (4 cr; offered when feasible) Hellman, Morrison, Savage
Survey of major philosophical problems concerning nature and structure of space, time, and space-time.

5606. PHILOSOPHY OF QUANTUM MECHANICS. (4 cr; prereq 3601 or Phys 3501 or Math 3142 or #)
Introduction to problems of interpretation of ordinary (nonrelativistic) quantum mechanics: two-slit experiment, Schrodinger 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 SCIENCE: PROBLEMS OF THE BIOLOGICAL SCIENCES. (4 cr; prereq course in philosophy of science or biology; offered when feasible) Caplan
Major philosophical questions that arise in connection with biology: structure and status of evolutionary theory, reductionism in biology, legitimacy of teleology, nature of species, relation of biology to social sciences.

5608. PHILOSOPHY OF SCIENCE: THEORY AND MEASUREMENT. (4 cr; prereq 5201 or #; offered when feasible) Savage
Introduction to theory of measurement, its applications in philosophy of science, metaphysics, and epistemology.

5609. PHILOSOPHY OF SCIENCE: PHILOSOPHICAL ISSUES OF PERCEPTION AND COGNITION. (4 cr; prereq 1002 and either 3601 or 3607 or 5601 or 5607 or 5105 or Psy 3031 or Psy 3051 or Psy 5011 or Psy 5031 or #; offered when feasible) Savage
Philosophical implications of contemporary theories of perception and perceptual thinking.

5611. PHILOSOPHY OF THE SOCIAL SCIENCES I. (4 cr; prereq 12 cr philosophy or social sciences or #; offered when feasible) Root, Scheman
Criteria for describing and explaining human actions; problems of objectivity, reduction, freedom.

5612. PHILOSOPHY OF THE SOCIAL SCIENCES II. (4 cr; 5611 recommended; offered when feasible) Root, Scheman
Intensive study of certain topics in 5611.

5613. RELATIVISM. (4 cr; prereq 1002 or #; offered alt yrs) Mason, Root, Scheman
Attempts of philosophers, social scientists, and students of literature to understand aspects of human life and discourse by appealing to alleged relativities of concepts and institutions to culture, language, world view, or conceptual scheme.

5614. PHILOSOPHY OF SCIENCE: CURRENT ISSUES IN THE PHILOSOPHY OF PSYCHOLOGY. (4 cr; prereq Psy 3051 or Psy 5011 or 3607 or 5601 or #; offered when feasible) Owens, Savage
Problems and prospects of recent approaches to study of the mind.

5615. MINDS, BODIES, AND MACHINES. (4 cr; prereq 4 cr in philosophy or #; offered alt yrs) Gunderson, Owens
Philosophical relevance of cybernetics, artificial intelligence, and computer simulation.

5621. PHILOSOPHY OF HISTORY. (4 cr; prereq 8 cr in philosophy or 12 cr history; offered when feasible) Hopkins, Mason
Philosophical interpretations of history; philosophical aspects of historical methods.

5622. PHILOSOPHY AND FEMINIST THEORY. (4 cr; prereq 8 cr in Phil or in women's studies or #)
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) Staff
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 the *Class Schedule*.

5760, 5770. SELECTED TOPICS IN PHILOSOPHY. (4 cr per qtr; prereq 4 upper division cr in philosophy or #) Staff
Philosophical problems of contemporary interest. Specific topics announced in the *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.

5911. PHILOSOPHY IN LITERATURE. (4 cr; prereq major or minor in philosophy or literature or #; offered when feasible) Eaton, Root, Scheman
Basic philosophical ideas in civilization as expressed in major works of literature.

5970, 5990. DIRECTED STUDY AND RESEARCH. (1-5 cr per qtr; prereq #, △, CLA approval) Staff

8090. SEMINAR IN HISTORY OF PHILOSOPHY. (4 cr [may be repeated for cr]; prereq #) 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 the *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 the *Class Schedule*.

8180. SEMINAR: PHILOSOPHY OF LANGUAGE. (4 cr [may be repeated for cr]; prereq #) Staff

8210. SEMINAR: LOGICAL THEORY. (4 cr [may be repeated for cr]; prereq 5201, 5202 or #) Staff
Selected topics in the philosophy of logic.

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.

8410. SEMINAR: PHILOSOPHY OF LAW. (4 cr [may be repeated for cr], §Law 5843; prereq #; offered when feasible)
Especially for advanced political science, history, or sociology majors or minors and law students.

8510. SEMINAR: STUDIES IN AESTHETICS. (4 cr [may be repeated for cr]; prereq #) Eaton, Gunderson
Problems in aesthetics. Specific topics announced in the *Class Schedule*.

8550. SEMINAR: PHILOSOPHY OF RELIGION. (4 cr [may be repeated for cr]; prereq 5521 or #) Hopkins
Conceptual structure of religion.

8600. SEMINAR: PHILOSOPHY OF SCIENCE. (4 cr [may be repeated for credit]; prereq #)

8610. SEMINAR: PHILOSOPHY OF THE PHYSICAL SCIENCES. (4 cr [may be repeated for cr]; prereq #)

8620. SEMINAR: PHILOSOPHY OF BIOLOGY. (4 cr [may be repeated for credit]; prereq #)

8640. SEMINAR: PHILOSOPHY OF PSYCHOLOGY. (4 cr [may be repeated for cr]; open to advanced grad students in philosophy or psychology with written consent) Owens, Savage

8650. SEMINAR: PHILOSOPHY OF THE SOCIAL SCIENCES. (4 cr [may be repeated for cr]; prereq #)

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

Physical Education

Professor: Michael Wade, *director and director of graduate studies;* John F. Alexander[1]; William R. Charlesworth; Gary A. Fine; Roger T. Johnson; Arthur S. Leon; Herbert L. Pick; Jeralyn J. Plack; Jacqueline Shick; Lela J. Stoner; Albert Yonas

Associate Professor: Douglas H. Anderson; Richard S. Crow; March L. Krotee; Robert C. Serfass; Mary L. Young

Assistant Professor: Allen W. Burton; Nancy L. Greer

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 doctoral program are biodynamics, motor behavior, and sociocultural dimensions of sport. Emphases in the master's program include the above and, in addition, curriculum and instruction.

Prerequisites for Admission—Although prospective students generally have an undergraduate degree in the field, others may be admitted who have related preparation and a significant background in physical activity. Admitted students may be required to complete background preparation.

[1]*Also holds graduate faculty appointment in Education.*

Special Application Requirements—A completed interest/experience form, scores from the Miller Analogies Test, letters of recommendation evaluating the applicant's scholarship, and submission of a scholarly paper are required. Applicants for all emphases must submit a form on physical activity/sport background.

Master's Degree Requirements—Requirements include PE 5980, 8980, 8981 (Plan B only), EPsy 5260, and evidence of effective professional communication. The final examination is written and oral for Plan A students and oral only for Plan B students.

Doctoral Degree Requirements—Programs are individually designed in one area of emphasis. Common requirement examinations are based on PE 5980, and EPsy 8260, 8261, and 8262.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, School of Physical Education and Recreation, 110 Cooke Hall, University of Minnesota, 1900 University Avenue S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Note—Physical education course listings immediately follow the recreation, park, and leisure studies program description below.

Recreation, Park, and Leisure Studies

Professor: Michael Wade, *director of graduate studies*

Associate Professor: Bruce D. Anderson[1]; Diane P. Hedin; Timothy B. Knopp; Leo H. McAvoy[1]; Stuart J. Schleien; John H. Schultz[1]; Caroline R. Weiss[1]

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.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, voluntary/youth-serving agencies, and recreational sports, (intramurals). 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.

Master's Degree Requirements—Requirements include 5980, 8980, and 8981 (Plan B only). The community education emphasis is interdisciplinary and available under 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 15 credits in the historical, scientific, and philosophical foundations of recreation, park, and leisure studies; an emphasis area of at least 32 credits; thesis development of at least 49 credits (including 36 thesis credits); and a supporting program or minor of at least 24 credits. Foundation requirements are examined in association with the written preliminary examination.

Language Requirement—None.

[1]*Also holds graduate faculty appointment in Education*

For Further Information—Contact the director of graduate studies, School of Physical Education and Recreation, 110 Cooke Hall, University of Minnesota, 1900 University Avenue S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Note—Recreation, park, and leisure studies course listings immediately follow the physical education and school health education course listings below.

Physical Education (PE)

5100. TEACHING PHYSICAL EDUCATION FOR THE HANDICAPPED. (3 cr; prereq #)
Introduction to the role of physical education in the education of the handicapped individual, emphasizing understanding, principles of organization, administration, curriculum, supervision, and evaluation.

5101. PHYSICAL EDUCATION ACTIVITIES FOR THE HANDICAPPED. (3 cr; prereq 5100 or EPsy 5601)
Adaptation of methods, materials, and physical activities to meet the needs of the physically, mentally, or emotionally atypical student applied to specific handicaps in selected activity areas.

5102. PRACTICUM: PHYSICAL EDUCATION FOR THE HANDICAPPED IN AN ADAPTED SETTING. (1-3 cr [max 3]; prereq 5100, 5101 or #; S-N only)
Opportunity for teaching in schools or community settings; providing instruction for atypical individuals in segregated or adapted environment. Includes seminar for review of current theory and exchange of ideas and problems.

5103. PRACTICUM: PHYSICAL EDUCATION FOR THE HANDICAPPED IN A MAINSTREAMED SETTING. (1-3 cr; prereq 5100, 5101 or #; S-N only)
Teaching in public school environment; instruction for atypical individuals in mainstreamed setting. Includes seminar for review of current theory and exchange of ideas and problems.

5110. SUPERVISION OF PHYSICAL EDUCATION. (3 cr)
Functions; adaptations of accepted procedures for observation, guidance, and training of physical educators.

5111. PHYSICAL EDUCATION FACILITIES. (3 cr)
Planning of areas and facilities for physical education and athletics; emphasis on current trends and problems in the field.

5112. PHYSICAL EDUCATION EQUIPMENT. (3 cr)
Selection, purchase, and maintenance of athletic equipment and supplies with opportunity to investigate selected equipment in depth.

5120. ADVANCED BIOMECHANICS/KINESIOLOGY. (4 cr; prereq undergrad kinesiology or #)
Principles of mechanics applied to human movement, analysis of motor skills, application to individual projects.

5121. CONTRIBUTIONS OF BASIC SCIENCE TO PHYSICAL EDUCATION. (3 cr)
Recent research in related physical sciences; applications in selected areas.

5122. APPLIED PHYSIOLOGY. (3 cr; prereq 3386 or equiv or #)
Application of concepts in human physiology to exercise physiology, sports training, and physical activities, with particular reference to respiratory and cardiovascular systems.

5123. ANALYSIS OF MOVEMENT IN GYMNASTICS. (3 cr; prereq 3111)
Scientific principles of body mechanics and training relating to teaching, analysis, and development of advanced performance techniques.

5125. ADVANCED PHILOSOPHY OF PHYSICAL EDUCATION AND SPORT. (3 cr; prereq 3131 or #)
Examination of comprehensive, systematic, and revealing accounts of status of physical education and sport with respect to reality, knowledge, and value.

5126. ADVANCED PSYCHOLOGICAL AND SOCIOLOGICAL DIMENSIONS OF PHYSICAL ACTIVITY. (3 cr; prereq 3126 or #)
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.

5132. MOTOR DEVELOPMENT. (3 cr, §5131; prereq 3132 or #; A-F only)
Development aspects of motor skill acquisition from birth to physical maturity.

5133. PRACTICUM: ASSESSMENT OF PSYCHOMOTOR SKILLS IN YOUNG CHILDREN. (3 cr; prereq 3150 or #)
For the practitioner interested in collecting, treating, and analyzing assessment data.

5134. PERCEPTUAL-MOTOR DEVELOPMENT IN CHILDHOOD. (3 cr; prereq 3113 or #)
The motoric dimension of perception: emphasis on developmental tenets of perception, diagnosis and remediation of perceptual-motor deficiencies, and related research.

5135. MOTOR LEARNING AND HUMAN PERFORMANCE. (3 cr, §5130; prereq 3113 or 3135 or #; A-F only)
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)
Psychological aspects of coaching at the elementary, secondary, and college levels.

5140. BIOMECHANICS OF SPORT SAFETY. (3 cr; prereq undergrad kinesiology)
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 FScN 3600 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.

5150. TEACHING ELEMENTARY SCHOOL PHYSICAL EDUCATION. (3 cr; prereq tchg license or #)
Principles, techniques, and procedures in developing basic motor skills, physical fitness, and sports skills.

5151. CURRICULUM. (3 cr; prereq sr, 3322, 3323 or #)
For students without previous experience in curriculum; objectives, content, organization, evaluation, and trends.

5152. CURRICULUM DEVELOPMENT. (3 cr; prereq 5151 or #)
Trends, issues, and problems at selected levels of interest: elementary, secondary, junior college; for experienced teachers.

5160. EVALUATION IN PHYSICAL EDUCATION. (3 cr; prereq 3150 or equiv)
General principles and techniques of evaluation.

5161. PRACTICUM: CONSTRUCTION OF MOTOR PERFORMANCE TESTS. (3-6 cr; prereq 5160 or #)
Practical experience in development and/or revision of motor performance tests from preschool through college, with emphasis on test design and evaluation of instrument.

5162. PRACTICUM: CONSTRUCTION OF WRITTEN TESTS. (3-6 cr; prereq 5160 or #)
Practical experience in development of written tests, with emphasis on test design and evaluation of items.

5170. FOUNDATIONS OF PHYSICAL EDUCATION. (3 cr; prereq grad or MEd student)
Establishment of guidelines for individual and group professional action; examination of pertinent social forces, educational philosophies, and general ethics.

5328. PROSEMINAR: HISTORY OF SPORT AND PHYSICAL EDUCATION. (4 cr; prereq 3131 or #)
Examination of the secondary literature detailing and interpreting development and cultural integration of sport and physical education, primarily though not exclusively in the United States.

5351. SEMINAR: TEACHING PHYSICAL EDUCATION IN COLLEGES AND UNIVERSITIES. (1 cr [max 3]; prereq #)
Emphasis on improvement of instruction.

5371. SOCIOLOGY OF SPORT. (4 cr, §Soc 5371; prereq 3126 or #)
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.

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 #)
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]; prereq 5388 or #)
Supervised on-site training in testing, prescription, and direction of programs for adults.

5620. PRACTICUM: PREVENTION AND CARE OF ATHLETIC INJURIES. (3 cr; prereq Anat 1027 or equiv)
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.

5650. INTERNSHIP. (1-9 cr; prereq MEd, MA or PhD student, 18 cr at 5-level in PE and #)
On-the-job experience in private schools, colleges, private and state agencies in selected areas of physical education—administration, curriculum, supervision, and biomechanics.

5710. WORKSHOP: PHYSICAL EDUCATION FOR THE ELEMENTARY SCHOOL CHILD. (1-12 cr [max 12])
Current trends, instructional techniques, and resource materials.

5720. TOPICS IN PHYSICAL EDUCATION. (1-12 cr [max 12]; prereq #)
Current issues related to physical education and sport.

5740. WORKSHOP: COACHING OF INDIVIDUAL, DUAL, OR TEAM SPORTS. (1-12 cr [max 12])
Instruction at advanced level, including analyses of skills, game strategies, specific techniques of coaching, and methods of training and conditioning.

5750. ATHLETICS IN CONTEMPORARY SOCIETY. (3-9 cr)
Contemporary issues; background on organizational and management problems of interscholastic and intercollegiate athletics. Each offering focuses on a current problem.

5980. RESEARCH METHODOLOGY. (3 cr, §Hlth 5980; prereq ed or grad student)
Methods and design for research in health, physical education, and recreation.

5983. READINGS: PHYSICAL EDUCATION. (Cr ar [max 9]; 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 the purpose, methods, findings, conclusions, and implications.

8113. COLLEGE PHYSICAL EDUCATION ADMINISTRATION. (3 cr; prereq 8110)
Principles and procedures in the management of physical education programs in colleges and universities.

8126. SEMINAR: PSYCHOLOGICAL AND SOCIOLOGICAL DIMENSIONS OF PHYSICAL ACTIVITY. (3 cr; prereq 5126 or #; offered alt yrs)
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 #)
Sport psychological phenomena, including motivation, factors affecting participation, mental training to enhance performance, implications for coaches and teachers, trends, issues, related research.

8132. SEMINAR: MOTOR DEVELOPMENT. (4 cr; prereq 5132 or equiv, course in stat 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.

8150. PROFESSIONAL PREPARATION OF PHYSICAL EDUCATION TEACHERS. (3 cr; prereq 5151 or equiv)
Current needs, issues, trends, curriculum patterns and standards; for experienced teachers.

8320. SEMINAR: BIOMECHANICS. (3-9 cr; prereq 5120)
Application of one or more techniques of analysis to an individually selected problem.

8325. SEMINAR: PHILOSOPHY OF PHYSICAL EDUCATION AND SPORT. (3-9 cr [max 9]; prereq 5125; offered when feasible)
Philosophic bases of thought concerning physical education and sport; investigation of student-selected issues or problems regarding the status of physical education and sport, with respect to theories of reality, knowledge, and value.

8328. SEMINAR: HISTORY OF SPORT AND PHYSICAL EDUCATION. (4 cr; prereq 5328 or #; A-N only; offered when feasible)
Historical research tools and techniques; types and sources of primary evidence, critical examination of hypotheses, and writing, culminating in student primary research and presentation of scholarly papers.

8381. LABORATORY RESEARCH TECHNIQUES. (1-3 cr; prereq 5980 or ¶5980)
Demonstration and student participation in laboratory procedures involving assessment of exercise parameters.

8382. BIOMECHANICS: RESEARCH TECHNIQUES. (3 cr; prereq 5120 or #)
Laboratory course: developing expertise in techniques used for biomechanical research in human motion.

8980. GRADUATE RESEARCH SEMINAR. (1 cr [max 2]; S-N only; prereq #)
Reporting and discussion of student and faculty research activity. Required of all M.A. and Ph.D. candidates.

8981. RESEARCH PROBLEMS. (Cr ar; S-N only; prereq 8980 or #)
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, §8120; prereq MEd, adult special or grad student)
Investigation of the historical, sociological, and educational bases of the recreative use of leisure in contemporary society.

5160. CONSERVATION OF PARK RESOURCES. (3 cr; prereq 1520 or 5100 or △)
Environmental considerations in relation to recreation and leisure services.

5170. CAMP ADMINISTRATION. (3 cr; prereq 1540 or #)
Management and operation of group camping facilities.

5180. EMPLOYEE RECREATION SERVICES. (3 cr; prereq 1520 or 5100 or △)
Survey of history, development, and management patterns of employee recreation services in business, government, and industry.

5190. COMMERCIAL RECREATION. (3 cr; prereq 3550 or △)
Survey of the scope and development of profit-making recreation agencies, facilities, and services.

5200. RECREATION IN COMMUNITY EDUCATION. (3 cr; prereq 1520 or 5100 or △)
Recreation and leisure services in the community education process.

5210. INTRODUCTION TO THERAPEUTIC RECREATION. (3 cr; prereq 1520 or ¶5100 or Rec major or △)
Relationship of recreation to special populations; milieu and interdisciplinary approaches in delivery of services.

5220. THERAPEUTIC RECREATION SERVICES. (5 cr; prereq 5210 or △)
Recreation service for the ill, disabled, and other special populations.

5230. RECREATION AND MENTAL RETARDATION. (3 cr; prereq 5210, 5220 or #)
Issues relating to leisure services for persons with mental retardation problems; 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 #, △)
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 △)
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 △)
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 #, △)
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 FOR SPECIAL POPULATIONS. (3 cr; prereq 1520, Rec major or △)
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 handicaps.

5299. CLIENT ASSESSMENT AND PROGRAM EVALUATION IN THERAPEUTIC RECREATION. (4 cr; prereq 5220 or △)
In-depth study and application of approaches to therapeutic recreation, client assessment, program evaluation.

5300. FOUNDATIONS OF OUTDOOR EDUCATION. (3 cr; prereq sr, 1520 or 5100 or #)
Philosophical, historical, and educational foundations of outdoor education.

5310. PROGRAMMING IN OUTDOOR EDUCATION. (4 cr; prereq 5300 or #)
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. (4 cr; prereq 3150, fitness test of running 2 miles in less than 17 minutes or #)
Exploration of leisure and educational resources of wilderness and management of wilderness-based outdoor recreation and outdoor education programs.

5455. RECREATIONAL SPORTS. (3 cr, §PE 5255)
In-depth analysis of processes and benefits of recreational sports programming and participation.

5630. PRACTICUM: THERAPEUTIC RECREATION. (3-9 cr; prereq recreation MEd or grad student; S-N only)
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)
Supervised experiences in program operation; administrative and supervisory duties.

5750. LEGAL ISSUES IN LEISURE SERVICES. (4 cr; prereq 3550 or △)
Basic legal considerations in delivery of leisure services in public and private sectors.

5900. WORKSHOP: CONTEMPORARY ISSUES IN LEISURE SERVICES. (1-12 cr [max 12]; prereq △)
Contemporary issues emphasizing administrative and supervisory functions for recreation and allied professionals; individual offerings focus on special issues and/or professional groups.

5980. INTRODUCTION TO RESEARCH. (3 cr, §PE 5980; prereq MEd or grad student or △)
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 △)
Focus on conduct of recreation programs.

5983. READINGS: RECREATION. (1-3 cr; prereq MEd or grad student or △)
Independent study under tutorial guidance.

8310. SEMINAR: RECREATION AND PARK ADMINISTRATION. (1-9 cr; prereq △)
Critical study, supervised planning of fieldwork experience, and special problems under guidance of adviser.

8370. SEMINAR: ADMINISTRATIVE PROBLEMS IN THERAPEUTIC RECREATION. (3 cr; prereq 5220 or #)
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)
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. RESEARCH PROBLEMS. (1 cr; S-N only; prereq 5980, PsyF 5110 or EPsy 5260 or #)
Designing, reporting on individual problems. Required of all M.A. and Ph.D. candidates.

8981. RESEARCH PROBLEMS. (Cr ar; S-N only; prereq 8980 or #)
Individual problems.

Physical Medicine and Rehabilitation (PMed)

Professor: Essam A. Awad, *director of graduate studies;* Gary T. Athelstan

Clinical Professor: Paul M. Ellwood, Jr.

Associate Professor: Robert Patterson

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, Kenny Rehabilitation Institute, 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 designed 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—Contact the director of graduate studies, Department of Physical Medicine and Rehabilitation, Box 297 Mayo, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address).

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

8200f,w,s,su. PHYSIATRY SERVICE. (Cr ar) Staff
Service at University Hospitals, Hennepin County Medical Center, St. Paul-Ramsey Medical Center, Kenny Rehabilitation Institute, Veterans Administration Medical Center, and other affiliated hospitals.

8205f,w,s,su. READINGS IN PHYSICAL MEDICINE AND REHABILITATION. (2 cr per qtr) Benninghoff

8206f,w,s. CONFERENCE ON PHYSICAL MEDICINE AND REHABILITATION. (2 cr per qtr) Awad, Moret
Topics vary from quarter to quarter. Prepared papers required.

8207. BASIC AND APPLIED PHYSIATRY. (2 cr) Awad, staff
Assigned readings, lectures, and discussions on anatomic, physiologic, pathologic, biophysical, and psychological bases of physiatry.

8208. APPLIED ELECTRODIAGNOSIS IN KINESIOLOGY. (1 cr; prereq ¶8207) Staff
Laboratory exercises to provide applied learning experiences in kinesiology and neuromusculoskeletal anatomy and familiarization with electrodiagnostic principles and equipment.

8210f,w,s,su. RESEARCH IN PHYSICAL MEDICINE. (Cr ar) Awad, Patterson, and staff

8211f,w,s,su. ELECTRONICS IN PHYSICAL MEDICINE. (2 cr) Patterson
Review of principles of electronic circuits, vacuum tubes, power supplies, and their application in physical medicine.

8212f,w,s,su. ELECTROMYOGRAPHY. (Cr ar; prereq #) Benninghoff, staff
Clinical and laboratory training in use and interpretation of electromyography.

8213f,w,s. ELECTRODIAGNOSIS CONFERENCE. (Cr ar; prereq 8211 or #) Benninghoff, staff
Clinical presentation and discussion of cases examined in the Electrodiagnostic Laboratory.

8214f,w,s. READINGS IN ELECTROMYOGRAPHY. (1 cr; prereq #) Benninghoff, 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) Awad, Moret

8230. LEADERSHIP TRAINING FOR INTERDISCIPLINARY SETTINGS. (1 cr) Rosenberg

Physical Therapy (PMed)

Associate Professor: John D. Allison; Robert P. Patterson

Assistant Professor: Louis R. Amundsen, *director of graduate studies*

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 is designed to prepare 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 on-line computer recording and analysis of muscle strength; automated on-line assessment of cardiopulmonary endurance; assessment and training of elderly subjects and patients with dermatomyositis, spinal cord injuries, burns, cerebral palsy, and other conditions; and electromyographical study of movement. Specialized clinical opportunities are available in, for example, burns, cardiopulmonary and orthopedic conditions, geriatric and pediatric problems, and spinal cord injuries.

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. Fall or summer entry is advised.

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 prior to, 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—Contact the director of graduate studies, Physical Therapy, Box 388 Mayo Memorial Building, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

5135. PATHOKINESIOLOGY. (3 cr; prereq #) Pohtilla
Lecture and laboratory 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 #) Allison
Lecture and laboratory on instrumentation, physiological, anatomical, and kinesiological considerations related to electromyography and nerve conduction.

5182. FUNCTIONAL NEUROANATOMY AND NEUROPHYSIOLOGY. (5 cr) Huss

5291. SEMINAR: CONTEMPORARY ISSUES IN PHYSICAL THERAPY. (2 cr) Ellingham, Pauley
Issues in the health care delivery system as they relate to practice of physical therapy.

5810. ASSESSMENT OF THE ELDERLY. (3 cr; prereq #) Amundsen, Ellingham, Huss
Lecture and laboratory on developmental aspects of aging, with emphasis on assessment of physical and functional capacity.

5814. PHYSIOLOGICAL ASSESSMENT IN PHYSICAL THERAPY. (1-3 cr) Staff
Lecture and laboratory sessions on physiological assessment of, for example, endurance, strength, and coordination.

5817. SPECIAL TOPICS IN PHYSICAL THERAPY. (1-3 cr) Staff
Lecture and laboratory 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) Scudder, Amundsen
Current literature in physical therapy and related medical fields.

8135. ADVANCED KINESIOLOGY. (3 cr) Pohtilla
Functional anatomy stressing anatomical, physiological, and biomechanical aspects of normal and pathological human motion. Lecture with laboratory to include various techniques available for analysis.

8140. PHYSIOLOGICAL ASSESSMENT IN PHYSICAL THERAPY. (1 cr) Allison, Amundsen
Introduction to objective methods of assessing function of neuromuscular, cardiovascular, and perceptual motor systems.

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 from quarter to quarter. Prepared papers required.

8171. ADMINISTRATION OF PHYSICAL THERAPY SERVICES. (1-3 cr; prereq #) Pauley
Selected problems in administration of physical therapy in hospitals, clinics, and community agencies.

8172, 8173. EDUCATIONAL ADMINISTRATION IN PHYSICAL THERAPY. (1-3 cr per qtr; prereq #) Allison
Philosophy and objectives of physical therapy education, administrative structure, curriculum, and accreditation. 8172: Lectures and discussion. 8173: Clinical practice; analysis and construction of courses of study.

8180, 8181. PHYSIOLOGICAL BASES FOR THERAPEUTIC EXERCISE. (3 cr per qtr; prereq #) Kottke, Scudder
Lectures on physiology underlying therapeutic use of exercise.

8185. PROBLEMS IN PHYSICAL THERAPY. (Cr ar; prereq physical therapist) Staff

8188. TEACHING PRACTICUM. (Cr ar [max 8]; prereq #) Staff
Supervised experience in teaching and evaluation; development of skills in effective use of instructional materials in lecture and laboratory courses.

8192w. RESEARCH DESIGN IN PHYSICAL THERAPY. (3 cr; prereq #) Amundsen
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 #) Staff
Independent study utilizing methods of research appropriate to physical therapy.

8195. RESEARCH IN PHYSICAL THERAPY. (Cr ar; prereq 8192 or #) Staff

Physics (Phys)

Regents' Professor: Edward P. Ney; Alfred O. C. Nier (emeritus)

Professor: Marvin L. Marshak, *head*; Benjamin F. Bayman; J. Morris Blair; John H. Broadhurst; Laurence J. Cahill, Jr.; Charles E. Campbell; Keith S. Champlin; Lorne M. Chanin; Robert J. Collins; Hans W. J. Courant; Dietrich K. Dehnhard; Paul J. Ellis; George D. Freier (emeritus); Phyllis S. Freier; Stephen Gasiorowicz; Robert D. Gehrz; Clayton F. Giese; Allen M. Goldman; George W. Greenlees; J. W. Halley; Morton Hamermesh (emeritus); Kenneth Heller; Norton M. Hintz; Russell K. Hobbie; Chengcher Huang; Walter H. Johnson, Jr.; Joseph I. Kapusta; Paul J. Kellogg; Homer T. Mantis (emeritus); Konrad Mauersberger; Hendrick J. Oskam; Robert O. Pepin; William T. Peria; Earl A. Peterson; Serge Rudaz; Keith Ruddick; Wayne A. Stein; Roger H. Stuewer; Hiroshi Suura; Yau-Chien Tang; Oriol T. Valls; C. J. Waddington; Thomas F. Walsh; Walter V. Weyhmann; John R. Winckler (emeritus); William Zimmermann, Jr.

Adjunct Professor: Kenneth N. Erickson

Associate Professor: E. Dan Dahlberg, *director of graduate studies;* Yutaka Hosotani; Roger S. Jones; Robert L. Lysak; Erwin Marquit; Keith A. Olive

Assistant Professor: Chandan Dasgupta; Ronald A. Poling

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 associateships 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—Contact the director of graduate studies, Physics, School of Physics and Astronomy, 148 Tate Lab of Physics, University of Minnesota, 116 Church Street S.E., Minneapolis, MN 55455.

Note—For courses in astronomy and astrophysics, biophysics, and geophysics, see these sections of the bulletin.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5021-5022. INTRODUCTION TO ANALYTIC MECHANICS. (4 cr per qtr; prereq 3011, Math 3231 or equiv; 3 lect and 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 and 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.

5025. SPECIAL TOPICS IN ELECTRIC AND MAGNETIC FIELDS. (4 cr; prereq 5024; 3 lect and 1 problem hrs per wk; offered when feasible)
Special topics of interest to instructor.

5031-5032-5033. TOPICS IN MATHEMATICAL PHYSICS. (4 cr per qtr; prereq two 5xxx-level mathematics courses; 3 lect and 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 and 5024, advanced calculus or #; 3 lect and 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 student or grad student, or #; 2 lect and 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 student or grad student, Phys/Ast 5061 or #; 2 lect and 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.

5063. COMPUTATIONAL METHODS IN THE PHYSICAL SCIENCES III. (4 cr, §Ast 5063; prereq CLA jr or sr or IT upper div student or grad student, Phys/Ast 5062 or #; 2 lect and 6 lab hrs per wk)
Simulation of complex physical systems by advanced computational techniques. Major project selected by student in areas such as plasmas, stellar systems and evolution, magnetohydrodynamics, fluid or aerodynamic flow, molecular dynamics, statistical mechanics. Simulations use Supercomputer Institute Cray-2 and/or Cyber 205.

5091. PHYSICAL ACOUSTICS OF MUSIC. (5 cr; does not carry grad cr in physics; prereq 1 yr high school algebra, upper division or grad standing in music or music education or equiv background in music theory and practice or #; 3 lect, 1 discussion, and 3 lab hrs per wk; offered when feasible)
Principles of physics and acoustics related to musical sounds, musical instruments, and electronic production and reproduction of musical sounds. Laboratory work is an integral part of course.

5101-5102. INTRODUCTION TO QUANTUM MECHANICS. (4 cr per qtr; prereq 3512; 3 lect and 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 FORTRAN programming desirable; 3 lect and 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 and 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. Laboratory: 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. Laboratory: 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 prior to registration.

5151-5152-5153. QUANTUM MECHANICS. (4 cr per qtr; prereq 5102 or equiv, advanced calculus or #; 3 lect and 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 and 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 or advanced undergrad students 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 and 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.

5351. EXPERIMENTAL PARTICLE PHYSICS. (4 cr; prereq 3513; 3 lect hrs per wk and field trips; offered when feasible)
Interactions of particles and photons with matter and radiation. Detectors for particles and photons used in elementary particle, nuclear, and cosmic ray physics.

5371. INTRODUCTION TO ELEMENTARY PARTICLE PHYSICS. (4 cr; prereq 5102 or equiv; 3 lect and 1 problem hrs per wk)
Relativistic kinematics; mass, spin, isopin, 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.

5441. INTRODUCTORY DYNAMIC METEOROLOGY I. (5 cr; prereq 1291or 1341 or 1441 and Math 3213 or 5602 or #; 3 lect and 3 lab hrs per wk; offered when feasible)
Fluid dynamics of large scale weather systems; mathematical introduction to quasi-geostrophic model used in numerical weather prediction. Concurrent laboratory study of weather charts to illustrate application of theory.

5442. INTRODUCTORY DYNAMIC METEOROLOGY II. (4 cr; prereq 5441 or #; offered when feasible)
Energetics and general circulation of the atmosphere.

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; phenomena in intense coherent radiation including nonlinear effects.

5805. CONTEMPORARY OPTICS. (4 cr; prereq #; 3 lect and 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.

5911-5912. CONCEPTS IN PHYSICS. (4 cr per qtr [no cr for physics majors]; prereq 3511, 3512, 3513, 3515 or equiv; 3 lect and 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.

5930. PHYSICS FOR HIGH SCHOOL TEACHERS: CURRENT TOPICS. (3 cr [may be repeated for cr]; does not carry grad major or minor cr in physics; prereq general physics, #; 3 integrated lect, discussion, and tour hrs per wk)
Five areas of current interest in physics research.

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 △)

5951-5952. PHYSICS FOR JUNIOR HIGH SCHOOL TEACHERS. (5 cr per qtr; does not carry grad major or minor cr in physics; prereq #)
Demonstration lectures and laboratory exercises on physics topics taught in junior high school physical science.

5954su. PRACTICAL PHYSICS FOR PHYSICS TEACHERS. (5 cr; does not carry grad major or minor cr in physics; prereq college-level intro physics; 8 lect and 10 lab hrs per wk; offered alt yrs)
Basic principles of physics for secondary teaching. Laboratory work with simple inexpensive demonstration/laboratory devices that adapt readily to high school physics classes.

5961. PHYSICAL SCIENCE FOR ELEMENTARY SCHOOL TEACHERS. (4 cr [no cr for undergrad or grad majors or minors in physics]; prereq elem school teacher recommended by participating school district)
Development of in-depth understanding of physics topics for elementary school teaching; synthesis of mathematical concepts, problem-solving strategies, and model building to explain physical world.

5970. DIRECTED STUDIES. (1-5 cr; prereq #, △)
Independent, directed study in areas arranged by student and faculty member.

5980. RESEARCH SEMINAR. (1 cr; primarily for beginning grad students 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, △)
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.

8000. SEMINAR: THEORETICAL PHYSICS. (Cr ar)

8065. ADVANCED TOPICS IN COMPUTATIONAL PHYSICS. (Cr ar; prereq some working knowledge of FORTRAN, #)
Discussion of supercomputer architecture and programming; other topics of current interest.

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.

8121. ADVANCED QUANTUM MECHANICS. (3 cr; prereq 5153 or #)
Advanced topics in nonrelativisitic quantum mechanics, with emphasis on the use of second quantization to treat many-body and radiating systems. Diagrammatic and Green's function techniques introduced.

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 every 3rd yr)
Atomic and molecular structure, with emphasis on interpretation of quantum numbers and selection rules in terms of symmetry. Experimental data summarized and compared with theoretical predictions.

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: SOLID-STATE AND LOW-TEMPERATURE PHYSICS. (Cr ar)

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 #)
(Same as EE 8150, 8151) 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)
(Same as EE 8152) Properties of magnetic materials in relation to exchange interactions and elementary spin excitations.

8233. SUPERCONDUCTIVITY. (3 cr; prereq #; offered when feasible)
Properties of superconductors discussed and analyzed using the concept of a macroscopic wave function; relation of this approach to the macroscopic theory.

8234. TECHNIQUES OF LOW-TEMPERATURE PHYSICS. (3 cr; prereq #; offered when feasible)
Introduction to low-temperature phenomena and techniques used to obtain these temperatures.

8235. LIQUID AND SOLID HELIUM. (3 cr; prereq #; offered when feasible)
Introduction to experiment and theory concerning the behavior of liquid and solid helium. Superfluidity of He4, fermi liquid theory of He3, and He3-He4 mixtures and solid helium.

8238. ADVANCED TOPICS IN SOLID-STATE AND LOW-TEMPERATURE PHYSICS. (Cr ar; offered when feasible)
Possible topics: theory of superconductivity, theory of superfluidity, properties of systems at millidegree temperatures, collective effects in magnetic systems.

8300. SEMINAR: NUCLEAR PHYSICS. (Cr ar)

8311-8312-8313. NUCLEAR PHYSICS. (3 cr per qtr; prereq 5153 or ¶5151-5152-5153, 5301 or #)
Bound and continuum states of atomic nuclei. Two-nucleon problem and nuclear forces. Collective excitations of complex nuclei and their description in terms of nuclear models. Nuclear reaction mechanisms and use of reactions to obtain information about nuclear structure.

8321. ADVANCED TOPICS IN NUCLEAR PHYSICS. (Cr ar)
Possible topics: theory of nuclear matter, beta and gamma ray spectroscopy, nuclear fission, etc.

8360. SEMINAR: MASS SPECTROSCOPY. (Cr ar)

8370. SEMINAR: ELEMENTARY PARTICLE PHYSICS. (Cr ar)

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.

8380. ADVANCED TOPICS IN ELEMENTARY PARTICLE PHYSICS. (Cr ar; prereq #)
Discussion of topics of current interest.

8381-8382-8283. 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: COSMIC RAY AND SPACE PHYSICS. (Cr ar)

8411-8412. COSMIC RAY AND SPACE PHYSICS. (3 cr per qtr; 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.

8420. SEMINAR: MAGNETOSPHERIC PHYSICS. (Cr ar [max 3 cr])

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.

8440. SEMINAR: ATMOSPHERIC PHYSICS. (Cr ar)

8445. ADVANCED TOPICS IN ATMOSPHERIC PHYSICS. (Cr ar)
Possible topics: radiative transfer in planetary atmospheres, atmospheric electricity, atmospheric tides and oscillations, properties of water substance, numerical modeling of atmospheric flow.

8500. PLAN B PROJECT. (4 cr [no cr toward PhD]; S-N only; prereq #)
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.

8900. SEMINAR: HISTORY OF 20TH-CENTURY PHYSICS. (1-3 cr; prereq #)

8950. SEMINAR: PROBLEMS OF PHYSICS TEACHING AND HIGHER EDUCATION. (1 cr; prereq grad standing in physics or #)
Lectures and informal discussions of courses and curricula, techniques, and materials important in undergraduate physics instruction; relation to problems of higher education. Speakers drawn from seminar participants and physics faculty, from other units of University, and occasionally from outside University. Students enrolled for credit must carry out a small instructional development project under faculty guidance. Designed especially as orientation for beginning graduate teaching associates and to provide background and experience for those preparing for careers in physics teaching at any level.

8990. RESEARCH IN PHYSICS. (Cr ar; prereq #)

Physiology (Phsl)

Professor: Robert F. Miller, *head;* Richard L. Purple, *director of graduate studies;* Marvin B. Bacaner; H. Mead Cavert; Sue Donaldson; Eugene Grim; Franz Halberg; Arthur S. Leon; David G. Levitt; Maurice W. Meyer; Jack H. Oppenheimer; Richard E. Poppele; John F. Soechting; Carlo A. Terzuolo

Associate Professor: John H. Anderson; Timothy J. Ebner; Edwin W. Haller[1]; Lois J. Heller[1]; Charles K. Knox; Hon Cheung Lee; Gary R. Marchand[1]; David Mohrman[1]; Robert S. Pozos[1]; Edward K. Stauffer[1]; O. Douglas Wangensteen; Lorentz E. Wittmers, Jr.[1]

Assistant Professor: Jurgen Fohlmeister

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

Degrees Offered—M.S.[2] (Plan A and Plan B) and Ph.D.

[1]*University of Minnesota, Duluth*
[2]*For information on the master's 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.*

Curriculum—Physiology is the application of mathematics, physics, and chemistry to the study of structure and function in living systems. As a "hybrid" field in which expertise from other disciplines is ordinarily combined, a rather wide diversity of knowledge may be required. Students entering the program generally bring to it strength and enthusiasm from one or more of the sciences listed above. The program emphasizes a quantitative approach to understanding the functions of cells, organs, and organ systems. Students take a core concentration that provides a broad background in the physiology of membranes, cells, and organ systems. In addition to the core of commonly required knowledge, individualized programs are structured for each student to build on strengths in particular areas of research.

The Ph.D. program typically requires four to five years, with a two-year core that culminates in the written and oral preliminary examinations. Supporting work is accepted from any of a number of disciplines, which include, but are not limited to, biochemistry, cell and molecular biology, chemistry, computer sciences, engineering, mathematics, and physics. Following the oral preliminary examination, additional coursework may be decided upon by the student in consultation with the adviser. Laboratory experience generally begins near the end of the first year and becomes progressively more intense as the student moves from the preliminary exams to the formulation of a research thesis. Specialty areas of this program include cell physiology, membrane and transport phenomena in organ systems, and neurophysiology, with a particular 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 foreign students, a TOEFL score of at least 550 is highly recommended. For all applicants, three letters of recommendation must be submitted.

Master's Degree Requirements—A one-year core academic program is offered in medical human physiology or the equivalent. Programs are thereafter individualized to meet the needs of each student.

Doctoral Degree Requirements—The two-year core sequence consists of a three-quarter sequence in cell and molecular biology and cell physiology and two two-quarter sequences in medical physiology and medical neuroscience. Substitution or waiver of these requirements is possible upon petition to and concurrence by the physiology graduate program committee. Supporting work is individualized to meet the needs of each student.

Language Requirements—None. A reading knowledge of a foreign language relevant to the student's major field of interest is highly recommended, and all students are expected to gain a solid background in the use of computers and in a computer language.

For Further Information—Including the manual for graduate studies used by physiology, contact the director of graduate studies, Department of Physiology, 6-255 Millard Hall, University of Minnesota, 435 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5100w. SYSTEMS PHYSIOLOGY. (5 cr; prereq biochem and human anatomy; primarily for dental students)
Principles of physiology of circulation, respiration, digestion, excretion, metabolism, endocrine glands.

5101s. NEUROSCIENCE FOR DENTAL STUDENTS. (2 cr; prereq courses in biochemistry and human anatomy, ¶Anat 5110 [2 cr] required; 3 lect and 3 lab hrs per wk)
Basic principles of nervous function examined through study of neuroanatomy and neurophysiology.

5102w. PHYSIOLOGY AND DENTISTRY. (1 cr; for dental students only; prereq 5101) Meyer, staff
Lecture-conference course integrating physiology and dentistry.

5112. HUMAN NEUROSCIENCE B. (3 cr; prereq 1st-yr med or grad student; Anat 5111-Phsl 5112†)

5440f, 5441w. QUANTITATIVE PHYSIOLOGY. (3 cr; prereq 1 yr each of college chem, physics, math through integral calculus)
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, #)
Introduction to physiology, biochemical regulation, and physical chemistry of muscle contraction.

8110w. HUMAN PHYSIOLOGY. (4 cr; prereq anatomy, biochemistry)

8111s. HUMAN PHYSIOLOGY. (4 cr; prereq 8110, anatomy, biochemistry)

8113f,w,s,su. PROBLEMS IN PHYSIOLOGY. (Cr and hrs ar; prereq #) Staff
Topics assigned for readings or laboratory study; conferences.

8114f. BIOPHYSICS OF NERVE CELLS. (3 cr; prereq #; offered odd-numbered yrs) Fohlmeister
Hodgkin-Huxley model, cable theory and dendritic trees, propagated action potential, impulse initiation, theories of membrane transport, ion channel gating, gating currents, single channel gating, gating and shot noise in excitable membranes.

8115w. MATHEMATICAL NEUROPHYSIOLOGY. (4 cr; prereq calculus through ordinary differential equations, Stat 8501 or #; offered even-numbered yrs) Knox
Analysis of nerve impulse trains; interval distributions, auto- and cross-correlation functions, shot noise processes, applications of information theory. Models of neurons, including McCulloch-Pitts, random walk and "leaky integrator" models. Neural networks; randomly connected nets, discrete and cellular space models. Computer simulation techniques.

8117. CHRONOPHYSIOLOGY. (Cr and hrs ar; prereq #) Halberg
Emphasis on predictable aspects of physiological variability and their role in the definition of health and the diagnosis of disease. Physiological self-measurements, their analysis and interpretation. Course can be tailored to focus on specific interests of a given student.

8201f,w,s. LITERATURE SEMINAR. (1 cr ar) Staff

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)

8210.[1] SELECTED TOPICS IN PERMEABILITY. (2-4 cr; prereq 8110 or equiv, #) Grim, Levitt
Advanced seminar.

8211.[1] SELECTED TOPICS IN HEART AND CIRCULATION. (2-4 cr; prereq 8110, 8111 or equiv, #) Bacaner, Cavert, Heller, Mohrman
One or more seminars in advanced physiology of heart and circulation.

8212.[1] SELECTED TOPICS IN RESPIRATION. (2-4 cr; prereq 8110, 8111 or equiv, #) Wangensteen
Advanced seminar.

8213.[1] SELECTED TOPICS IN ALIMENTARY PHYSIOLOGY. (2-4 cr; prereq 8110, 8111 or equiv, #) Grim
Advanced seminar.

8216f,w,s.[1] SELECTED TOPICS IN NEUROPHYSIOLOGY. (2-4 cr; prereq CBN 5111, Phsl 5112) Poppele, Staff
Advanced seminar.

8217s. PROPERTIES OF RECEPTOR SYSTEMS. (3 cr; prereq #; offered even yrs) Poppele
Physiological role of receptors as information gathering and relay devices; behavior of a number of specific receptor organs and their functional components.

8219s. SPINAL CORD PHYSIOLOGY AND MOTOR CONTROL. (3 cr; prereq #; offered odd yrs) Terzuolo
Physiological basis of motor control at different functional levels (spinal cord, brain stem, thalamus and basal ganglions, cerebral cortex and cerebellum) in terms of cellular mechanisms, input-output relations, and modeling.

8227s. METHODS IN PHYSIOLOGY. (3 cr; prereq #) Stish

Planning

See Public Affairs.

Plant Breeding

Professor: Donald C. Rasmusson, *director of graduate studies;* Peter D. Ascher; Donald K. Barnes; Robert H. Busch; David W. Davis; Sharon L. Desborough; Franklin D. Enfield; Jon L. Geadelmann; Burle G. Gengenbach; Florian I. Lauer; Carl A. Mohn; Ronald L. Phillips; Robert E. Stucker; Deon D. Stuthman

[1]*Students should consult the department for offerings during any specific quarter.*

Associate Professor: James J. Luby; James H. Orf; Howard W. Rines; James C. Sentz; David A. Somers

Assistant Professor: Nancy J. Ehlke; Stephen J. Openshaw

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 and Landscape Architecture. 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.

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—Contact the Department of Agronomy and Plant Genetics, University of Minnesota, 1991 Upper Buford Circle, St. Paul, MN 55108; or the Department of Horticultural Science and Landscape Architecture, 305 Alderman Hall, University of Minnesota, 1970 Folwell Avenue, St. Paul, MN 55108.

Note—For descriptions of courses, consult the course listings of the respective departments.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Agro 5020w. INTRODUCTION TO PLANT BREEDING. (4 cr; prereq GCB 3022 or equiv) Orf

Agro 8200w. PRINCIPLES OF PLANT BREEDING I. (3 cr; prereq 5020, Stat 5301 or #) Rasmusson

Agro 8210s. PRINCIPLES OF PLANT BREEDING II. (3 cr; prereq 8200 or #) Openshaw

Agro 8220w. APPLICATION OF QUANTITATIVE GENETICS TO PLANT BREEDING. (3 cr; prereq 8210, GCB 5042; offered even yrs) Stucker

Agro 8230f. CYTOGENETICS. (4 cr; prereq GCB 5031 or #; 3 lect and 2 lab hrs per wk) Phillips

Agro 8240s. PLANT GENETICS IN RELATION TO PLANT IMPROVEMENT. (3 cr; prereq GCB 5031) Gengenbach, Somers

Agro 8270f,w. SEMINAR: PLANT BREEDING. (1 cr) Staff

Agro 8280s. CURRENT TOPICS IN PLANT BREEDING. (2 cr; prereq 8210 or #) Stucker

Agro 8310f,su. ORIENTATION TO FIELD CROP BREEDING. (1 cr; prereq 5020 or #) Stuthman

Agro 8330f,w,s,su. RESEARCH IN PLANT GENETICS. (Cr ar) Staff

Biol 5003f,w,s. GENETICS. (4 cr, §GCB 3022, §GCB 5022; prereq 5001) Staff

FR 5152.* FOREST GENETICS. (3 cr; prereq forestry sr or #) Mohn

GCB 5031w. ADVANCED GENETICS I. (4 cr; prereq 3022 or Biol 5033 [with grade of A or B] and Biol 5001 or BioC 5751 or #) Lefebvre

GCB 5033s. POPULATION AND QUANTITATIVE GENETICS. (4 cr; prereq 3022 or Biol 5003, a course in biometry or statistics or #) Rich

GCB 5042f. QUANTITATIVE GENETICS. (4 cr; S-N only; prereq 5033...Stat 5301 recommended) Enfield

Hort 5037. SYSTEMATICS AND UTILIZATION OF VEGETABLE CROPS GERMPLASM. (3 cr; prereq Agro 5020 or #; offered fall of odd yrs) Davis

Hort 8022w. BREEDING ASEXUALLY PROPAGATED CROPS. (3 cr; prereq Agro 5020; offered odd yrs) Lauer, Luby

Hort 8023f.* EVOLUTION OF CROP PLANTS. (3 cr) Ascher

Hort 8061f,w,s.* SEMINAR: DISCUSSIONS IN INCOMPATIBILITY. (1 cr; prereq #) Ascher

Hort 8063f,w,s.* SEMINAR: DISCUSSIONS IN HORTICULTURAL PLANT BREEDING. (1 cr; prereq #) Davis, Lauer, Luby

Stat 5301. DESIGNING EXPERIMENTS. (5 cr, §5163; prereq 3012 or 5021 or 5133 or #)

Plant Pathology (PlPa)

Professor: Philip O. Larsen, *head;* Robert A. Blanchette, *director of graduate studies;* Neil A. Anderson; Ernest E. Banttari; Robert M. Brambl; William R. Bushnell; David W. French; James V. Groth; Bill W. Kennedy; Thor Kommedahl; Sagar V. Krupa; Benham E. L. Lockhart; David H. MacDonald; Richard A. Meronuck; Chester J. Mirocha; Francis L. Pfleger; Alan P. Roelfs; Darroll D. Skilling; Elwin L. Stewart; Ward C. Stienstra; P. S. Teng; Roy D. Wilcoxson; Richard J. Zeyen

Associate Professor: Donald V. McVey; Thomas H. Nicholls; James A. Percich

Assistant Professor: Carol E. Windels

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. Plant pathology majors have the option of pursuing a special emphasis in mycology. Courses related to mycology are also offered by the Departments of Botany, Food Science, and Microbiology.

Prerequisites for Admission—Master's degree applicants must have a sound collegiate 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. All students accepted into the department with a B.S. degree will be admitted into the M.S. degree program. After a minimum of two quarters, students may elect to change their degree status to a Ph.D. program. Criteria for the change will include scholastic standing, potential for success in completing a Ph.D., and writing competency. Ph.D. applicants with an M.S. degree or proven master's-level competency in plant pathology should also have all the prerequisites for the master's program. If prerequisite deficiencies exist, they must be corrected during the first year of the graduate program.

Special Application Requirements—Graduate Record Examination scores, a statement of objectives, and three letters of recommendation must be submitted to the department.

Master's Degree Requirements—Students must take the M.S. core courses (PlPa 5005, 5006, 5007, and 5008) and a minimum of 1 credit of colloquium (PlPa 8200) or seminar (PlPa 8201 or 8202). Remaining coursework requirements are determined by the student's graduate adviser and the director of graduate studies according to general Graduate School requirements. The final examination is oral.

Doctoral Degree Requirements—Ph.D. students must take the core courses (8001, 8002, and 8003) in sequence, and at least 2 credits of colloquium (8200) or seminar (8201 or 8202). The student's advisory committee and the director of graduate studies determine any other coursework in the program. Written comprehensive

examinations are mandatory and are administered in January following completion of PlPa 8003 by a committee of five graduate faculty members elected by the faculty.

Emphasis in Mycology—M.S. students pursuing this emphasis in the plant pathology major must fulfill all M.S. requirements and, in addition, complete 5105, 5106, and 5107. Ph.D. students pursuing the mycology emphasis must fulfill all Ph.D. requirements and, in addition, at least 12 credits in mycology, including 5102, 5109, or 8111.

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, including two of the following three courses: 5005, 5006, and 5007. For Ph.D. degree students, 18 credits are required, including 5005, 5006, and 5007. Students planning a minor in plant pathology should consult the director of graduate studies.

For Further Information—Contact the director of graduate studies, Plant Pathology Program, 495 Borlaug Hall, University of Minnesota, 1991 Buford Circle, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5002. INTRODUCTORY PLANT PATHOLOGY FOR ADVANCED STUDENTS. (5 cr, §3001, §5050; prereq 14 cr plant sciences or #) MacDonald
General plant pathology.

5005f. VIRUSES AND BACTERIA IN PLANT DISEASE. (4 cr; prereq 20 cr biology including botany, biochemistry, plant physiology) Banttari, Kennedy
Diseases of plants caused by bacteria and viruses, with emphasis on effects, symptoms, pathogen identification, and control.

5006w. FUNGI, ALGAE, AND PARASITIC SEED PLANTS IN PLANT DISEASE. (4 cr; prereq 5105, 20 cr biology including botany, biochemistry, plant physiology, mycology) Kommedahl
Fungi, algae, and parasitic seed plants as plant pathogens, representative types with particular reference to the techniques used in their identification and control.

5007. AIR POLLUTION AND OTHER ABIOTIC CAUSES OF PLANT DISEASE. (3 cr; prereq 20 cr biol including biochem)
Lectures, readings, and discussions about characteristics and effects of phytotoxic air pollutants (60%) and water, temperature extremes, soluble salts, mineral elements, allelopathy and pesticides (40%) as causes of plant disease.

5008. INTRODUCTION TO PLANT NEMATOLOGY. (2 cr; prereq 3001 or 5002 or #)
Characteristics, strengths, and weaknesses of plant and soil nematodes through study of biology and morphology of five important genera of plant parasitic nematodes. Field and laboratory experiences in sampling, soil and plant tissue processing, identification and counting, and control of plant nematodes.

5015. PLANT NEMATOLOGY. (4 cr; prereq 5008 or #)
Lectures, readings, and laboratory work with emphasis on identification of plant parasitic nematodes to species; experimental techniques for studying plant nematodes; attraction, movement, and feeding by plant nematodes; and biological, chemical, and physical factors that affect nematode survival and multiplication.

5050s. FOREST PATHOLOGY. (4 cr, §1001; prereq Biol 1103 or equiv) Blanchette
Diseases of forest and shade trees; wood decay. Symptoms, etiology, and control. Lectures, laboratory and field work.

5102su. FIELD MYCOLOGY. (6 cr; prereq 9 cr botany or #; offered during Lake Itasca Biology Session) Staff
General characteristics of fungi, especially those used in identification; cultural and taxonomic procedures and practices.

5104w. AGRICULTURAL SYSTEMS ANALYSIS AND MODELING. (4 cr; prereq Math 1142 or #) Teng

5105f. INTRODUCTION TO THE STUDY OF FUNGI. (4 cr, §5106, §5107; prereq 9 cr botany or Biol 1002 or #) Anderson, Groth, and Stewart
Structure, habits, classification, and identification of fungi.

5106w. MYCOLOGY: ASCOMYCETES—FUNGI IMPERFECTI. (4 cr; prereq 5105 or equiv or MicB 3103 or #; offered alt yrs) Stewart
Lectures and laboratory exercises in taxonomy, identification, life histories, genetics, and ecology of fungi.

5107s. MYCOLOGY: BASIDIOMYCETES. (4 cr; prereq 5105 or equiv or MicB 3103 or #; offered alt yrs) Stewart
Lectures and laboratory exercises in taxonomy, identification, life histories, genetics, and ecology of fungi.

5109w. BIOCHEMISTRY AND MOLECULAR BIOLOGY OF FUNGI. (4 cr; prereq 8 cr biochemistry or #; offered alt yrs) Brambl
Lectures, assigned readings, and discussions of the chemical structure and activities of the fungus cell, including growth, development, and morphogenesis, regulation of intermediary metabolism, protein and nucleic acid synthesis, respiration, cytoplasmic inheritance and mitochondrial biogenesis, reproduction and spore germination, viruses and plasmids, toxins and antibiotics, and photobiology.

5200s. POISONOUS PLANTS. (2 cr; prereq #) Kommedahl
Systematic study of important plants poisonous to animals. Lecture and field trips in field identification.

5215w. INSECTS IN RELATION TO PLANT DISEASES. (4 cr, §Ent 5215; prereq 5 cr entomology, 5 cr plant pathology or equiv or #) Staff
Insect transmission and dissemination of plant pathogens; plant insect relationships; habits of principal insect vectors—practical control methods.

5500s. PLANT DISEASE EPIDEMIOLOGY AND MANAGEMENT. (4 cr; prereq 3001 or 5050 or #) Teng
Introduction to concepts, principles, and methodology in quantitative study of plant disease epidemics.

5650su. CLINICAL PLANT PATHOLOGY. (2, 4, or 6 cr; prereq 3001 or 5002 or #) MacDonald and staff
Field, clinical, and laboratory experience in diagnosis, treatment, and control of plant diseases of field crops, fruit crops, vegetable crops, turf, ornamentals, and trees.

5700. PLANT DISEASE CONTROL. (4 cr; prereq 1001 or #) Percich
Control of plant diseases utilizing biological, cultural, disease resistance, and chemical procedures in an integrated manner. Emphasis on use and mode of action of fungicides.

8001f. PLANT DISEASE THEORY I, MOLECULAR TO CELLULAR. (4 cr; prereq 5005, 5006, 5007 or #) Brambl, Mirocha, Zeyen
Lectures, reading, and writing. Plant disease at the molecular, organelle, and cellular levels. Elements of parasite specificity and generalized disease phenomena found or associated with subcellular and cellular levels of plant organization.

8002w. PLANT DISEASE THEORY II, TISSUES TO WHOLE PLANTS. (4 cr; prereq 5005, 5006, 5007 or #, 8001) Banttari, Kommedahl, Krupa, and Zeyen
Effects of plant disease on plant tissues, organs, and interaction of tissues and organs that form whole plant. Disease situations in roots, vascular systems, photosynthetic systems, and reproductive systems of plants.

8003s. PLANT DISEASE THEORY III, POPULATIONS. (4 cr; prereq 5005, 5006, 5007, or #, 8001, 8002) Groth, Teng, staff
Disease in populations of plants; agroecosystems, natural ecosystems, and interrelatedness of plant disease over large geographic areas. Population genetics, epidemiology, and geopathology.

8090.* ADVANCED PROCEDURES AND RESEARCH IN PLANT PATHOLOGY. (Cr ar) Staff
Special assignment of work in laboratory and field problems in pathological research.

8095. ADVANCED PROCEDURES AND RESEARCH IN MYCOLOGY. (1-6 cr) Staff
Special assignment of work in laboratory and field problems in mycology.

8111. GENETICS OF PATHOGENS AND PLANT DISEASE. (4 cr; prereq 1001 or 5050, GCB 3022) Anderson, Groth
Incompatibility systems, sexual and somatic recombination mechanisms in plant pathogens. Genetic aspects of host-pathogen interaction; gene-for-gene concept; generalized resistance; genetics of epidemics; nature of host genes for resistance and pathogen genes for virulence. Strategies for developing disease resistant plants.

8200f. PLANT PATHOLOGY COLLOQUIUM. (Cr ar) Staff
Invited specialists, faculty members, and graduate students present colloquium topics.

8201w. SEMINAR (1 cr) Staff
Critical review and presentation of current problems and progress in plant pathology. Selected topic (differing from 8202) and seminar instructors announced two quarters in advance.

8202w. SEMINAR (1 cr) Staff
Critical review and presentation of current progress and problems in plant pathology. Selected topic (differing from 8201) and seminar instructors announced two quarters in advance.

Plant Physiology (PlPh)

Professor: Carroll P. Vance (agronomy and plant genetics), *director of graduate studies*; Russell S. Adams (soil science); Robert M. Brambl (plant pathology); Mark L. Brenner (horticultural science and landscape architecture); William R. Bushnell (plant pathology); John V. Carter (horticultural science and landscape architecture); R. Kent Crookston (agronomy and plant genetics); William P. Cunningham (genetics and cell biology); Sharon L. Desborough (horticultural science and landscape architecture); Albert W. Frenkel (botany); Burle G. Gengenbach (agronomy and plant genetics); Wesley P. Hackett (horticultural science and landscape architecture); Gary H. Heichel (agronomy and plant genetics); Alan B. Hooper (genetics and cell biology); Robert J. Jones (agronomy and plant genetics); Willard L. Koukkari (botany); Sagar V. Krupa (plant pathology); Pen H. Li (horticultural science and landscape architecture); Chester J. Mirocha (plant

pathology); Douglas C. Pratt (botany); Irwin Rubenstein (genetics and cell biology); Steve R. Simmons (agronomy and plant genetics); Lawrence H. Smith (agronomy and plant genetics); Joseph R. Sowokinos (horticultural science and landscape architecture); Eduard J. Stadelmann (horticultural science and landscape architecture); Edward I. Sucoff (forest resources); Harold F. Wilkins (horticultural science and landscape architecture); Donald L. Wyse (agronomy and plant genetics)

Associate Professor: David D. Biesboer (botany); Florence K. Gleason (botany); Albert H. Markhart (horticultural science and landscape architecture); Carolyn D. Silflow (genetics and cell biology); David A. Somers (agronomy and plant genetics); Thomas K. Soulen (botany)

Assistant Professor: J. Stephen Gantt (botany); John W. Gronwald (agronomy and plant genetics); Neil E. Olszewski (botany)

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—Program faculty reside in a number of plant-oriented departments in the Colleges of Agriculture, Biological Sciences, and Forestry. Emphases in the major, therefore, are available in many areas of plant physiology, ranging from the molecular to the organismal and environmental.

Prerequisites for Admission—A background in basic biological and physical sciences and in mathematics is required. Any deficiencies should be corrected early in the graduate program.

Special Application Requirements—Applicants must submit scores from the Graduate Record Examination. Three letters of recommendation evaluating the applicant's scholarship and research potential and a complete set of transcripts (in addition to that required by the Graduate School) are also required. Students may enter the program at any time, but the deadline for certain fellowship applications is January 15.

Master's Degree Requirements—Course programs are planned by the student and adviser, tailored to suit the student's career objectives and research interests. Programs must include 5182, 5183, and 5184, or their equivalents, and at least one seminar (8251). Students should also take 8310 as early as possible. The remainder of the program must include the minor or related field(s) and additional plant physiology courses and/or appropriate courses offered by related programs. A final oral examination is required.

Doctoral Degree Requirements—Specific course requirements are the same as for the master's degree. Doctoral students must register for at least one additional seminar.

Language Requirements—None.

Minor Requirements for Students Majoring in Other Fields—Proposed minor courses must include two of the following: 5182, 5183, and 5184, or their equivalents.

For Further Information—Contact the director of graduate studies, Plant Physiology Program, 220 Biological Sciences Center, University of Minnesota, 1445 Gortner Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5131f,s. SURVEY OF PLANT PHYSIOLOGY. (4 cr, §3131, §Bot 3131, §Bot 5131; prereq Biol 1103 or Biol 3012, BioC 1302 or ¶BioC 1302 or Biol 3021 or BioC 5001) Frenkel, Gleason, Olszewski, Soulen
Same as PlPh 3131, but includes a weekly discussion and advanced reading session.

5132f. PLANT PHYSIOLOGY LABORATORY. (2 cr, §Bot 5132; prereq 5131 or ¶5131)
Laboratory course to accompany PlPh 5131.

5167s.* PHYSIOLOGY OF THE PLANT CELL. (3 cr; prereq plant anatomy, inorganic and organic chemistry or biochemistry; offered alt yrs) Stadelmann
Characteristics of the living state, general aspects of cell metabolism, development of the cell, polarity, differentiation, and irritability of the cell and cellular movements.

5168s.* EXPERIMENTAL PROTOPLASMATOLOGY. (3 cr; prereq #; offered alt yrs) Stadelmann
Physical and physicochemical properties of living protoplasm in plant cells, including viscosity, wall attachment, permeability, primary and secondary fluorescence, vital staining.

5182s.* PLANT METABOLISM. (3 cr, §Bot 5182; prereq 5131) Soulen
Plant metabolism including photosynthesis, respiration, and the synthesis of macromolecules by plants. 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, §Bot 5183; prereq 5131 or equiv) 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. The absorption, distribution, and function of inorganic elements.

5184f.* PLANT GROWTH AND DEVELOPMENT. (3 cr, §Bot 5184; prereq 5131 or equiv) Hackett, Olszewski
Control of seed germination; mobilization of macromolecular breakdown products during germination and seedling growth; photomorphogenesis; chloroplast development; flowering and photoperiodism; fruit development and ripening; seed formation; senescence; mechanisms of action of plant growth substances.

5188f,w,s.* RESEARCH PERSPECTIVES IN PLANT PHYSIOLOGY. (Cr ar; prereq Chem 3100 and Chem 3101, 8 cr biochemistry and #, △) Staff
Laboratory course in which student undertakes well-defined research problem of limited scope.

5703f. INTERNAL WATER BALANCE. (2 cr; prereq #; offered alt yrs) Stadelmann, staff
Laboratory course; components of water balance in plants (turgor, osmotic, water potentials) measured using various techniques. Discussion included on matching method to experimental goals.

5721s, 5723w, 5726f. METHODS OF PLANT ANALYSIS. (Cr ar; prereq Chem 3100, Chem 3101, 8 cr biochemistry, #)
In-depth experimental laboratory approach to microscopic analysis, sample preparation, fractionation, isolation, and measurement of plant compounds employing modern methods of plant physiology. Discrete and independent units in:

5721s. THE PRIMARY PLANT METABOLITES. (Cr ar; offered alt yrs) Li
Laboratory experience in the extraction and quantification of sugars, free amino acids, and nonvolatile organic acids.

5723w. PLANT HORMONES AND TISSUE CULTURE. (Cr ar) Brenner
Laboratory experience in tissue culture and the extraction, purification, and quantification of plant hormones.

5726f. ANALYSIS OF CELL STRUCTURE. (Cr ar; offered alt yrs) Stadelmann
Experimental laboratory approach to microscopic analysis.

5970f,w,s.* SPECIAL PROBLEMS IN PLANT PHYSIOLOGY. (Cr ar; prereq △) Staff
Research, readings, instruction.

8251f,w. SEMINAR: PLANT PHYSIOLOGY. (1 cr) Staff
Critical review of progress and problems in plant physiology.

8281s.* GROWTH AND DIFFERENTIATION OF PLANTS. (3 cr; prereq 5184; offered alt yrs) Brenner
Nature and characterization of plant growth, with analysis of the physiological changes that occur during growth and differentiation of plants; hormonal control of growth processes.

8285f. PHOTOSYNTHESIS. (3 cr; prereq 5182; offered alt yrs) Frenkel
Detailed survey of the present state of knowledge of photosynthesis.

8310f. METHODS IN PLANT PHYSIOLOGY. (1 cr) Staff
Orientation to plant physiology program. Introduction to graduate faculty and research projects.

Courses Offered by Other Programs

For course descriptions, see the respective departments.

Agro 5030. WEED CONTROL

Agro 8050. PHYSIOLOGY OF FIELD CROPS

BioC 8225. TRACER TECHNIQUES

Bot 8287. PLANT MOLECULAR BIOLOGY

FR 8101. RESEARCH PROBLEMS: FOREST-TREE PHYSIOLOGY

Hort 5040. PLANT GROWTH REGULATION

Hort 5041. ENVIRONMENTAL PHYSIOLOGY OF HORTICULTURAL PLANTS

Hort 8045. PLANT HARDINESS

Hort 8052. ADVANCED PROBLEMS IN PHYSIOLOGY OF HORTICULTURAL CROPS

MicB 5106. ADVANCED GENERAL MICROBIOLOGY LABORATORY

MicB 5321. PHYSIOLOGY OF BACTERIA

PlPa 5109. BIOCHEMISTRY AND MOLECULAR BIOLOGY OF FUNGI

Soil 5240. MICROCLIMATOLOGY

Soil 5340. ORGANIC AND PESTICIDAL RESIDUES

Soil 8632. SOIL MICROBIOLOGY

Political Science (Pol)

Professor: Edwin Fogelman, *chair;* Charles H. Backstrom; Terence W. Ball; Roger Benjamin; Raymond D. Duvall; William H. Flanigan; John R. Freeman; Virginia H. Gray; Robert T. Holt; Brian L. Job; Samuel Krislov; Thomas M. Scott; W. Phillips Shively; Frank J. Sorauf; John L. Sullivan

Associate Professor: Mary G. Dietz, *director of graduate studies;* James Farr; Robert B. Kvavik; Jack S. Levy; August H. Nimtz, Jr.; Martin W. Sampson; L. Earl Shaw, Jr.; Steven S. Smith; David J. Sylvan; Charles E. Walcott

Assistant Professor: Kathryn A. Sikkink; Kaare Strom

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: 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 February 1. Graduate study in the Special M.A. program may begin in any quarter; application deadlines are those established by the Graduate School. Applicants for the joint program with the Humphrey Institute must apply to either the political science department or the Humphrey Institute graduate program in public affairs. Students earn an M.A. degree in public affairs and a Ph.D. degree in political science. For further information about the joint program, 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 director of graduate studies.

Doctoral Degree Requirements—Required coursework includes 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—Contact the director of graduate studies, Department of Political Science, 1414 Social Sciences Building, University of Minnesota, 267 19th Avenue South, Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Methodology

8101. SCOPE AND METHODS OF POLITICAL SCIENCE. (3 cr; prereq △) Staff
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 △) Staff
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 △; should be taken in 2nd or 3rd yr) Staff
Designed to acquaint future political scientists with intellectual issues, techniques, and resources pertinent to their future professional roles. Modules in teaching (required module), sponsored research and administration, and writing for publication; students must complete at least two modules.

8140. INDIVIDUAL READINGS AND RESEARCH IN METHODOLOGY. (1-3 cr; prereq # and △) Staff

8150. RESEARCH SEMINAR: METHODOLOGY. (3 cr; prereq #) Staff
Supervised research and research training in selected topics and problems.

8160. SELECTED TOPICS IN METHODS OF POLITICAL SCIENCE. (3 cr; prereq #) Staff
Readings and research in special topics or problems.

Methods of Political Analysis

8121. INTRODUCTION TO QUANTITATIVE ANALYSIS. (4 cr; prereq Stat 5021 or equiv or #; lab section required) Staff
Survey of data collection; levels of measurement; measures of association; substantive exercises in political analysis.

8123. ADVANCED TOPICS IN REGRESSION ANALYSIS. (4 cr; prereq 8121 or equiv or #; lab section required) Freeman, Sullivan
General linear model; extensions of linear model; problems in regression analysis; causal models.

8125. DYNAMIC ANALYSIS. (4 cr; prereq 8121 or equiv or #; lab section required) Freeman
Time series regression analysis; simultaneous equations; stochastic processes.

8127. MEASUREMENT THEORY. (4 cr; prereq 8121 or equiv or #; lab section required) Sullivan
Reliability and validity of measurement. Unidimensional scaling and indices; bloc and cluster analysis; multidimensional scaling, factor analysis.

Political Theory

5610. TOPICS IN POLITICAL THEORY. (4 cr; 3051 or 1061 or 8 cr social science or #) Staff
Topics specified in *Class Schedule*.

8200. UNDERSTANDING POLITICAL THEORY. (4 cr; prereq △) Staff
Introduction to major approaches and concepts in political theory.

8240. INDIVIDUAL READING AND RESEARCH IN POLITICAL THOUGHT. (3 cr per qtr; prereq # and △) Staff

8250. RESEARCH SEMINAR: POLITICAL THEORY. (3 cr; prereq #) Staff
Supervised research and research training in selected topics and problems.

8260. TOPICS IN POLITICAL THEORY. (3 cr; prereq #)
Readings and research in special advanced topics or problems.

Development of Political Thought

5654. DEVELOPMENT OF POLITICAL THOUGHT: ANCIENT AND MEDIEVAL (PLATO TO AQUINAS). (4 cr; 1061 or 9 cr social science recommended) Ball, Dietz
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 REVOLU TION). (4 cr; 1061 or 9 cr social science recommended) Ball, Dietz
Renaissance; Machiavelli; More; Reformation; Luther; Calvin; liberalism; Hobbes and Locke; Enlightenment; Montesquieu; Rousseau.

5656. DEVELOPMENT OF POLITICAL THOUGHT: 19TH AND 20TH CENTURIES (AGE OF REVOLUTION TO THE PRESENT). (4 cr, §5669; 1061 or 9 cr social science recommended) Ball, Dietz, Fogelman
French Revolution and reaction; Burke; utilitarianism; Bentham; Hegel; socialism; Marx; rise of democracy; Mill; Tocqueville; selected 20th-century thinkers.

5657. MARX AND THE MARXISTS. (4 cr; prereq 1061 or 9 cr social science or #) Ball, Dietz, Farr
Central ideas of Karl Marx and major subsequent interpretations of Marxism. Original writings of Marx, Engels, Lenin, Gramsci, Mao, other leading Marxists, and scholarly interpretations.

8201, 8202, 8203. DEVELOPMENT OF POLITICAL THOUGHT. (3 cr per qtr; prereq #) Staff
In general, topics in 8201 will relate to ancient and medieval, in 8202 to early modern, and in 8203 to modern and recent political thought.

8215. DEVELOPMENT OF AMERICAN POLITICAL THOUGHT. (3 cr; prereq #) Ball, Fogelman, Shaw
Major issues and thinkers (political leaders, novelists, academics, others). Relation of political thought to problems of American culture.

Analytic Political Theory

8211. LINGUISTIC ANALYSIS AND POLITICAL CONCEPTS. (3 cr; prereq #) Ball
Systematic introduction to linguistic analysis and its relevance to political-theoretical inquiry.

8231. DEMOCRATIC THEORY. (3 cr; prereq #) Ball, Fogelman, Shaw
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.

8235. SELECTED TOPICS IN ANALYTIC POLITICAL THEORY. (3 cr; prereq #) Staff
Readings and research in special advanced topics or problems.

Empirical Political Theory

8221. EMPIRICAL THEORY. (3 cr; prereq #) Fogelman
Intensive examination of selected empirical theories such as theories of power, conflict, decision making, and functionalism.

8222. POSITIVE THEORY. (3 cr; prereq #) Staff
Extensive survey of positive 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.

8223. FORMAL MODELS. (3 cr; prereq 1 yr calculus or equiv and #) Staff
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.

8225. GAME THEORY. (3 cr; prereq #) Staff
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.

8236. SELECTED TOPICS IN EMPIRICAL POLITICAL THEORY. (3 cr; prereq #) Staff
Readings and research in special advanced topics or problems.

American Politics

5303. THE AMERICAN DEMOCRACY. (4 cr; prereq 1001 or equiv or #) Flanigan, Jacobs, Shaw
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 △) Staff
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 # and △) Staff

8350. RESEARCH SEMINAR: AMERICAN POLITICS. (3 cr; prereq #) Staff
Supervised research and research training in selected topics or problems.

8360. TOPICS IN AMERICAN POLITICS. (3 cr; prereq #) 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 politics and behavior field.

5741. POLITICAL BEHAVIOR OF WOMEN. (4 cr; prereq 1001 or equiv or 3051 or #) Gray
Women as political actors. Mass political behavior, women's political movements, women in political parties and elective office, status of women in different societies.

5767. PUBLIC OPINION AND VOTING BEHAVIOR. (5 cr; prereq 1001 or equiv or #) Flanigan, Shively
Major factors influencing electoral decisions; political attitude formation and change. Data analysis laboratory required.

5769. POLITICAL POLLING. (4 cr; prereq 3766 or 5737 or 5738 or 5767 or Jour 3796) Sullivan
Use of polling in political campaigns; assessing candidate images; sample selection; questionnaire construction; impact of question working; interviewing technique; telephone polling; analysis of poll data.

8301. PUBLIC OPINION AND POLITICAL PARTICIPATION. (3 cr; prereq #) Flanigan, Shively
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.

8310. POLITICAL PSYCHOLOGY AND SOCIALIZATION. (3 cr; prereq #) Sullivan
Theories of socialization, opinion formation, and attitude change. Theories of political psychology; personality and political behavior; political style and ideology.

Organizational Political Behavior

5704. ORGANIZATIONAL THEORY AND BEHAVIOR. (4 cr, §5304; prereq 1001 or equiv or #) Walcott
Operation and significance of complex, formal organizations in the political system; public bureaucracy. Communication and influence processes; decision making and innovation; relation of organization to environment.

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
National, state, and local campaigns and elections, research in local political parties and campaigns.

8303. POLITICAL PARTIES. (3 cr; prereq #) 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 #) Flanigan, Gray, Jacobs, Kvavik
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.

8317. ORGANIZATIONAL BEHAVIOR. (3 cr; prereq #) Walcott
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.

National Government Process

5523. THE POLITICS OF THE REGULATORY PROCESS. (4 cr; prereq 1001 or equiv or #) 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 #) Backstrom, Shaw, 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 #) Smith, Walcott
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 #) Krislov, Sorauf
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.

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 between 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.

5328. METROPOLITAN GOVERNMENT AND POLITICS. (4 cr; prereq 1001 or equiv or #) Scott
Development of modern American metropolis with emphasis on central cities and suburbs; intergovernmental relationships in the metropolis; state and federal responses to metropolitan problems; politics of reforming metropolitan government.

8321. URBAN POLITICS. (3 cr; prereq #) 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 #) Gray
Application of comparative method to study of American state politics; emphasis on measurement of concepts, usefulness of conceptual frameworks, and 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
Nature of constitutions, judicial review, organization and powers of national government; nation-state, and interstate relations.

5502. PRINCIPLES OF AMERICAN CONSTITUTION II. (5 cr, §3323; prereq 1001 or equiv, 5501 or 3309 or sr) Krislov
Due process; civil rights and civil liberties.

8314. JUDICIAL PROCESS. (3 cr; prereq #) Krislov, Sorauf
See National Governmental Process subdivision listing for description.

8331. CONSTITUTIONAL LAW. (3 cr; prereq 5501, 5502 or #) Krislov

Public Policy

5321. AMERICAN ECONOMIC POLICY. (4 cr; prereq 1001 or equiv or #) Staff
Economic policymaking processes; major issues such as fiscal and monetary policy, subsidies, economic regulation, and direct controls; governmental impact on the private economic sector.

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-political science grad or #) Staff
Major policy issues such as American strategic theory and war capabilities; limited war theory and capabilities; arms control and disarmament. Defense policymaking processes in Executive Office, Congress, Department of Defense, military services, private sector. Implications of American defense policies for foreign and domestic policy.

8335. PUBLIC POLICY. (3 cr; prereq #) 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.

8337. POLICY EVALUATION. (3 cr; prereq #) Freeman
Critical review and application of techniques available for policy evaluation prior to and after policy adoption.

8412. AMERICAN FOREIGN POLICY. (3 cr; prereq 8411 or #) Sampson
See Foreign Policy subdivision of International Relations subfield listing for description.

International Relations

5810. ADVANCED TOPICS IN INTERNATIONAL POLITICS AND FOREIGN POLICY. (1-4 cr; prereq 3835 or 3836 or non-political science grad or #) Staff
Topics of current analytic or policy importance in international relations and foreign policy. Topics vary.

8400. INTERNATIONAL RELATIONS. (4 cr; prereq △) Staff
Introduction to analysis of international relations and foreign policy.

8440. INDIVIDUAL READING AND RESEARCH IN INTERNATIONAL RELATIONS. (1-3 cr; prereq # and △) Staff

8450. RESEARCH SEMINAR: INTERNATIONAL POLITICS AND FOREIGN POLICY. (3 cr; prereq #) Staff
Supervised group research and research training in selected topics or problems.

8460. TOPICS IN INTERNATIONAL POLITICS. (3 cr; prereq #) Staff
Readings and research in advanced topics or problems; content varies with instructor.

International Politics

5881. INTERNATIONAL LAW. (5 cr; prereq 3835 or non-political science grad or #) Staff
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, diplomatic and consular agents' treaties and agreements, human rights.

5883. INTERNATIONAL ORGANIZATIONS. (4 cr; prereq 3835 or non-political science grad or #) Duvall
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 PEACE AND VIOLENCE. (4 cr; prereq 3835 or non-political science grad or #) Job, Levy
Normative issues surrounding international violence; causes of violence and possible mechanisms for creating international peace; alternative structures for limiting future violence and maintaining peace.

5886. INTERNATIONAL DIPLOMACY, BARGAINING AND NEGOTIATION. (4 cr; prereq 3835 or non-political science grad or #) Staff
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-political science grad or #) Duvall, Sylvan
Trade, aid, investment, and international monetary relations as political-economic processes; role of multinational corporations; problems of dependence and interdependence; strategic issues in East-West economic relations.

8401. ADVANCED INTERNATIONAL RELATIONS THEORY. (3 cr; prereq #) Duvall, Job, Levy, Sampson, Sylvan
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 8401 or #) Duvall, Job, Levy
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.

8404. INTERNATIONAL HIERARCHY. (3 cr; prereq 8400 or 8401 or #) Duvall, Sampson
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 8401 or #) Duvall, Sylvan
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-political science grad or 6 cr ROTC or #) Staff
For description, see Public Policy subdivision of American Politics subfield listing.

5875. AMERICAN DIPLOMACY AND FOREIGN ECONOMIC POLICY. (4 cr; prereq 3836 or non-political science grad or #) Sampson, Sylvan
Issues and processes related primarily to economic or diplomatic aspects of U.S. foreign policy; implications for U.S. defense and domestic policies; problems of coordinating information gathering, decision making, and implementation of foreign policy under crisis and noncrisis conditions.

5877. COMPARATIVE FOREIGN POLICY. (4 cr; prereq 3836 or non-political science grad 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) Levy, Sampson, Sylvan
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-political science grad or #) Staff
Topics of current analytic or policy importance in comparative politics. Topics vary.

5461. WESTERN EUROPEAN GOVERNMENT AND POLITICS. (5 cr, §5441; prereq 3051 or non-political science grad or #) Holt, Shively, Strom
Political institutions in their social setting; problems of power and responsibility, government stability; political decision making, government and the economic order.

5463. GOVERNMENT AND POLITICS OF SCANDINAVIAN COUNTRIES. (4 cr, §Scan 5463; prereq 3051 or non-political science grad or #) Kvavik, Strom
Scandinavian political institutions and behavior; Scandinavian party politics, interest groups, and legislative behavior. Voting patterns and voter alignments. Emergence of social democratic state.

5465. CANADIAN GOVERNMENT AND POLITICS. (4 cr, §5456; prereq 3051 or non-political science grad or #) Job
Structure and operation of Canadian government institutions; Canadian political parties and electoral behavior; French-Canadian nation; federal-provincial distribution of powers and conflicts; current public policy issues including U.S.-Canadian relations.

5467. JAPANESE GOVERNMENT AND POLITICS. (4 cr, §5453; prereq 3051 or non-political science grad or #; offered when feasible) Staff
Economic and political development of Japan; operation of government forms and political parties, their relation to traditional social structures; patterns of change.

5471. GOVERNMENT AND POLITICS OF THE SOVIET UNION. (4 cr, §5443; prereq 3051 or non-political science grad or #) Staff
Rise of Bolshevism; sources and nature of Bolshevik ideology; history and institutional character of the Soviet regime; sources of power; role of the party and functional groups; patterns of change.

5473. CHINESE GOVERNMENT AND POLITICS. (4 cr, §5454; prereq 3051 or non-political science grad or #) Staff
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.

5476. GOVERNMENT AND POLITICS OF SOUTH ASIA. (4 cr, §5446; prereq 3051 or non-political science grad or #; offered when feasible) Staff
Government institutions in their historical and social setting. Dynamic processes of modernization in democratic institutional framework. Public policies involving social and economic development; agrarian reform, population control, industrial growth.

5477. MIDDLE EASTERN GOVERNMENT AND POLITICS. (4 cr, §5457; prereq 3051 or non-political science grad or #) Krislov, Nimtz, 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, §5448; prereq 3051 or non-political science grad 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-political science grad or #) Sikkink
Latin American political heritage, political processes, and contemporary public policy issues; problems of social, economic, and political change in selected countries.

5481. THE POLITICS OF NATIONAL ECONOMIC RELATIONS. (4 cr; prereq 3051 or non-political science 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.

8600. INTRODUCTION TO COMPARATIVE POLITICS. (4 cr; prereq △) Staff
Main analytic approaches to comparative political analysis.

8601. GOVERNMENT AND POLITICS IN WESTERN EUROPE. (3 cr; prereq 5461 or equiv or #) Kvavik, Shively, Strom
Analysis of political institutions; political development; social structures; ideologies; parties and pressure groups; voting behavior.

8603. SCANDINAVIAN GOVERNMENT AND POLITICS. (3 cr; prereq 5463 or equiv or #) Kvavik, Strom
Political institutions of the Scandinavian countries, socioeconomic basis of politics, parties and interest groups; patterns of voting behavior.

8605. GOVERNMENT AND POLITICS OF AFRICA. (3 cr; prereq 5478 or equiv 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 THE U.S.S.R. (3 cr; prereq 5471 or equiv or #) Staff
Rise of Bolshevism; sources and nature of the belief system; development of Communist regime; institutional features; organization of power; role of the party; social, economic, and foreign policy.

8611. GOVERNMENT AND POLITICS IN EAST ASIA. (3 cr; prereq 5473 or equiv or #) Staff
East Asian political institutions in their social setting with emphasis on Japan and China; political development; ideologies; relationship of social structure to political institutions; parties and pressure groups.

8615. GOVERNMENT AND POLITICS OF INDIA AND SOUTHEAST ASIA. (3 cr; prereq 5476 or equiv or #; offered when feasible) Staff
Political institutions in India and selected countries of Southeast Asia in their cultural setting; political development; ideologies; relationship of social structure to political institutions; parties and pressure groups.

8619. GOVERNMENT AND POLITICS OF LATIN AMERICA. (3 cr; prereq 5479 or equiv 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.

8633. COMPARATIVE SOCIOPOLITICAL CHANGE. (3 cr; prereq #) Nimtz
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 #) Duvall, Freeman
Comparison of political and economic systems of industrialized countries; political-business cycles, business and unions as interest groups; patterns of government spending.

8640. INDIVIDUAL READINGS AND RESEARCH IN COMPARATIVE POLITICS. (3 cr per qtr; prereq # and △) Staff

8641. COMPARATIVE MASS POLITICAL BEHAVIOR. (3 cr; prereq #) Nimtz, 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.

8645. COMPARATIVE ANALYSIS OF ELITES IN AN INSTITUTIONAL CONTEXT. (3 cr; prereq #) Benjamin, Nimtz
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.

8650. RESEARCH SEMINAR: COMPARATIVE POLITICS. (3 cr; prereq #) Staff
Supervised research and research training in selected topics and problems.

8660. TOPICS IN COMPARATIVE POLITICS. (3 cr; prereq #) Staff
Readings and research in special advanced topics or problems.

Portuguese

See Hispanic and Luso-Brazilian Literatures and Linguistics.

Psychiatry

Professor: Paula J. Clayton, *head;* William Schofield, *director of graduate studies;* Lawrence M. Greenberg; James A. Halikas; Leonard L. Heston; John T. Kelly; David T. Lykken; Manfred J. Meier; Michael K. Popkin; Lloyd K. Sines; Travis I. Thompson; Joseph J. Westermeyer

Clinical Professor: Faruk S. Abuzzahab

Associate Professor: Marilyn E. Carroll; Elke D. Eckert; Barry D. Garfinkel; Judith M. Garrard; Harold R. Ireton; Jerome L. Kroll; Thomas B. MacKenzie; James E. Mitchell

Assistant Professor: Gerald J. August; William H. Frey; William M. Grove; Daniel R. Hanson; Dorothy K. Hatsukami; Norman G. Hoffmann

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

Degree Offered—M.S.Psychiat. (Plan A only).

Curriculum—Study for the M.S. degree may be pursued concurrently with residency training, a four-year program that meets the requirements of the American Board of Psychiatry and Neurology. Also available is a five-year program in child psychiatry.

Prerequisites for Admission—Applicants must hold an M.D. degree from an approved medical school and have been accepted for residency training in psychiatry.

Master's Degree Requirements—Major study entails didactic seminars in psychiatric nosology, psychopathology, and psychiatric and psychotherapeutic interventions. The minor field of study may be in a basic medical science, such as neuroanatomy or pharmacology, or in such fields as anthropology, philosophy, psychology, sociology, or public health. A final written examination is required before the final oral examination.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Department of Psychiatry, Box 393 Mayo, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address).

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Adult Psychiatry (AdPy)

5800. CASE CONFERENCE: PSYCHIATRY IN MEDICINE. (1 cr; prereq MD or #) Popkin

5801. CONSULTATION-LIAISON PSYCHIATRY. (Cr ar; prereq MD) Popkin

5811. APPLIED BEHAVIOR ANALYSIS. (2 cr; prereq MD or #) Eckert, Hatsukami

8205. SPECIAL ASSIGNMENTS IN PSYCHIATRY. (1 cr; prereq MD, 8201, 8203) Staff

8206. RESEARCH METHODS IN PSYCHIATRY. (Cr ar; prereq #) Grove, Mitchell

8208. SURVEY OF PHYSIOLOGICAL TREATMENTS. (2 cr; prereq #) Staff

8209. CLINICAL PSYCHOPATHOLOGY. (3 cr) Sines

8210. CLINICAL PSYCHOPHARMACOLOGY. (1 cr; prereq 8208) Abuzzahab and staff
Basic pharmacology and clinical use of psychotropic agents.

8221. SEMINAR: CURRENT LITERATURE. (1 cr; prereq #) Simon

8224. INTRODUCTION TO GROUP THERAPY. (1 cr) Staff

8226. BIOLOGICAL PSYCHIATRY. (3 cr; prereq MD or #) Heston

8238. CASE CONFERENCE IN PSYCHOLOGICAL MEDICINE. (1 cr; prereq MD or #)

8239. CONTINUOUS CASE SEMINAR: PSYCHOANALYTICALLY ORIENTED PSYCHOTHERAPY. (1 cr; advanced psychiatric residents and psychology interns only; prereq #) London

8243. SEMINAR: INTRODUCTION TO CLINICAL THEORY OF PSYCHOANALYTIC PSYCHOTHERAPY. (3 cr; prereq #) Horton

8244. COMPARATIVE THEORIES OF PSYCHOTHERAPY. (3 cr; prereq #) Schofield

8249. CLINICAL NEUROPSYCHOPHARMACOLOGY. (2 cr) Abuzzahab

8264. PRESENTATIONS ON CURRENT AND APPROPRIATE LITERATURE PERTAINING TO ALL PHASES OF MENTAL HEALTH CARE. (1 cr; limited to residents on rotation to Mpls Veterans Administration Medical Center Psychiatry Service) Murtaugh

8265. READINGS: PSYCHOSOMATIC MEDICINE, CONSULTATION-LIAISON PSYCHIATRY. (Cr ar [max 3 cr]; prereq MD or #) Popkin

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.

5206. THERAPEUTIC METHODS IN CHILD, ADOLESCENT, AND FAMILY PSYCHIATRY. (1 cr; prereq med student, #) Greenberg
Therapeutic techniques utilized in child, adolescent, and family psychiatry reviewed through presentation and discussions of ongoing cases.

5520. OUTPATIENT CLINICAL CHILD AND ADOLESCENT PSYCHIATRY FOR PRIMARY CARE TRAINEES. (4.5-9 cr; prereq med student, #) Greenberg
Supervised diagnostic and therapeutic experiences in an outpatient setting.

5602. INTRODUCTORY READINGS IN CHILD AND ADOLESCENT PSYCHOPATHOLOGY. (3 cr; prereq med student or MD, #) Staff
Assigned readings and discussion with faculty as an introduction to child, adolescent, and family psychiatry. Topics include child development, diagnostic and therapeutic techniques, and psychopathology.

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, and #) 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.

5609. CHILD DEVELOPMENT. (3 cr; prereq MD and/or #)
Observation conducted at the University-affiliated child care center consisting of three sessions with infants, three sessions with toddlers, and four sessions with preschoolers. Each session consists of one hour of observation of unstructured activities under the guidance of faculty members, one hour of group discussion with child psychiatry and child development faculty, and one hour of demonstration illustrating the characteristic behaviors of each age group.

5610. BIOMEDICAL RESEARCH: PRINCIPLES AND DESIGN. (3 cr; prereq introductory statistics, #) Staff
Designed to help students develop a basic understanding and skills for planning and executing biomedical research and for critical reading of research reports and articles. Theoretical models, generating research hypotheses, selecting appropriate research strategies, determining appropriate statistical analyses, interpreting results. Issues in research with human subjects, relationship between research and clinical work, the computer as a research tool, resources available for literature searches.

5612. WORKSHOP: EATING DISORDERS IN CHILDREN AND ADOLESCENTS. (1 cr)
Presentations on clinical characteristics of anorexia nervosa, bulimia, and obesity; medical complications. Treatment modalities: psychodynamic, family/systems, cognitive-behavioral, and pharmacological therapist.

5619. WORKSHOP: SEXUAL DEVELOPMENT AND DEVIANCE IN CHILDREN AND ADOLESCENTS. (1 cr)
Development of sexual identity and expected course of establishing sexual preference; frequent patterns of sexual maladjustment for both males and females. Approaches to understanding and intervention.

5621. WORKSHOP: EATING DISORDERS IN CHILDREN AND ADOLESCENTS. (1 cr)
Theories of etiology, individual and family psychodynamics, medical complications, relationship to depression and prognosis. Practical aspects of treatment: individual and family psychotherapy, behavior and group therapy, pharmacotherapy, and inpatient management.

5622. WORKSHOP: CONDUCT DISORDERS. (1 cr)
Origins and presentation of conduct disorders. Effect of developmental stage on symptoms of conduct disorders and consequences for child. Outpatient, inpatient, and residential/foster care treatment.

5623. WORKSHOP: SUICIDE—CHILDREN, ADOLESCENTS, AND FAMILIES. (1 cr)
Prevalence of suicide in children and adolescents. Recognizing early warning signs of depression and suicidal behavior in classroom, working with families who have lost children to suicide.

5624. WORKSHOP: MEDICAL AND PSYCHOLOGICAL ASPECTS OF OBESITY AND ITS TREATMENT. (1 cr)
Health hazards; effects on self-image, self-esteem, peer group interactions; relationships to development of serious psychiatic disorders (anorexia, bulimia); early detection; prevention; treatment modalities. Case studies and role of parents, teachers, and peers as support systems.

5625. WORKSHOP: STRESS, MOOD, AND SELF-ESTEEM IN CHILDREN AND ADOLESCENTS. (1 cr)
Role of environmental (e.g., family system dysfunction, bereavement, peer problems) and biological events (e.g., medical illness, changes associated with puberty); detection, differential diagnosis, treatment modalities. Case studies.

5626. WORKSHOP: THE DISTURBING CHILD/ADOLESCENT IN THE CLASSROOM. (1 cr)
Developmental issues, various disorders (attention deficit, conduct, depression, anxiety, learning disabilities), and psychophysiology explored, using illustrative clinical material. Importance of diagnostic workup as first step in effective intervention.

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.

5633. ANXIETY DISORDERS IN CHILDHOOD AND ADOLESCENCE. (1 cr)
Characteristics of anxiety disorders in youth and children, including school phobia, panic attack, separation anxiety, and obsessive-compulsive disorder; etiological factors; approaches to intervention and strategies for prevention.

5634. DEVELOPMENTAL DYSLEXIA: THEORY, RESEARCH, AND CLINICAL DIFFERENTIATION. (1 cr)
Neuropsychological and cognitive processes found in dyslexic children, with special attention to subtypes of dyslexia; assessment methods and intervention programs.

5635. COGNITIVE-BEHAVIORAL THERAPY FOR CHILDREN AND ADOLESCENTS. (1 cr)
Therapeutic procedures to increase children's ability to control their behavior and emotions, with review of the literature. Model for working with families and school systems within cognitive-behavioral framework.

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, #) Greenberg, Stocking
Therapeutic techniques utilized 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, #) Pearson
Supervised consultation, diagnostic, and short-term therapy experiences in pediatrics and pediatric neurology.

8218. GROUP THERAPY. (1 cr; prereq MD, #)
Readings and illustrative group therapy examples reviewed to complement the concurrent clinical experiences.

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.

8243. SCHOOL CONSULTATION. (2 cr; 10 hrs per wk; prereq MD, #)
Supervised clinical and consultative experiences in a school setting with literature and clinical seminars.

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.

Psychology (Psy)

Regents' Professor: Ellen S. Berscheid; Paul E. Meehl

Professor: Thomas J. Bouchard, Jr., *chair;* John P. Campbell, *director of graduate studies;* Gary T. Athelstan; Ellen S. Berscheid; Irving Biederman; Eugene Borgida; Dwight A. Burkhardt; James N. Butcher; John G. Darley (emeritus); Mark L. Davison; Rene V. Dawis; Richard A. Depue; Marvin D. Dunnette; Byron Egeland; Patricia Faunce; Paul W. Fox; Norman Garmezy (emeritus); Jo-Ida C. Hansen; Willard W. Hartup; Paul E. Johnson; Thomas J. Kiresuk; Eric Klinger; Gordon E. Legge; Gloria Leon; Rodney G. Loper; David T. Lykken; Manfred J. Meier; David H. Olson; J. Bruce Overmier; Dallis K. Perry; Herbert L. Pick, Jr.; Warren W. Roberts; Paul C. Rosenblatt; Ivan Ross; William Schofield; Mark Snyder; Sheldon B. Sparber; Alan L. Sroufe; Zigfrid T. Stelmachers; June L. Tapp; Auke Tellegen; Travis I. Thompson; Neal F. Viemeister; David M. Wark; Richard A. Weinberg; David J. Weiss; James E. Ysseldyke

Associate Professor: Gail B. Peterson, *assistant chair;* Marilyn E. Carroll; William G. Iacono; Matthew McGue; Mary Jo Nissen; Carol H. Pazandak; James B. Preus; Pearl P. Rosenberg

Assistant Professor: Phillip L. Ackerman; Robert A. Cudeck; John H. Fleming; Charles R. Fletcher; Martha H. Gonzales; Darwin D. Hendel; Ruth Kanfer; Susan Nicol

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, counseling, differential/behavior genetics, experimental, industrial/organizational, personality, school psychology, psychometrics, and social psychology. M.A. programs are offered in industrial/organizational and 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 grade point averages 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. In general, since most M.A. programs are practitioner-oriented, Plan B is preferred.

Doctoral Degree Requirements—There are no general course require-

ments. Each student's program is individually planned in consultation with the adviser. In addition to the requirements of the Graduate School, the department requires successful completion of four general written preliminary examinations and a preliminary examination covering the major area of concentration. Each specialty area also requires completion of a series of Ph.D.-level seminars designed to 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—Contact the Office of Graduate Admissions or the director of graduate studies, Department of Psychology, 105 Elliott Hall, University of Minnesota, 75 East River Road, Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5011. THEORIES OF LEARNING AND COGNITION. (4 cr; prereq 3011 or #)
Learning theories and contemporary theories of information processing and cognition. Examples from animal research.

5012-5013. PSYCHOLOGY OF LEARNING. (4 cr per qtr; prereq 1005, 3011 or EBB 3111 or #, except for grad students) Overmier
Classical conditioning; instrumental learning. Evaluation of relevant theories.

5014. PSYCHOLOGY OF HUMAN LEARNING AND MEMORY. (4 cr; prereq 1005 or 3011 or 3051 or #, except for students in honors sequence and grad students) Fox
Processes and principles in human learning and memory. Feedback, instruction and learning, individual differences in learning, cognitive processes in learning and retention, theories of human memory.

5015. ADVANCED LEARNING AND COGNITIVE PROCESSING. (4 cr; prereq 3011 or 3051 or 5014, except for students in honors sequence and grad students)
Cognitive processes in human pattern recognition, attention, and memory.

5019. ANALYSIS OF COMPLEX BEHAVIOR. (5 cr; prereq 1001, jr or sr or grad student)
Principles of experimental analysis of behavior applied to more complex phenomena, including creativity, emergent behavioral processes, social behavior, private events, psychopathology, and communication.

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. SENSORY PSYCHOBIOLOGY. (4 cr, §NSc 5034; prereq 3031 [except for grad students] or #) Burkhardt
Analysis of properties and biological mechanisms of sensory perception in humans and animals. Emphasis on color vision, visual sensitivity and adaptation, electrical activity of eye and brain.

5051. PSYCHOLOGY OF HUMAN-MACHINE INTERACTION. (4 cr; prereq 3051 or 3031 or #) Legge
Psychological and cybernetic models of human-machine communication; analysis of factors that limit performance. Psychology of computer use, design and evaluation of sensory aids, and psychological perspective on robots.

5054. PSYCHOLOGY OF LANGUAGE. (4 cr; prereq 3011, except for students in honors sequence and grad students)
Theories and experimental evidence involved in past and present conceptions of psychology of language.

5061. FUNDAMENTALS OF PHYSIOLOGICAL PSYCHOLOGY. (4 cr, §3061; prereq 1001) Roberts
Physiological and neuroanatomical mechanisms underlying behavior of higher vertebrates. Sensory mechanisms, sleep, wakefulness, and attention processes. Effects of drugs on behavior.

5062. NEUROPSYCHOLOGY OF MOTIVATION AND LEARNING. (4 cr, §NSc 5062; prereq 5061 or #) Roberts
Brain mechanisms of aggression, fear, pain, hunger, thirst, reproductive behavior, learning, and memory.

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.

5135. INTRODUCTION TO INDIVIDUAL DIFFERENCES. (4 cr, §3135; prereq 3801 or equiv, 5862 or #) Bouchard
Differential methods in study of human behavior. Nature of psychological traits and influence of age, sex, heredity, and environment in causation of individual and group differences in ability and temperament.

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
Methodology appropriate in analyzing contribution of genetic and environmental factors to variance observed in normal and abnormal traits in humans and animals. Intelligence, neuroses, and psychoses. For all examples, independent variable will be the genotype of an organism.

5138w. TOPICS IN DIFFERENTIAL PSYCHOLOGY: 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 and personality changes associated with aging.

5141. PSYCHOLOGY OF WOMEN. (4 cr; prereq 1001; offered when feasible)
Psychological and physical sex differences, stressing developmental and environmental influences on dependency, aggression, achievement motivation, and achievement. Sex roles and sexuality during various life phases.

5201. SOCIAL PSYCHOLOGY. (4 cr; prereq 3201, psych honors major or grad student or #) Berscheid
Classical and contemporary theories and research in social psychology emphasizing social influence and group dynamics.

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.

5205. APPLIED SOCIAL PSYCHOLOGY. (4 cr; prereq 3201 or grad or #) Gonzales
Overview of applications of social psychology research and theory to such areas as criminal justice system, media, behavioral medicine, desegregation, advertising, victimology, juvenile delinquency, institutions, and energy conservation programs.

5206. RESEARCH METHODS IN SOCIAL PSYCHOLOGY. (4 cr; prereq 3201, 3801 or equiv or grad student or #) Fleming
Overview of randomized and quasi-experimental designs suitable for research in social psychology. Validity, operational, and ethical issues in social psychological research.

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 student) Leon
Comprehensive review of psychological disorders. Etiology and clinical research findings emphasized.

5609w. PSYCHOBIOLOGY OF ADDICTIVE BEHAVIOR. (4 cr; prereq 1001) Carroll, Hatsukami
Factors implicated in control of addictive behavior. Genetic, neurochemical, and environmental findings as they relate to alcoholism, drug abuse and dependence, smoking, obesity, bulimia, compulsive gambling, and other forms of addictive behavior.

5701. PERSONNEL AND INDUSTRIAL PSYCHOLOGY. (4 cr; prereq 3801 or equiv, 8 cr in psych or #) Campbell
Application of principles of individual differences and psychological measurement to problems of recruiting, selecting, and evaluating members of ongoing organizations. Job analysis, job behavior description, performance measurement, selection and placement strategies, minority group employment, and utility of organizational strategies in occupation selection and placement.

5702. PSYCHOLOGY OF INDIVIDUAL BEHAVIOR IN ORGANIZATIONS. (4 cr; prereq 3801 or equiv, 8 cr in psychology or #) Kanfer
Application of psychological research and methodology to study of human behavior in ongoing organizations. Models of motivation, 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 in psychology or #) Campbell
Theories, methods, and research findings pertaining to improving the performance of individuals, groups, and organizations; individual training and development; group work methods and problem solving strategies; methods of organizational development.

5704. ENGINEERING PSYCHOLOGY. (4 cr; prereq 3801 or equiv, 8 cr in psych or #) Ackerman
Survey of capacities and limitations of humans in person-machine interactions. Attention, perception, manual control, human-computer interface, human factors applications.

5705. WORK MOTIVATION. (4 cr; prereq 3801 or equiv, 8 cr in psych or #) Kanfer
Motivational processes and morale in work contexts. Emphasis on process theories of performance, turnover/withdrawal, work attitudes and interpersonal influences.

5861. QUANTITATIVE METHODS IN PSYCHOLOGY. (4 cr; prereq #; offered when feasible) Viemeister
Elementary set theory, probability theory, matrix algebra, difference equations; applications to construction and evaluation of behavior models.

5862. PSYCHOLOGICAL MEASUREMENT: THEORY AND METHODS. (4 cr; prereq 3801 or equiv, honors or grad student) 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.

8004w-8005s†. SEMINAR: PHILOSOPHICAL PSYCHOLOGY. (3 cr per qtr; prereq course in logic or philosophy, PhD candidate in psychology or philosophy) Lykken, Meehl
Discussion of selected philosophical and methodological problems.

8010. ADVANCED TOPICS IN LEARNING. (3 cr; prereq 5012-5013 or #) Overmier

8015. READINGS IN THE ANALYSIS OF OPERANT BEHAVIOR. (3 cr; prereq 5019 or #; offered alt yrs) Thompson
Readings in classic and recent books, monographs, and articles in operant conditioning. Not recommended for first-year graduate students.

8019s. SEMINAR: READINGS IN BEHAVIOR THEORY. (3 cr; prereq 5017 or 5012 or #) Overmier, Peterson
Analysis of classic issues in behavior theory and current research literature bearing on their resolution.

8020. SEMINAR: CONDITIONING AND LEARNING. (3 cr; prereq #) Overmier, Peterson, others

8031. SEMINAR: VISUAL PERCEPTION. (3 cr; prereq 5031 or #) Legge
Physiological, psychological, and cognitive determinants of visual perception. Discussion of current research.

8035. VISION. (3 cr, §NSc 8035; prereq 5034) Burkhardt
Critical examination of selected topics in contemporary vision research. Representative topics: neuroelectric activity, color, binocular and spatial vision, adaptation.

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 laboratory experience.

8056. SEMINAR: PSYCHOLOGY OF LANGUAGE. (3 cr; prereq 5054, #) Fletcher

8070. SEMINAR: PSYCHOPHARMACOLOGY. (1 cr; prereq #) Sparber
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 #) Depue
Theory and research in psychopathology; evaluation of current experimentation in various behavior disorders.

8116, 8117. RESEARCH SEMINAR: PSYCHOPATHOLOGY. (3 cr per qtr; prereq 5605 or equiv, 1 yr grad study or #) Garmezy
Review of theoretical and empirical status of specific problem areas in psychopathology.

8120. PERSONALITY, THERAPY, AND WOMEN. (4 cr; prereq 5101, 8 cr in psychology or #) 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
Discussion of social psychological theory and research in social cognition.

8202. ADVANCED SOCIAL PSYCHOLOGY—CLOSE RELATIONSHIPS. (3 cr; prereq #) Berscheid
Discussion of theory and research concerning the development, maintenance, and dissolution of close relationships.

8204-8205-8206. SEMINAR: RESEARCH IN SOCIAL PSYCHOLOGY. (3 cr per qtr; prereq PhD candidate in psychology, #) Berscheid, Borgida, Fleming, 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.

8410. PERSPECTIVES IN LEARNING, PERCEPTION, AND COGNITION. (1 cr; offered S/N) Broen, Overmier, 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 psych student or #) Counseling psychology staff
Theories of counseling, their psychological assumptions and implications for practice; origins, development, and current status of vocational counseling.

8502. COUNSELING PSYCHOLOGY II: ASSESSMENT. (3 cr; prereq 5862 and counseling psych student or #) Counseling psychology staff
Counseling use of selected assessment procedures and instruments including intelligence, abilities, interests, needs, values, and personality.

8503. COUNSELING PSYCHOLOGY III: INTERVIEWING. (3 cr; prereq 8501, 8502 and counseling psych 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. (3 cr per qtr; prereq 8501, 8502, 8503 or equiv; offered S/N) Loper, others
Counseling experience with students in an academic setting; emphasis is on the educational, vocational, and personal problems of college students.

8517-8518-8519. PRACTICUM IN REHABILITATION COUNSELING. (3 cr per qtr; prereq 8503 or #; offered when feasible) Athelstan, others
Counseling experience with physically and emotionally disabled clients in approved public and private rehabilitation agencies.

8520. FIELDWORK IN APPLIED PSYCHOLOGY. (1-6 cr; prereq #) Pazandak, Wark

8524, 8525, 8526. SEMINAR: STUDENT PERSONNEL WORK. (1-4 cr per qtr; prereq grad student) Counseling psychology staff
Topics and problems relating to content, development, and coordination of comprehensive college student personnel programs.

8541, 8542, 8543. SEMINAR: PRACTICES, APPROACHES, AND ISSUES IN COUNSELING PSYCHOLOGY. (1 cr per qtr; prereq grad student in counseling psychology or #) Haynes
Lectures and discussions on a wide variety of applications of counseling, counseling theory, techniques, research, and issues in the field. In each area, experts share ideas and lead discussions.

8544-8545-8546. SEMINAR: RESEARCH IN COUNSELING PSYCHOLOGY. (1 cr per qtr; prereq #) Dawis, Hansen
Presentation and discussion of research in counseling psychology with emphasis on process and outcome research.

8560. INTERNSHIP IN COUNSELING PSYCHOLOGY. (1-12 cr; prereq #) Counseling psychology staff

8561-8562-8563. SEMINAR: VOCATIONAL COUNSELING FOR WORK ADJUSTMENT. (2 cr per qtr; prereq #) Dawis
Topics and problems in vocational counseling for work adjustment. Research, operationalization, and application of the theory of work adjustment.

8564-8565-8566. ADVANCED SEMINAR: VOCATIONAL COUNSELING FOR WORK ADJUSTMENT. (2 cr per qtr; prereq 8563 or #) Dawis
Advanced topics and research on application of the theory of work adjustment to vocational counseling.

8574s. SEMINAR: STRONG VOCATIONAL INTEREST BLANK/STRONG-CAMPBELL INTEREST INVENTORY. (2 cr; prereq grad or #) Hansen
Lectures and discussion on history and development of SVIB-SCII. 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 psychology major) Butcher, Depue, Iacono, Tellegen
Presentation of theory and practice in clinical application of assessment techniques and interviewing. Observation, administration, scoring, and interpretation are focus of laboratory experience.

8620. PRACTICUM IN CLINICAL PSYCHOLOGY. (1-6 cr; prereq #)
Field experience in professional work in clinical settings.

8621, 8622, 8623. PROFESSIONAL METHODS IN CLINICAL PSYCHOLOGY II. (3, 2, 2 cr per qtr; prereq clinical psychology major, 8611, 8612, 8613) Leon
Seminar on theories of individual and group treatment techniques. Lectures on and demonstrations of contemporary theories of individual and group methods of psychological intervention with adults and children. 8621: Theories of intervention. 8622, 8623: Techniques of intervention.

8631, 8632, 8633. PROFESSIONAL METHODS IN CLINICAL PSYCHOLOGY III: TECHNIQUES OF INTERVENTION. (3 cr per qtr; prereq clinical psychology major, 8611, 8612, 8613) Leon
Lectures, demonstrations, and supervised experience in the application of techniques in individual and group treatment methods with psychologically disturbed persons.

8640. SEMINAR: TOPICS IN CLINICAL PSYCHOLOGY. (1-6 cr; prereq #) Clinical psychology staff
Discussion of various topics in clinical psychology of interest to class and instructor.

8644-8645-8646. SEMINAR: ADVANCED CLINICAL PSYCHOLOGY. (1 cr per qtr; prereq advanced statistics, #; offered when feasible)
Practicum in diagnosis and evaluation of personality traits and structure in relation to occupational and social roles.

8654. SEMINAR: CRISIS INTERVENTION. (3 cr; prereq #) Butcher

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.

8670x. INTERNSHIP IN CLINICAL PSYCHOLOGY. (2-4 cr per qtr; prereq PhD candidate in clinical psychology and permission of director of clinical psychology training program) Clinical psychology staff

8701-8702. SEMINAR: INDUSTRIAL AND ORGANIZATIONAL PSYCHOLOGY. (4 cr per qtr; prereq #; offered alt yrs) Ackerman, Campbell, Dunnette, Kanfer

8703, 8704. SEMINAR: INDUSTRIAL AND ORGANIZATIONAL PSYCHOLOGY. (4 cr per qtr; prereq #; offered alt yrs) Ackerman, 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)
Based on a syllabus of required and optional reading. Topics announced by Department of Psychology.

8971. SEMINAR: ISSUES IN PSYCHOLOGY AS A PROFESSION. (1 cr; prereq 1st-yr psych grad) Staff
Ethical and practical issues in applied and research psychology.

8980. DIRECTED TEACHING IN PSYCHOLOGY. (1-6 cr; prereq #) Staff
Supervised experience in the teaching of psychology.

8990.* RESEARCH PROBLEMS. (1-6 cr; prereq #) Graduate staff

Public Affairs (PA)

Professor: G. Edward Schuh, *dean;* Richard S. Bolan, *director of planning degree program;* James E. Jernberg, *director of graduate studies;* Dean E. Abrahamson; John S. Adams; Charles H. Backstrom; John R. Borchert; John E. Brandl; Harlan Cleveland; Robert C. Einsweiler; Nancy N. Eustis; Donald P. Geesaman; James L. Hetland, Jr.; Stephen A. Hoenack; Morris M. Kleiner; Robert T. Kudrle; James W. Vaupel

Associate Professor: Barbara J. Nelson, *program director*; John M. Bryson

Assistant Professor: Margaret E. Dewar; Simon Fass

Senior Fellow: Thomas R. Dewar; Barbara L. Lukermann; Robert W. Terry

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.P.) 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 as soon as possible after admission. A special remedial course in intermediate microeconomics is 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 Humphrey Institute of Public Affairs. All applicants must submit Graduate Record Examination scores. All application materials should be submitted by February 1 for applicants seeking financial aid, and by April 1 for other applicants. Students should enter the program in fall quarter. Applications received after the April 1 deadline will be considered; however acceptance is dependent on availabilty of space.

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, worth six credits, of at least three months. The internship requirement can be waived for persons having equivalent experience.

For the M.P. 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, worth six credits, of at least three months. 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, public health, or political science, are available. Applicants must submit separate applications to the two programs.

Language Requirements—None.

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—Contact the admissions coordinator, Hubert H. Humphrey Institute of Public Affairs, 230 Humphrey Center, University of Minnesota, 301 19th Avenue South, Minneapolis, MN 55455.

Core Courses

5001. POLICY PROCESS I. (3 cr; prereq #) Political and economic forces shaping public policy. Policy cycle (agenda setting, decision making, implementation, evaluation, termination) in public institutions.

5002. POLICY PROCESS II. (3 cr; prereq 5001, #) Continuation of 5001. Theories and practice of organizational management. Introduction to complex organizations, individual behavior and organizational action, ethical issues, systems of managerial planning and control, and leadership in complex organizations.

5011. POLICY ANALYSIS I: APPLIED MICROECONOMICS FOR POLICY ANALYSIS. (3 cr; prereq Intermediate Microeconomics, #) "Market failure" concept. Overview of public finance. Cost-benefit analysis, systems analysis, and incentive issues in public organizations.

5012. POLICY ANALYSIS II. (3 cr; prereq 5011, #) 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. (3 cr; prereq #)
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. (3 cr; prereq 5021, #)
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 #)
Evolution of federal system and modern system of intergovernmental relations in U.S. 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 governmental units.

5102. LEGAL ENVIRONMENT OF PUBLIC AFFAIRS. (3 cr)
Role of courts in public participation, policy making, and administration. Introduction to legal reasoning and use of law and legal resources in resolving policy issues and in managing administrative processes.

5111. MANAGEMENT OF PUBLIC AND NONPROFIT ORGANIZATIONS. (3 cr)
Application of 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 #)
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 special or △)
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.

5121-5122†. PUBLIC BUDGETING I-II. (3 cr per qtr; prereq grad student or major in PA or planning or PubH; sequence must be taken in same academic year)
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 △)
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.

5131. INFORMATION AND INCENTIVES FOR IMPROVED DECISION MAKING IN BUREAUS. (3 cr; prereq #)
Improving responsiveness of large bureaucracies to demands of constituencies. Use of decentralized incentives, as opposed to centralized directives, for improving responsiveness. Problems of designing a management information system to improve decentralized decision making in large organizations. Educational organizations, health care delivery, law enforcement, provision for welfare services.

5191, 5192, 5193, 5194, 5195, 5196, 5197, 5198, 5199. TOPICS IN PUBLIC AND INDEPENDENT SECTOR MANAGEMENT, (3 cr per qtr; prereq grad or adult special student or △)
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 #)
See Management of Public and Non-Profit Organizations for description.

5200. INTRODUCTION TO PLANNING. (3 cr)
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 △)
Theory of planned action. Philosophical roots of planning. Models of planned change. Planning theory and practice.

5202. PLANNING METHODS.
(4 cr)
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 △)
Nature, role, uses, and limitations of group techniques in public affairs and planning; specific techniques. Interorganizational focus.

5221. LAW AND URBAN AFFAIRS. (3 cr)
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 #)
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. (4 cr)
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.

5232. SEMINAR IN PLANNING AND ANALYSIS OF DEVELOPMENT PROJECTS. (3 cr; prereq 5202, #)
Application of project analysis methods. Case studies.

5241. CASE STUDIES IN PLANNING AND PLAN MAKING. (3 cr; prereq #)
Planning strategies, plan format and content, and plan preparation; changes with time and context. Relation to public attitudes and issues; to work with elected officials, citizens, private sector, and implementing agencies; and to planning agency capabilities. State, regional, and local examples.

5291, 5292, 5293, 5294, 5295, 5296, 5297, 5298, 5299. TOPICS IN PLANNING. (3 cr per qtr; prereq grad or adult special student or △)
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.

5320. MODELING AND CAUSAL INFERENCE IN THE SOCIAL SCIENCES. (3 cr; prereq 5011, 5012, #)
See Policy Analysis for description.

5602-5603. METROPOLITAN ANALYSIS I-II. (4 cr per qtr)
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. DEVELOPMENT MANAGEMENT SYSTEMS. (3 cr; prereq 5621, △)
Integrated systems of controls and incentives to manage land development at state, metropolitan, and local government levels. Traditional planning and land use devices, tax and fee techniques, environmental regulations and innovative controls.

5701. TECHNOLOGY PLANNING I. (3 cr; prereq △)
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. TECHNOLOGY PLANNING II. (3 cr; prereq 5701, △)
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. TOPICS IN POLICY ANALYSIS I, II. (3 cr per qtr; prereq grad student or public affairs or planning major or # for 5301; public affairs or planning major, 5011, 5012 or 5013 or △ for 5302; ¶5011 recommended for 5301)
Decision analysis, inventory models, queuing, simulation, various forms of linear and non-linear programming, systems analysis, advanced evaluation methods, and other topics.

5310. POLICY AND EVALUATION RESEARCH. (3 cr; prereq grad student or adult special or △)
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.

5320. MODELING AND CAUSAL INFERENCE IN THE SOCIAL SCIENCES. (3 cr; prereq 5011, 5012 or △)
Application of concepts of causal relationships and behavioral theory to modeling and empirical estimation in social sciences; review of empirical literature as teaching device.

5391, 5392, 5393, 5394, 5395, 5396, 5397, 5398, 5399. TOPICS IN POLICY ANALYSIS. (Cr ar; prereq grad or adult special student or △)
Advanced work in application of policy analysis techniques to complex policy problems.

8300. CASE STUDIES IN POLICY ANALYSIS. (3 cr; prereq 5011, 5012, △)
Topics in microeconomics applied to systems problems of government. Market and nonmarket resource allocation; cost-effectiveness and cost-benefit analysis. Case method employed.

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 special or △)
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.

5402. SEMINAR: SOCIAL THEORY AND SOCIAL PLANNING. (3 cr; prereq grad student or adult special or △)
Major contemporary theories of societal guidance; what planner has done and can do with regard to social goals and problems; examples from national, state, and metropolitan planning.

5403. SOCIAL PLANNING PRACTICE. (3 cr; prereq △)
Seminar. Review of policy and planning practice. Significant themes in field of socioeconomic thought and action.

5411. ISSUES IN AGING. (3 cr; prereq △)
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 special or △)
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 △)
Analysis of major issues in aging field.

5414. MULTIDISCIPLINARY PERSPECTIVES ON AGING. (4 cr, §CPsy 5305, §Educ 5440, §HSU 5009, §SHCE 5009, §Soc 5960, §SW 5024; prereq grad student or adult special or △)
Introduction to aging and aging process.

5421. CHILDREN, YOUTH, AND THE WELFARE STATE. (3 cr; prereq grad student or adult special or △)
Historical overview of juvenile justice and child welfare systems in U.S. Role of juvenile courts, status of children. Contemporary issues, e.g., youth and poverty, institutional policies, legal issues, impacts of legislative, fiscal, and administrative reforms.

5430. LABOR POLICY. (3 cr; prereq grad student or adult special or △)
Analysis of public policies respecting 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 special or △)
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 POLICY. (3 cr; prereq grad student or adult special or △)
Definitions of poverty, its causes and remedies. Past and current policies responding to poverty, political and economic feasibility of alternatives. Emphasis on U.S. policy with comparisons to "developing" and "developed" countries.

5433. SOCIAL WELFARE REFORM AND INCOME SUPPORT POLICY. (3 cr; prereq grad student or adult special or △)
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. (3 cr; prereq grad student or adult special or △)
Public policy issues of special concern to women in U.S.

5442. SEMINAR ON WOMEN AND PUBLIC POLICY. (3 cr; prereq grad student or adult special or △)
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.

5461. PROFESSIONAL SERVICES AND PUBLIC POLICY. (3 cr; prereq grad student or adult special or △)
Goals, operation, and impacts of a variety of service organizations compared and contrasted; general patterns and critical issues; incentives and disincentives operating in organizational (often bureaucratic) settings; emphasis on fieldwork.

5491, 5492, 5493, 5494, 5495, 5496, 5497, 5498, 5499. TOPICS IN SOCIAL POLICY. (3 cr per qtr; prereq grad or adult special student or △)
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 △)
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 special or △)
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. (3 cr; 5501 or equiv, grad student or adult special or △)
Application of theory to public efforts to influence economic development. Topics include role of small business, development finance, import substitution strategies, location incentives. Critical analysis of whether and how these approaches can influence economic development.

5511. COMMUNITY-BASED COMMUNITY AND ECONOMIC DEVELOPMENT. (3 cr)
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.

5521. DEVELOPMENT AND CHANGE. (3 cr; prereq grad student or adult special or △)
Images, theories, practices, and ethical premises in promoting social, economic, and political change.

5591, 5592, 5593, 5594, 5595, 5596, 5597, 5598, 5599. TOPICS IN ECONOMIC AND COMMUNITY DEVELOPMENT. (Cr ar; prereq grad or adult special student or △)
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 grad student or adult special or △)
Economic, political, social, and legal significance of multinational corporation; major policy options open to both individual and international bodies.

5910. THE PUBLIC ECONOMY. (3 cr; prereq grad student or adult special or △)
Government role in and impact on economy; determinants of national income, employment, and price level; fiscal and monetary policy.

8540. AGRICULTURAL DEVELOPMENT PLANNING. (3 cr; prereq grad student or △)
Food and agricultural problems of less developed countries, deterrents to agricultural development; planning as solution; theory, procedures, and organization of planning; unique problems of planning in agricultural sector; planning process in agriculture.

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)
See Planning and Urban Affairs for description.

5601. LAND USE. (4 cr; prereq grad student or adult special or △)
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)
See Planning and Urban Affairs for description.

5611. HOUSING POLICY. (3 cr; prereq grad student or adult special or △)
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 special or △)
Developer's perspective, financial considerations. Role of local government, federal programs, and regulations. Land acquisition. Development management. Marketing. Citizen involvement.

5622. DEVELOPMENT MANAGEMENT SYSTEMS. (3 cr; prereq 5621, grad student or adult special or △)
See Planning and Urban Affairs for description.

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 special student or △)
Analysis of large-scale planned communities, agricultural preservation, historical preservation, infrastructure planning and programming, and urban transportation policy.

8540. AGRICULTURAL DEVELOPMENT PLANNING. (3 cr; prereq △)
See Economic and Community Development for description.

8600. SEMINAR: LAND USE PLANNING. (3 cr; prereq grad student or △)
Topics vary, similar to advanced topics course.

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. TECHNOLOGY PLANNING I. (3 cr; prereq grad student or adult special or △)
See Planning and Urban Affairs for description.

5702. TECHNOLOGY PLANNING II. (3 cr; prereq 5701, grad student or adult special or △)
See Planning and Urban Affairs for description.

5711. ENERGY POLICY I. (3 cr; prereq grad student or adult special or △)
Role of energy in contemporary societies; means to satisfy energy requirements; present U.S. energy system; relatively nontechnical description of energy fuel cycles, environmental and social impacts, regulatory frameworks, resource base, and relationship to energy policy options.

5712. ENERGY POLICY II. (3 cr; prereq 5711, grad student or adult special or △)
Review of major U.S. energy policy since 1940s; current U.S. energy policy; policy instruments and policy process.

5713. ENERGY RESOURCE USE AND SYSTEMS CHANGE. (4 cr; prereq grad student or adult special or △)
Social-cultural system factors in development, production, control, distribution, and use of energy, water, key resources, and food in U.S. and other societies. Social-cultural evaluation, interaction among societies, growth/no-growth issues, emerging global interdependence.

5721. ENVIRONMENTAL POLICY I. (3 cr; prereq adult special or grad student or △)
Systems in natural and physical environment. Environmental impacts of technological innovation. Associated social controversy. Legislative, judicial, regulatory responses.

5722. ENVIRONMENTAL POLICY II. (3 cr; prereq sr or adult special or grad student; 5721 not required)
Systems in natural and physical environment; environmental aspects of technological innovation; associated social controversy; legislative, judicial, regulatory responses.

5791, 5792, 5793, 5794, 5795, 5796, 5797, 5798, 5799. TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY. (3 cr per qtr; prereq grad or adult special student or △)
Topics include hazardous waste, energy efficiency, nuclear technologies, and atmospheric carbon dioxide.

5920. WORKSHOP IN PUBLIC INTEREST RESEARCH. (3 cr; prereq #)
Clinical projects in support of interest group policy objectives. Emphasis on consumer and environmental topics, public interest legal activities. Policy analysis using impact statements and relating to regulatory agencies and legislative bodies. Research papers required.

8540. AGRICULTURAL DEVELOPMENT PLANNING. (3 cr; prereq △)
See Economic and Community Development for description.

8791, 8792, 8793, 8794, 8795, 8796, 8797, 8798, 8799. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY. (3 cr per qtr)
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 grad student or adult special or △)
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.

5810. DEVELOPMENT ADMINISTRATION. (4 cr; prereq grad student or adult special or △)
Problems and issues in international development; aid relationship; workforce development, administrative reform; regional approach; public enterprise; case studies.

5820. THE MULTINATIONAL CORPORATION. (4 cr; prereq grad student or adult special or △)
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 special 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.

5831. FOREIGN ECONOMIC POLICIES OF THE INDUSTRIAL STATES. (4 cr; prereq Econ 1001, Econ 1002, grad student or adult special or #)
Analysis of policy problems facing decision makers of industrial countries in areas of trade, investment, monetary, and international economic affairs. Close attention to domestic political context.

5891, 5892, 5893, 5894, 5895, 5896, 5897, 5898, 5899. TOPICS IN FOREIGN POLICY. (Cr ar; prereq grad or adult special student, △)
Analysis of such topics as management of international organizations, practice of diplomacy, management of foreign posts, and reexamination of disarmament strategies.

8540. AGRICULTURAL DEVELOPMENT PLANNING. (3 cr; prereq △)
See Economic and Community Development for description.

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

5900. ADMINSTRATIVE INTERNSHIP. (3 cr; prereq #)
Fieldwork in approved administrative agency under joint supervision of agency employee and faculty member; rotation through various assignments, solution of special problems, seminar discussion of experiences, and preparation of report.

5901. COMPUTER APPLICATIONS IN PUBLIC AFFAIRS. (1 cr; prereq PA or planning major or #)
Comprehensive introduction to computer systems and applications as used in fields of public affairs.

5910. THE PUBLIC ECONOMY. (3 cr)
See Economic and Community Development for description.

5920. WORKSHOP IN PUBLIC INTEREST RESEARCH. (3 cr; prereq #)
See Technology, Energy, and Environmental Policy for description.

5930. THE ROLE OF THE MEDIA IN PUBLIC AFFAIRS. (3 cr; prereq grad student or adult special or △)
Readings and case studies exploring historical and contemporary role of media in defining and shaping public opinion and policy. Survey of critical research and professional skills used in hard news coverage, investigative reporting, and documentaries. Some field experience.

5940, 5941, 5942. SEMINAR ON LEADERSHIP IN PUBLIC POLICY. (3 cr per qtr; prereq #)
Mid-career course in leadership, social ethics, and public policy. Forty participants, including ten from Third World, examine nature and styles of leadership; frames of reference for policy analysis, justice, and common good; current social and cultural trends; the arts; and range of self-selected policy issues.

5950, 5951, 5952. MODERNIZATION AND HUMAN DEVELOPMENT. (3 cr per qtr)

5960. CREATIVITY IN PUBLIC AFFAIRS. (3 cr)
Alternative theories of creativity regarding source of creativity, social conditions conducive to creativity, and problems and potentials of innovator in public and private contexts. Experiments and exercises for enchancing creative skills in public planning and policy making.

5970, 5971, 5972. DIRECTED STUDY. (3 cr per qtr; prereq #)

8900. PUBLIC AFFAIRS INTERNSHIP. (6 cr max; prereq △, completion of core courses in public affairs)
Supervised fieldwork in approved local, state, or federal agency, or private or nonprofit organization. Formal report on internship required.

8910. INDEPENDENT STUDY. (Cr ar; prereq #)
Individual reading or research project.

8921, 8922, 8923, 8924, 8925, 8926, 8927, 8928, 8929. PUBLIC AFFAIRS WORKSHOP. (Cr ar; prereq #)
Client-oriented projects on selected policy issues. Policy areas differ each offering.

8930, 8931, 8932, 8933, 8934, 8935, 8936, 8937, 8938, 8939. FIELDWORK IN PUBLIC AFFAIRS. (3 cr; prereq #)
Individual study of current public problem, combining seminar discussion and experience working with an agency trying to do something about the problem.

8998. SEMINAR: LEADERSHIP AND PROFESSIONAL PRACTICE IN PUBLIC AFFAIRS. (3 cr; prereq 8900, public affairs major or planning major or #, completion of 36 cr including 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: James Boen, *director of graduate studies;* Michael L. Baizerman; Henry W. Blackburn; Stanley L. Diesch; Robert W. ten Bensel; Robert L. Veninga

Associate Professor: Mila A. Aroskar; Lester E. Block; Robert W. Blum; Judith E. Brown; Judith M. Garrard; James Kincannon; Rexford D. Singer; Lee D. Stauffer

Adjunct Associate Professor: Lee E. Schacht

Assistant Professor: Debra G. Froberg; Susan G. Gerberich; Sharon K. Ostwald; Michael D. Resnick; Carolyn L. Williams

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 curriculum offers preparation for broad, multidisciplinary work in public health as well as concentrations in such specialties as public health nursing and maternal and child health. For information regarding admission procedures and degree requirements, contact the director of graduate studies.

Language Requirements—None.

Minor Requirements for Students Majoring in Other Fields—Courses are selected by agreement among the candidate, major adviser, and director of graduate studies.

For Further Information—Contact the director of graduate studies, School of Public Health, Box 197 Mayo, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

5001. PHILOSOPHICAL AND CONCEPTUAL BASES OF PUBLIC HEALTH PRACTICE. (3 cr; prereq public health grad student or grad student or #) Schwanke
Socialization to public health. Multidisciplinary analysis of philosophical, conceptual bases and action components of problems, issues. Legal, ethical, scientific, historical, economic, and social bases of public health principles, concepts, values, beliefs, and methods.

5002. PUBLIC HEALTH ISSUES IN HISTORICAL PERSPECTIVE. (4 cr, §HMed 5002; offered alt yrs) Eyler
Evolution of major recurring problems and issues in public health including the 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.

5003. FUNDAMENTALS OF ALCOHOL AND DRUG ABUSE. (2 cr; prereq sr or grad) Rothenberger
Lecture, discussion, and special readings on scientific, sociocultural, and attitudinal aspects of alcohol and other drug abuse problems. Incidence, prevalence, high risk populations, prevention, and intervention.

5004. FIELD INSTRUCTION IN PUBLIC HEALTH. (Cr ar; prereq #)
Generalized, function-oriented, or discipline-oriented community experience under academic and professional supervision. Emphasis on application of acquired knowledge and skills relevant to health issues and problems.

5005.* TOPICS IN PUBLIC HEALTH. (Cr ar; prereq advance proposal and #) Staff
Individualized, directed instruction. Selected readings in public health with discussion based on these readings.

5006. INTRODUCTION TO COMMUNITY HEALTH. (5 cr, §5016, §Nurs 5625; prereq pharmacy student, nursing student, nurse, public health student, other health professional or #; offered when feasible)
Lectures, discussions, seminars, and readings on critical and current issues in community health emphasizing public health programs and controversies.

[1] *Inquiries concerning coursework leading to the master of public health or master of hospital administration degree should be addressed to the dean of the School of Public Health, Box 197 Mayo, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455. Applicants wishing to pursue an M.S. or Ph.D. degree in biometry, environmental health, epidemiology, or hospital and health care administration (Ph.D. only) are referred to the separate listings for these programs in this bulletin.*

5007. PRINCIPLES OF PUBLIC HEALTH. (2 cr) Kane
Strategies, barriers, and policy choices implied by variety of public health goals and activities; historical and contemporary public health issues. Goal is to derive set of principles that identify public health efforts.

5008. WORKSHOP OR INSTITUTE IN PUBLIC HEALTH. (1-2 cr; prereq 3035 or 5035; offered when feasible) Staff
Special topics, nonregular program, or course in public health for preservice or in-service helping professionals.

5013. INTERDISCIPLINARY TEAM TRAINING IN HEALTH SERVICES DELIVERY. (3 cr, §HSU 5001, §HSU 5300; prereq #) Cohn, Schwanke
Interdisciplinary team development with application to public health, human service projects. Didactic content, experiential methods, activities to develop attitudes, skills essential to effective team goal setting, decision making, problem solving and task accomplishment.

5015. TOPICS IN INTERDISCIPLINARY STUDIES. (Cr ar; prereq #)

5016. INTRODUCTION TO PUBLIC/COMMUNITY HEALTH. (3 cr, §5006, §SW 5131; prereq pharmacy, dental hygiene, grad public health student or #; offered when feasible)
Lectures, discussions, and seminars on historical evolution of public/community health, status of organization and delivery of health services, and future organizational changes and innovative models for prevention. Epidemiology and prevention of communicable and chronic diseases, chemical dependency, mental health, and measurement of community health status. Health problems and service needs of the poor, minorities, and women. Group or individual project interviews with community health professionals.

5020. PUBLIC HEALTH SOCIAL WORK INTEGRATIVE SEMINAR. (2 cr, §SW 5020; prereq beginning level MSW/MPH student) Bracht, Schwanke
Assists students in dual degree program to develop an integrated public health social work identity. Synthesizes from both fields the common historical and philosophical developments, roles and functions, trends, professional values, and knowledge and research bases.

5033. GROUP THERAPY: THEORY AND PRACTICE. (3 cr; students working toward certificate must take A-N)
Introduction to group therapy concepts through lecture, small group experience, and role playing. Stages in group development, use of Hill intervention matrix, group leader roles and functions, Yalom's curative factors, group process, termination of group, critical incidents in chemical abuse groups.

5040. DYING AND DEATH IN CONTEMPORARY SOCIETY. (3 cr, §Hlth 5402, §Mort 5040, §HSU 5040; prereq health science major, public health grad student, education sr, certified teacher, mortuary science major or #) Burger, Rothenberger
Concepts, attitudes, ethics, and life-style management related to dying, death, grief, and bereavement. Emphasis on preparing community health and helping professionals and educators for educational activities in this area.

5043. ANALYSIS OF ALCOHOL/DRUG PROBLEMS. (3 cr, §HSU 5033; prereq sr, public health or grad student)
Lectures and readings on scientific, sociocultural, and attitudinal aspects of alcohol and other drug problems; nature, extent, high risk factors, prevention and intervention.

5044. TOPICS IN ALCOHOL AND DRUG PROBLEMS. (1-4 cr; prereq advance proposal, #)
Individualized, directed instruction. Readings and discussion on alcohol and drug problems.

5045. DEVELOPMENT AND PREVENTION OF ADOLESCENT DRUG ABUSE. (3 cr; prereq 5043, HSU 5033 or #) Meland, Perry
Lectures, readings, discussion. Published studies of and reviews on secondary prevention of smoking, drinking, and associated problems among adolescents in this country and others.

5047. INTERVENTION/SECONDARY PREVENTION OF DRUG ABUSE IN ADULTS. (3 cr; prereq 5043, HSU 5033 or #)
Lectures, readings, discussion. Published studies of and reviews on secondary prevention of smoking, drinking, and associated problems among adults in this country and others.

5054. FOUNDATIONS OF PUBLIC HEALTH EDUCATION. (3 cr; prereq health education student or community health education student or #)
Social, behavioral, and educational aspects of disease; theoretical bases of health education; history of health education; ethical issues related to planned change.

5056. HEALTH EDUCATIONAL APPROACHES TO CHANGE THROUGH PLANNING. (3 cr; prereq 5055, grad in health sciences or #) Schwanke
Elements of comprehensive health/health education planning; theory, process, models, evaluation components.

5057. HEALTH EDUCATION ISSUES ARISING FROM PLANNED AND UNPLANNED SOCIETAL CHANGE. (3 cr; prereq 5055, grad student in health sciences or #) Rothenberger
Major processes of societal change. Health education implications for individuals and communities.

5059. INTERPERSONAL BEHAVIOR IN HEALTH ORGANIZATIONS. (4 cr, §HSU 5010) Veninga
Application of research and theory from the social sciences to organizational problems in hospitals and public health agencies. Focus on organizational behavior and what health professionals can do to improve organizational performance. Leadership behavior, conflict resolution strategies, committee effectiveness, and the management of change.

5064. THE TEACHING-LEARNING PROCESS IN THE HEALTH CARE SETTING. (3 cr, §HSU 5011) Garloff
Lectures, group discussion, written assignments and projects. Designed to meet projected professional needs of students.

5065. HEALTH IN THE WORKPLACE: A HEALTH EDUCATION PERSPECTIVE. (3 cr) Veninga
Relationship of work and health. Relationship of work to onset of disease, effects of stress (information overload and underload, shift work, role conflict, quality control mechanisms) and its effect on employee health, and health education programs designed to prevent occupationally related illnesses.

5084, 5085. INTERNSHIP IN HEALTH EDUCATION PRACTICE I, II. (Cr ar; prereq health education student or community health education student or #)
Internship in health or public health setting, under academic and professional supervision. Emphasis on application of acquired health education knowledge and skills to relevant health issues and problems.

5086. SEMINAR: COMMUNITY HEALTH EDUCATION. (2 cr; prereq health education student or community health education student or #) Luepker
In-depth analysis of current intervention and evaluation methods and future directions of community health education designed to improve health behavior.

5090. RESEARCH TOPICS IN HEALTH EDUCATION. (2-8 cr; prereq health education student or community health education student or #)
Scholarly review of health education research and experience in selected area (Plan B project).

5093. SEMINAR: HEALTH EDUCATION IN THE WORKPLACE. (2 cr; prereq health science grad student)
In-depth analysis of current practices and future directions of job-related education designed to improve health behavior.

5150. TOPICS IN ENVIRONMENTAL HEALTH. (Cr ar; prereq #) Barber, staff
Selected readings and discussions of problems in environmental health.

5151. ENVIRONMENTAL HEALTH. (3 cr; prereq #) Singer, staff
Methods for promoting human health and comfort by controlling environment.

5152. ENVIRONMENTAL HEALTH. (2 cr) Vesley
General principles of environmental health relating to macro and micro environments and products consumed or used by people.

5153. CASE STUDIES IN ENVIRONMENTAL HEALTH. (2 cr; prereq environmental health major and ¶5152, or #) Barber, staff
Current applications of environmental health principles and practices. Relation of past didactic work to real-life problems encountered by environmental health professionals.

5154. FIELD EXPERIENCE IN ENVIRONMENTAL HEALTH. (1-6 cr; prereq environmental health major) Staff
Assignments working with organizations on environmental health concerns, under joint supervision of faculty adviser and organization staff.

5158. HEALTH RISK EVALUATION. (3 cr; prereq environmental health majors or #) Stevens
General principles of health risk assessment and management: environmental pollutants; public domain and workplace, legislation and regulations.

5159. SEMINAR: ENVIRONMENTAL HEALTH. (1 cr; prereq environmental health students only) Staff

5161. ADMINISTRATION OF ENVIRONMENTAL HEALTH PROGRAMS. (3 cr; prereq #) Stauffer
Administrative organization of environmental health activities.

5171. ENVIRONMENTAL MICROBIOLOGY. (4 cr; prereq MicB 3103 or #) Ruschmeyer, Vesley
Survival, dissemination, transportation, and significance of microorganisms in the environment; application of principles to environmental health problems.

5177. PUBLIC HEALTH BIOLOGY. (3 cr; prereq environmental health students or #) Ruschmeyer
Introduction to plant and animal forms important in environmental health; biological aspects of water supply, waste treatment, stream, and special phenomena related to human disease transmission.

5181. AIR POLLUTION. (4 cr; prereq general chemistry or #) Swackhamer
Overview of current air pollution problems; sources; chemistry of air pollutants and polluted atmospheres; potential human health effects; air pollution control technology; laws regulating air pollution.

5184. AIR ANALYSIS (3 cr; prereq 5211 or #) McJilton
Laboratory and field exercises involving air flow calibration, dynamic calibration of field equipment for analysis of air contaminants, respirable mass sampling, dust counting and sizing, and instrumentation for measuring physical environmental stresses.

5185. FIELD INSTRUMENTATION. (1 cr; prereq 5211) McJilton
Laboratory experience with instruments used by industrial hygienists in field evaluations of occupational exposures to toxic agents. Sampling strategy.

5186. ENVIRONMENTAL CHEMISTRY. (3 cr; prereq general chemistry and organic chemistry or #) Swackhamer
Chemical and physical properties of pollutants that determine distribution and persistence; environmental fate testing; trace analysis of pollutants in environment.

5194. OCCUPATIONAL SAFETY. (2 cr) McJilton
Occupational safety procedures, environmental controls to reduce injuries on and off the job, safety program development and administration.

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)
Radiation laboratory for 5201.

5211. INDUSTRIAL HYGIENE ENGINEERING. (3 cr) McJilton
Concepts and techniques used in occupational health; evaluation of potential hazards, preventive techniques.

5213. ERGONOMICS IN OCCUPATIONAL HEALTH. (2 cr; prereq #) Jetzer
Basis for understanding injury risk of lifting, material handling, and repetitive motion activity in occupational environment. Topics include biomechanics, strength testing, back and wrist injury, and strategies for reducing risk of injury.

5214. AGRICULTURAL OCCUPATIONAL HEALTH. (3 cr) McJilton
Occupational health problems of agricultural workers; practical and available preventive measures; educational and administrative needs.

5215. APPLIED OCCUPATIONAL TOXICOLOGY. (3 cr; prereq 5261 or #) Willard
Basic toxicology and physiology with emphasis on environmental contaminants. Inhalation toxicology of the work environment and air pollution.

5218. FIELD PROBLEMS IN OCCUPATIONAL HEALTH. (3 cr; prereq 5211, #) McJilton
Guided evaluation of potential occupational health problems; recommendations and design criteria for correction if indicated.

5219. SEMINAR: OCCUPATIONAL HEALTH. (1 cr; prereq occupational health student)
Interdisciplinary discussions of current occupational health issues.

5233. BIOLOGICAL SAFETY. (2 cr; prereq #) Vesley
Topics include assessment of risk; primary barriers; laboratory design criteria; safety devices and equipment; personnel practices; sterilization and decontamination; laboratory 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.

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.

5254. HAZARDOUS WASTE MANAGEMENT. (1 cr) Visiting lecturers
Overview of problems and possible solutions. Technical, political, social, economic, and regulatory factors.

5261. GENERAL ENVIRONMENTAL TOXICOLOGY. (3 cr) Stevens
Application of basic biochemical, anatomical, and physiological principles to field of environmental toxicology; assessment of potential health hazards; approaches to solution of problems.

5262. TOXICOKINETICS AND METABOLISM OF ENVIRONMENTAL AGENTS. (3 cr; prereq 5261 or #) Stevens
Toxicokinetic models for chemical distribution and fate; quantitative toxicological relationships; bioavailability; chemical monitoring.

5266. RISK ASSESSMENT AND MANAGEMENT. (1 cr) Visiting lecturers
General principles and practices, including data extrapolation techniques, model selection, public preference analysis, contextural analysis, and equity analysis.

5267. ENVIRONMENTAL AND OCCUPATIONAL TOXICOLOGY. (3 cr) Stevens
Basic principles of toxicology (absorption, distribution, metabolism, excretion and site of action); tissue specificity of chemical injury; risk assessment.

5268. SEMINAR: TOXICOLOGY AND HUMAN POPULATIONS. (1 cr; prereq environmental health student or #) Stevens, Mandel
Scientific evaluation of epidemiological studies that deal exclusively with human exposure to toxic agents. Classroom presentations.

5271. OCCUPATIONAL EPIDEMIOLOGY. (3 cr; prereq basic epidemiology and biostatistics) Mandel
Basic principles and concepts in ascertaining health effects in workplace; review and discussion of strategies for identifying excess risk, evaluating strengths and weaknesses of research techniques, assessing bias and confounding.

5274. PRINCIPLES OF OCCUPATIONAL EPIDEMIOLOGY. (2 cr; prereq bachelor's degree, registration in special occupational health symposium) Mandel
Basic concepts in epidemiology and principles and methods related to evaluation of health effects of occupational exposure.

5275. EPIDEMIOLOGY AND THE LAW. (1 cr) Mandel, Shindell
Basic principles and methods of epidemiology and use of epidemiologic studies in legal proceedings.

5300. PUBLIC HEALTH AND HUMAN—ANIMAL ENVIORNMENTAL RELATIONSHIPS. (2 cr) Anderson, Diesch
Survey of comparative medicine in human relationship to biologic environment; interrelationship between animal and human health; sources of animal diseases; ecology of zoonoses; food production and hygiene; laboratory animal medicine.

5301. PERSPECTIVES: INTERRELATIONSHIPS OF PEOPLE AND ANIMALS IN SOCIETY TODAY. (2 cr; prereq 3301, CVM 5100)
Interrelationship of people and animals from related and/or opposing viewpoints. Social and economic consequences of problems and issues such as pets and people sharing an urban environment; animal rights; and differences in cultures and their influence on animal/human relationships.

5310. DISEASES TRANSMITTED BETWEEN ANIMALS AND HUMANS. (4 cr; prereq VPH major or #)
Selected diseases transmitted between animals and human beings with emphasis on diagnostic problems, epidemiology, prevention, control, and evaluation.

5315. PROBLEMS IN DISEASE CONTROL AND ERADICATION. (4 cr; prereq VPH major or #)
Past and present disease control and eradication programs and factors influencing degree of success and failure. Students will develop models for proposed disease control and eradication programs in the United States or a foreign country for group evaluation and analysis.

5326. RESEARCH IN ANIMAL/HUMAN HEALTH. (Cr ar; prereq VPH major or #) Anderson, Diesch
Research in animal health as related to human health.

5330. EPIDEMIOLOGY I. (4 cr; prereq basic courses in microbiology and statistics, preferably biostatistics) Burke, Snowdon, Sprafka
Basic epidemiologic principles applicable to infectious and noninfectious disease; host-agent-environment complex; factors underlying spread of infectious disease; laboratory applications of statistical and epidemiologic methods.

5335. EPIDEMIOLOGY OF INFECTIONS AND COMMUNICABLE DISEASES. (3 cr; prereq basic epidemiology and biostatistics, #)
Epidemiologic evaluation of host-agent-environmental factors in planning and implementing methods for surveillance, investigation, control, and eradication of infections and communicable diseases with public health significance.

5340. EPIDEMIOLOGY II: STRATEGIES AND METHODS. (4 cr; prereq 5330 or #) Folsom
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.

5342. PUBLIC HEALTH LABORATORY PRACTICE. (3 cr; prereq MicB 5216, 5232, 5234, #) Stickle
Overview of microbiological, biochemical, and laboratory improvement procedures of modern public health laboratory. In-depth laboratory experience taught at Minnesota Department of Health.

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 laboratory, and isolation techniques. Emphasis on applied aspects. Course enhanced by hospital experience, but basic clinical background provided.

5380. APPLIED HUMAN NUTRITION. (4 cr; prereq biochemistry or equiv) Leon
Bioenergetics, physical activity, and health; assessment of nutritional intake, and clinical and biochemical assessment; food composition and requirements; food additives; food-drug interactions; physiological effects of starvation and dieting; anorexia nervosa; relationship of blood lipids and diet to coronary heart disease and cancer.

5382. CLINICAL TRIALS II. (3 cr; prereq epidemiology or biometry 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.

5384. HUMAN PHYSIOLOGY. (4 cr; prereq basic biology or anatomy) 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; utilization of energy; integrated control systems; and age and physiologic function.

5385. PHYSIOLOGY OF EXERCISE. (Cr ar; prereq Phsl 5101 or equiv and #; offered when feasible) Crow, Leon
Effects of exercise conditioning and deconditioning on body composition, metabolism, and function.

5386. PUBLIC HEALTH ASPECTS OF CARDIOVASCULAR DISEASES. (3 cr; prereq basic epidemiology and biostatistics) Grimm, Luepker
Evaluation of population studies and trials on cardiovascular diseases; modifiable risk factors for coronary heart disease; prevention of 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.

5388. EPIDEMIOLOGY OF MENTAL DISORDERS. (3 cr; prereq 5330 or other basic epi course or #) Williams
Application of epidemiological research methods to mental disorders. Overview of the three generations of epidemiological research, focusing on methodological variations in studies leading to different rates. Incidence/prevalence rates for major mental disorders.

5391. INTRODUCTION TO BEHAVIORAL EPIDEMIOLOGY. (3 cr; prereq public health or health science student, professional in health-related discipline, grad in social or behavioral science, or #) Jeffery, Pirie
Theoretical, measurement, and research issues in behavioral epidemiology. Lifespan patterns in development, change, and maintenance of behaviors related to major chronic diseases. Risk-related behaviors from epidemiological perspective, using concepts of prevalence, incidence, risk, and trends.

5392. PUBLIC HEALTH APPROACHES TO HEALTH BEHAVIOR CHANGE. (3 cr; prereq grad standing or #) Perry
Introduction to public health approaches to health behavior change. Overview of major conceptual models and methods for promoting positive health practices or preventing adoption of health-compromising behaviors.

5393. EVALUATION OF COMMUNITY HEALTH BEHAVIOR INTERVENTIONS. (3 cr; prereq grad standing or #) Murray
Introduction to evaluating community-based health behavior intervention programs. Outcome and process evaluation methodology, measurement of health behaviors, and design issues for evaluating field studies.

5394. MASS COMMUNICATION AND PUBLIC HEALTH. (3 cr, §Jour 5150; prereq credits in social or behavioral science, 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 health 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.

5396. EPIDEMIOLOGIC SURVEY METHODS. (3 cr; prereq 5330 and 5450, 5451, and 5452 or equiv statistics courses, or #) Folsom
Design and implementation of epidemiologic surveys, including issues of sampling and sample size determination, interview and questionnaire standardization, and organization and analysis of health survey research.

5397. SOCIAL ENVIRONMENT AND HEALTH BEHAVIOR CHANGE. (3 cr; prereq 5392 or #) Mullis, Schaefer
Social environmental approaches to health behavior; review of historical efforts to modify health environments; current environmental factors contributing to chronic disease risk and creating need to address behavior change; successful and unsuccessful community-based campaigns.

5399. TOPICS IN EPIDEMIOLOGY. (2-3 cr; prereq basic epidemiology and biometry or #)
One or more topics of current epidemiologic interest.

5400. INTRODUCTION TO BIOSTATISTICAL METHODS IN THE BIOLOGIC AND HEALTH SCIENCES. (4 cr; prereq Biol 1009, Chem 1004-1005, Math 1111 or Math 1201 or #) Staff
Basic biostatistical methods for design and analysis of clinical and laboratory studies in biology and health sciences. Condensed and accelerated course for advanced undergraduate and graduate students or those training for careers in health professions or biological sciences.

5404f. INTRODUCTION TO BIOSTATISTICS AND STATISTICAL DECISION. (4 cr; prereq health services research, policy, and admin student) Weckwerth
Variation; frequency distribution; probability; significance tests; estimation; trends; data handling; simple operations research applications. Statistical approach to rational administrative decision making. Lectures and laboratory.

5409f. BIOMETRY IN CLINICAL STUDIES. (3 cr; prereq DDS, MD, DVM, PharmD, 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 hypothesis utilizing t and Chi-square distributions. Interpretation of statistical analyses in clinical literature.

5413f. VITAL AND HEALTH STATISTICS. (1 cr) Kjelsberg
Morbidity, mortality, fertility, health personnel and facilities, data sources; demographic characteristics and projections; rates; adjustment of rates; federal-state-local statistical programs.

5414f, w. BIOMETRIC METHODS I. (3 cr; prereq public health or grad regis or #) Boen, Goldman
Basic quantitative methods for public health students including descriptive statistics; graphic methods; measures of variation; estimation concepts and procedures; random sampling; confidence intervals for means and proportions; t and Chi-square tests of significance.

5415w. BIOMETRIC METHODS II. (3 cr; prereq grade of B in 5414 or 5409 or #) Goldman
Continuation of basic statistical methods, including correlation, regression, analysis of variance and nonparametric tests. Introduction to use of computer (SPSS) for data analysis.

5420f. STATISTICAL COMPUTING I: USING STATISTICAL PACKAGES. (3 cr; prereq 5450 or ¶5450 or #) Jeffries
Use of three popular statistical computer packages—SPSS, BMDP, SAS—for analysis of biomedical data using micro- and mainframe computers. File management capabilities of packages. Case study approach.

5450f. BIOMETRY I. (4 cr; prereq familiarity with basic concepts of calculus or #) Jeffries
Probability models, including binomial, Poisson, and Gaussian, with applications in biological and health sciences; hypothesis testing and internal estimation for Gaussian model, using SPSS for computations.

5452w. BIOMETRY II. (4 cr; prereq 5450) Jeffries
Inference for binomial and Poisson probability models, with health science applications; one-way and two-way ANOVA, including nonparametric methods; simple linear regressions and correlation techniques, with applications in bioassay; use of statistical packages for analysis.

5454s. BIOMETRY III. (4 cr; prereq 5452 or #) Smith
Multiple regression techniques for biological and health science data; estimation, testing, and prediction; model selection; applications in bioassays, among others; logistic regression; repeated measurements; use of statistical packages for analysis.

5456s. BIOMETRY CONSULTING SEMINAR. (Cr ar; prereq biometry student) Boen, staff
Consultant and client interaction; communication and formulation of the biometric problem. Role and responsibility of the biometrician. Robustness and relevance of frequently used analytical techniques. Internship experiences.

5459s. INTRODUCTION TO MATHEMATICAL THEORY IN BIOMETRY. (3 cr; prereq 2 qtrs calculus, ¶5452) Jeffries
Generating functions, curve fitting, iterative estimation, tests, propagation of error, and related topics with illustrations from epidemics and population growth, bioassay, clinical trials, demography, and other bio-health-science areas.

5460f. DEMOGRAPHIC METHODS IN PUBLIC HEALTH. (2 cr, §Soc 5561; prereq biometry or epidemology major or #) Grimm, Kjelsberg
Demographic parameters of mortality, natality, morbidity, and migration. Sources of demographic data in censuses, surveys, and registration systems. Refinement and adjustment of parameters by factor specification and standardization. Measurement of population change. Generation and current life tables. Stationary population models. Population estimation.

5461s. BIOMETRIC TOPICS IN EPIDEMIOLOGY. (3 cr; prereq 5452) Connett
Design and analysis of case-control studies, including misclassification, confounding factors, Mantel-Haenszel procedure, matching designs, and sample size estimation. Cohort analysis in epidemiology, including Poisson regression models for use with person-years of observation.

5462w. CLINICAL TRIALS I. (3 cr; prereq 5452, biometry or epidemiology 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.

5470. TOPICS IN BIOMETRY. (Cr ar; prereq #) Selected readings with discussion based on these readings.

5471s. BIOMETRY LITERATURE SEMINAR. (2 cr; prereq BHIS grad student or #; offered alt yrs) Basic journals and references of biometry. Orientation to current biometric research problems. Use of online literature retrieval methods and bibliographic references such as Index Medicus. Preparation and delivery of technical presentations.

5500. HUMAN GROWTH AND DEVELOPMENT: HEALTH IMPLICATIONS. (3 cr) Berkseth
Overview of stages of human growth and development and of their implications for physical and psychosocial health throughout the life span.

5502. PROGRAM PLANNING AND DEVELOPMENT IN PUBLIC HEALTH NURSING. (3 cr; prereq grad status) Spradley
Planning, development, implementation, and evaluation of health programs in context of community health needs assessment. Application of organizational development and planned change theories to program planning.

5503. COMMUNITY HEALTH SYSTEMS DEVELOPMENT: A PUBLIC HEALTH, COMMUNITY-ORIENTED PERSPECTIVE. (3 cr [1 cr fieldwork]; prereq grad or MPH student)
Community health systems development: public policy, health planning, systems design, community organization.

5504. COMMUNITY HEALTH SYSTEMS MAINTENANCE. (2-3 cr; prereq 5503 or #) Staff
Maintaining community health systems: subsystems, group processes, coordination, information systems, quality assurance, community organizations, consumer advocacy, volunteers, grantwriting. Optional fieldwork.

5506. PUBLIC HEALTH LEADERS AS EDUCATORS. (3 cr; prereq 5509 or #) Ostwald
Philosophical/value perspectives on education and persons as teachers/learners. Transformational learning and leadership for non-education specialist public health leaders.

5507. CONSULTATION IN HUMAN SERVICES. (2-3 cr [1 cr fieldwork opt]) Staff
Consultation theory and methods applied to human services: community, organizational, and clinical. Develop ment of contracts, work plans, evaluation, and project reports.

5509. FOUNDATIONS FOR PUBLIC HEALTH NURSING LEADERSHIP. (3 cr; prereq public health nursing student) Aroskar, Spradley
Knowledge, theories, models and frameworks. Philosophical, historical, and contemporary perspectives. Links public health nursing with public health, management, and other sciences and disciplines.

5510. RESEARCH METHODOLOGY IN PUBLIC HEALTH NURSING. (1-3 cr; prereq #) Staff
Guidance in development of study design, implementation, and analysis.

5511. HEALTHY ADULTS: A PUBLIC HEALTH PERSPECTIVE. (3 cr) Ostwald
Models and theories of health and wellness as they relate to adult population in pluralistic society. Educational, engineering, and enforcement interventions used in primary prevention: ethical considerations, compliance rates, and economic implications.

5512. ADULTS AT RISK: A PUBLIC HEALTH NURSING APPROACH. (3 cr; prereq 5511 or #) Ostwald
Development of health maintenance protocols for specific aggregates of adult population, emphasizing secondary prevention. Development of community-based health education programs aimed at reduction of morbidity and mortality, using PRECEDE model of health education.

5513. TOPICS: ADULT HEALTH. (1-3 cr; prereq #) Ostwald
Individualized, directed instruction of selected problems and current issues in adult health for public health nurses.

5514. SEMINAR: APPLICATIONS OF RESEARCH METHODOLOGY IN PUBLIC HEALTH NURSING. (3 cr; prereq 5806, 5509, or #) Froberg
Discussion of research design in public health nursing; application of research principles to individual projects; development of research proposal through peer review process.

5516. ETHICAL DIMENSIONS OF PUBLIC HEALTH. (1 cr; prereq grad or #) Aroskar
Ethical issues and dilemmas that confront public health professionals and agencies. How ethical/value aspects interface with political, legal, economic, and cultural considerations.

5517. THE ELDERLY: A HIGH RISK POPULATION. (3 cr) Ostwald
Characteristics of over-65 age group that place them at high risk for disability, institutionalization, and death. Health maintenance, rehabilitation, and alternatives to institutionalization.

5520. TOPICS: MULTIDISCIPLINARY PERSPECTIVES ON AGING. (4 cr, §CPsy 5310, §Educ 5440, §HSU 5009, §PR 5671, §Soc 5960, §SW 5024) Ostwald
Sociological, biological, and psychological aspects of aging; theories of aging; death and bereavement; issues and problems of older adults in America; human services and their delivery systems (health, nutrition, long-term care, education); public policy and legislation; environment and housing; retirement.

5523. PUBLIC ETHICS/POLITICS AND PUBLIC HEALTH. (2-3 cr; prereq School of Public Health student or #) Aroskar
Ethical/value aspects related to decision making in public health inverventions. Responsibilities of state in relation to health, politics, and public ethics; distributive justice in pluralistic society.

5529. PUBLIC HEALTH NURSING SEMINAR: LEADERSHIP ROLES IN PUBLIC HEALTH NURSING. (1 cr; prereq public health nursing grad student)
Role theory as basis for analyzing roles and functions of contemporary public health nursing leaders. Students design roles for themselves that demonstrate synthesis of public health knowledge and skill.

5530. PUBLIC HEALTH NURSING PRACTICUM. (1-4 cr; prereq #) Aroskar
Guided application of education and/or management concepts and theories to delivery of indirect public health nursing services in community-based settings.

5531. PUBLIC HEALTH NURSING PRACTICUM. (1-4 cr; prereq #) Aroskar
(Continuation of 5530)

5532. PUBLIC HEALTH NURSING SEMINAR II: RESEARCH STUDIES IN PUBLIC HEALTH NURSING. (1 cr; prereq #) Staff
Presentation and critique of completed research. Required of all public health nursing (MPH) students.

5544. HEALTH OF CHILDREN IN DAY CARE. (3 cr; prereq upper div or grad student in health sciences or related field, #) Berkseth
Physical and psychosocial health risks of young children in day care; current and potential health promotion and disease prevention strategies for this population.

5550. NURSING ADMINISTRATION SEMINAR I. (3 cr) Spradley
Management and organizational concepts and theories.

5551. NURSING ADMINISTRATION SEMINAR II. (3 cr; prereq grad student) Spradley
Selected organizational and management issues.

5552. NURSING ADMINISTRATION SEMINAR III. (1-3 cr) Spradley
"State of the Art" of nursing administration in context of external organizational environment. Synthesis with public health practice.

5575. TOPICS IN PUBLIC HEALTH NURSING. (Cr ar; prereq #) Staff
Individualized learning experiences arranged with public health nursing faculty.

5576. THE POLITICAL PROCESS IN PUBLIC HEALTH. (3 cr; prereq MPH student or grad or #) McGovern
Preparation for assuming leadership in health policy arena. Policy development; political, legislative, and regulatory processes; political strategies in public health.

5582. COLLABORATIVE HEALTH CARE PRACTICE IN GERONTOLOGY. (2-3 cr) Ostwald
Theories of aging; critical issues in providing health care for elderly; clinical focus on assessment and management of common health problems of older adult within holistic, interdisciplinary framework; optional clinical experience with older adults in ambulatory and long-term care settings.

5590. THEORY AND PRACTICE OF OCCUPATIONAL HEALTH NURSING. (1-4 cr; prereq public health nursing or occupational health and safety or environmental health student or #) Olson
Introduction to major concepts and issues in occupational health and safety. Identification of conceptual framework for working with aggregate population of workers. Correlated field experiences.

5592. PLANNING AND COORDINATING AN EMPLOYEE HEALTH SERVICE PROGRAM. (3 cr; prereq occupational health nursing student)
Role development of occupational health nurse specialists related to various organizational structures, employee benefit programs, and health needs of workers. Students participate in evaluation component of an employee health program.

5593. TOPICS IN OCCUPATIONAL HEALTH AND ILLNESS. (2 cr; prereq grad or MPH student or #)
Major occupational health problems and tools utilized in their prevention and/or management. Primarily for students in the occupational health programs of medicine, nursing, industrial hygiene, and industrial safety, and in toxicology, epidemiology, and other areas of environmental and public health.

5594. INJURY PREVENTION IN THE WORKPLACE, COMMUNITY, AND HOME. (3 cr) Gerberich
Injury problems affecting public in workplace, community, and home; epidemiologic approach to strategies for prevention and control.

5595. SEMINAR: SAFETY IN THE WORKPLACE. (1 cr) Gerberich
Hazard analysis and prevention and control of injuries to the worker.

5596. PROBLEMS: SAFETY IN THE WORKPLACE. (2 cr; prereq occupational health and safety or grad or MPH student or #) Gerberich
Interdisciplinary approach to systematize and analyze data relevant to hazards in workplace. Forum format provides opportunity for students to further synthesize and evaluate findings.

5597. TOPICS: INJURY PREVENTION IN THE WORKPLACE, COMMUNITY, AND HOME. (1-3 cr; prereq #) Gerberich
Selected projects: opportunity for students to pursue projects relevant to injury problems.

5609. TOWARDS AN UNDERSTANDING OF CHILD SEXUAL ABUSE. (4 cr) ten Bensel
Historical understanding of child sexual abuse, including definitions, dynamics, effects upon victim, societal intervention, and prevention. Aimed at professional in public health, health sciences, social work, education, and law.

5610. PRINCIPLES OF MATERNAL AND CHILD HEALTH. (3 cr) 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.

5611. PROGRAMS IN MATERNAL AND CHILD HEALTH. (3 cr; prereq 5610, #) ten Bensel, staff
Current programs including C&Y, MIC, family planning, nutrition, dental care, EPSDT, neonatal intensive care, genetics, and school health. Community program leaders participate in class discussion.

5613. CHRONIC AND HANDICAPPING CONDITIONS OF CHILDREN. (3 cr) Leonard, Nelson
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.

5615. HEALTH OF THE SCHOOL AGE CHILD. (3 cr; prereq 5610, grad student or #) Berkseth
Review of major health problems among children of school age; methods of providing and evaluating school health services.

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.

5618. YOUTH AND HEALTH: AN INTRODUCTION. (3 cr, §YoSt 5133) Baizerman
Age-specific morbidity and mortality data regarding youth used as basis for class discussion and individual work on a health topic important to a youth population. Introduction to a youth development concept for use in problem analysis.

5620. CHRONIC AND HANDICAPPING CONDITIONS OF CHILDREN: PREDICTION AND INTERVENTION WITH HIGH RISK INFANTS AND YOUNG CHILDREN. (3 cr; prereq 5613 or #) Leonard, Schacht
Children who are handicappd, chronically ill or at risk, from the prenatal period through age 4, and families. Problems in identifying the infant at risk; analysis of various regional and state programs for screening, assessment, and diagnosis; critical examination of selected early intervention strategies; relationships between parents, health care providers, and educators; in-depth exploration of relevant legislation, needs, and concerns of this age group. Organization of medical care for the chronically ill child.

5621. MATERNAL AND CHILD HEALTH STUDENT/FACULTY SEMINAR. (1-3 cr; prereq MCH 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. MATERNAL HEALTH. (3 cr; prereq #) Lia-Hoagberg
Maternal needs, services, and issues (adult and adolescent pregnancy, reproductive health and family health). Preventive health and high risk problems and care systems for childbearing women in context of sociocultural, economic, and environmental factors.

5624. INTERNATIONAL HEALTH. (Cr ar, §Ped 5525; prereq #) Venters
Major health care problems in developing countries, political and economic constraints involved, and realistic possibilities for solution. Nutritional disturbances, tropical diseases, socioeconomic factors of family health, the role of folk medicine as a health resource, the use of health auxiliaries and the role of the physician in training them, factors that play a crucial role in patient acceptance.

5625. WORKING WITH ADOLESCENTS WORKSHOP. (1 cr) Blum
For teachers, school administrators, school nurses, and others dealing with teenagers. Presentation of major problems of youth from perspectives of professionals and teens. Drug use, teen sexuality, juvenile delinquency, normal adolescent problems and concerns.

5628. ADOLESCENT ABUSE. (3 cr) Blum
Issues related to physical and sexual abuse of teenagers; physical and psychological manifestations of abuse, incest and sexual assault, sexual abuse of males, consequences, treatment approaches, legal and ethical issues.

5629. PSYCHOSOCIAL ASPECTS OF CHRONIC ILLNESS AND HANDICAPPING CONDITIONS IN SCHOOL-AGE CHILDREN AND ADOLESCENTS. (3 cr; prereq 5613, 5620 or #) Blum, Leonard
Impact of chronic disease and handicapping conditions on development, including cognitive, sexual, social, educational, and vocational, of school-age and adolescent individuals. Current legislation, policies, and programs. Relationships between health care and education personnel, the family, and the child or adolescent. Special needs of the terminally ill and her or his family.

5630. FAMILY PLANNING ISSUES IN MATERNAL AND CHILD HEALTH. (3 cr) Lia-Hoagberg
Family planning and related issues, relationship to maternal and child health. Family decision making and problem solving. Opportunity for students to analyze issues and determine policy.

5634. HEALTH PROBLEMS OF YOUTH. (3 cr) Blum
Major health problems from multiple perspectives: morbidity and mortality data, public health professionals and youth. Suicide and accidents, pregnancy, sexuality, drug use and abuse, physical and sexual abuse, depression and loneliness. Framework presented to develop prevention programs.

5635. INTRODUCTION TO CONSULTATION IN YOUTH WORK. (3 cr, §YoSt 5711; prereq #) Baizerman
Major conceptual models for understanding consultation; use to analyze program development, research, program evaluation, clinical cases. Roles of consultant and consultee. Ethical issues. Focus on learning about, not how to do, consultation.

5637. SEMINAR: CROSS-CULTURAL HEALTH ISSUES IN MINNESOTA. (3 cr; prereq health and community professional)
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.

5639. PREVENTION: THEORY, PRACTICE, AND APPLICATION IN PUBLIC HEALTH SERVICE. (4 cr) Schanedling
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.

5642. CHILD ABUSE AND NEGLECT. (3 cr) ten Bensel
Survey of basic concepts and knowledge of child abuse and neglect. Historical overview; balance of rights between children and parents. Examples of child abuse and neglect, why it occurs, its consequences, and how society can intervene to prevent it.

5649. TOPICS: MATERNAL AND CHILD HEALTH. (Cr ar; prereq #) Staff
Selected readings and problems.

5700.* PUBLIC HEALTH ADMINISTRATION I. (3 cr; prereq public health administration 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 health administration student, 5700 or #) Stauffer
Issues, problems, activities, structure of local and federal public health agencies.

5702. PUBLIC HEALTH ADMINISTRATION III. (3 cr; prereq public health administration student, 5701 or #) Block
Issues, problems, structure, and activities of other agencies that influence public health, and their relationship to public health agencies.

5703. PUBLIC HEALTH ADMINISTRATION CLERKSHIP. (1-12 cr; prereq public health administration student or #) Block
Assignment to Minnesota Department of Health or other health agency for supervised work on a project of limited scope. Preparation of formal report.

5704. FIELD EXPERIENCE IN PUBLIC HEALTH ADMINISTRATION. (1-12 cr; prereq public health adminstration student or #) Block, staff
Supervised field experience at management level in selected community or public health agencies and institutions.

5707. INDEPENDENT STUDY: PUBLIC HEALTH ADMINISTRATION. (1-12 cr; prereq public health administration student or #)

5709. MENTAL HEALTH ADMINISTRATION. (1-3 cr; prereq student in mental health administration training project)
Historical overview, trends, governance, work force issues, disability groups, treatment controversies, legal aspects, financial considerations, and standards of quality assurances of mental health services.

5710. REGULATION AND HEALTH. (3 cr; prereq public health grad or health-related professional with BA or #; offered alt yrs) McInerney
Process of regulation in public health context. Perspectives of major disciplines on regulation, movement toward regulatory reform, nontraditional forms of regulation. Principles of administrative law; case studies in variety of health-related areas.

5711. PUBLIC HEALTH LAW. (4 cr; prereq public health student or #) McInerney
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 student in public health administration or in hospital and health care administration, or #) Christianson
Management of HMOs, prepaid group practices, and ambulatory care centers. Legal aspects of ethical concerns, quality assurance, financial management, impact on public health, international comparisons, impact of payment mechanisms and systems.

5715. ADMINISTRATIVE DECISION MAKING IN PUBLIC HEALTH AGENCIES. (2 cr; prereq public health administration student or #)
Process of public or government decision making from an administrative perspective. Case studies involving health issues and decision making based on state government situations. Case study analysis, group discussions, student presentations, interviews with public health decision makers and their staffs.

5720. MANAGEMENT COMMUNICATIONS. (3 cr; prereq public health student)
Improvement of administrative competence through more effective communications. Listening skills, negotiation strategies, interviewing processes, conflict resolution processes, and role of written communication in hospitals and public health agencies.

5723. ADMINISTRATIVE RESIDENCY. (Cr ar; prereq public health administration student or #)
Ten months of fieldwork in an approved health care planning or operating organization; rotation through departments, solution of management problems, and special projects. Preparation of thesis and formal report.

5727. HEALTH LEADERSHIP AND EFFECTING CHANGE. (3 cr, §HSU 5007; prereq public health student or grad student or #)
Application of broad theoretical base in planned change to solve managerial and organizational problems in students' roles as leaders in health professions.

5730. MULTIDISCIPLINARY ASPECTS OF HEALTH PROMOTION/DISEASE PREVENTION. (2 cr; prereq public health administration student or #)
Concepts and issues in disease prevention and health promotion. Medical, administrative, economic, public policy, and behavioral factors considered in examining history, controversies, current issues, legislation, cost/ benefit, and state of the art.

5731. ADMINISTRATIVE ASPECTS OF PLANNING DISEASE PREVENTION/HEALTH PROMOTION PROGRAMS. (4 cr; prereq public health administration student or #) Gunderson
Knowledge and skills for planning disease prevention and health promotion programs; determining prioritized health risks and problems from use and analysis of available data; planning process for setting up prevention/promotion programs. Management skills required for implementing, conducting, and evaluating programs.

5732. COMPETITION IN THE DELIVERY OF HEALTH SERVICES: A PUBLIC HEALTH PERSPECTIVE. (3 cr; prereq grad or public health student, health-related professionals or #) Block
Current trends, proposals, regulatory alternatives, alternative delivery system, reactions and behavior of providers, advertising and marketing, role of antitrust agencies and courts related to competition with focus on public health implications.

5739. TOPICS: PUBLIC HEALTH ADMINISTRATION. (Cr ar; prereq student in public health administration or #)
Selected readings in public health administration. Discussion.

5740. ORGANIZATIONAL BEHAVIOR. (3 cr; prereq ¶5742 and hospital administration student or #) Gordon
Human behavior in organizations. Motivation, leadership, influence of organizational structure, informal group behavior, interpersonal relations, supervision. Preventing and solving problems among individuals and groups in organizations.

5741. ORGANIZATIONAL THEORY. (3 cr; prereq hospital administration student or #) Choi
Application of organizational theory and methods of interorganizational relationships using the multihospital system as a focus.

5742. MANAGEMENT OF HEALTH CARE ORGANIZATIONS. (3 cr; prereq MHA student or #) Carpenter
Role of hospital in delivery of health services and relationships with other elements of health care system. Problems of achieving results, governance, medical staff, and role of administrator.

5744. PRINCIPLES OF PROBLEM SOLVING IN HEALTH SERVICES ORGANIZATIONS. (3 cr; prereq hospital administration student or grad-level student and #) Dornblaser, Sweetland
Lectures, seminars, and demonstrations on problem solving theory and techniques. Management problem solving of cases. Solution of a management problem within health services organization and presentation of report.

5745. ADVANCED PROBLEM SOLVING IN HEALTH SERVICES ORGANIZATIONS. (1-3 cr; prereq 5744) Dornblaser, staff
Solution of specific administrative case problems.

5746. CLERKSHIP. (3 cr; prereq 5744, hosp admin student) Miller, staff
Survey and solution of management problems within local health services organization; preparation of formal management report.

5747. HUMAN RESOURCES MANAGEMENT. (3 cr; prereq hospital administration student or #) Spradley
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. ADMINISTRATION OF SERVICES TO AN AGING CLIENTELE. (3 cr; prereq MHA student or #) Stryker-Gordon
Management in long-term care organizations. Institutional living in nursing homes. Lectures, field visits, and research papers.

5751. PRINCIPLES OF MANAGEMENT IN HEALTH SERVICES ORGANIZATIONS. (3 cr) Riley
Lectures and case studies on the role of health care services administrators, principles of management, and the administrative process.

5752. STRATEGIC AND FACILITIES PLANNING. (3 cr; prereq MHA student or #) Miller, staff
Institutional planning, role of program and physical facilities planning.

5754. MARKETING HEALTH SERVICES. (4 cr; prereq hosp admin student or #) Staff
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 hospital administration student or #) Tranter
Accounting principles and practices applicable to health care 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) Tranter
Budgeting for hospitals; operational, capital, and cash flow requirements for other health care organizations.

5758. HOSPITAL AND OTHER HEALTH CARE ORGANIZATION FINANCIAL STATEMENT ANALYSIS. (4 cr; prereq hospital administration student or #) Oszustowicz
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. HEALTH CARE FINANCIAL MANAGEMENT. (4 cr; prereq 5756, 5757, or #) Nantell
Basic principles of corporate finance and their application to health care organizations. Methods for evaluating alternative financing sources and operating decisions, using tools of financial analysis. Case studies and computer applications.

5760. OPERATIONS RESEARCH AND CONTROL SYSTEMS FOR HOSPITALS. (3 cr; prereq 5404 or #) Dowd
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 statistics) 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. EVALUATION CONCEPTS AND METHODS. (3 cr; prereq hospital administration student or #) Moscovice
Theory, practice, and politics of evaluation. All types of evaluative activities, from simple feedback mechanisms to the evaluation of large-scale programs.

5763. QUALITY OF HEALTH CARE: EVALUATION AND ASSURANCE. (3 cr; prereq MHA student or #) Staff
Characteristics of health organizations and current standards in health care field; implications for hospital and health care management, relationship of standards to health care evaluation.

5766. APPLIED FIELD RESEARCH I. (1 cr; prereq MHA student or #) Weckwerth, Resnick
Under faculty supervision, students select topic of importance in health care administration and formulate research problem and approach for field study.

5767. APPLIED FIELD RESEARCH II. (2 cr; prereq 5766) 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) Weckwerth
With counsel of faculty adviser, students carry out research analysis of selected topic and prepare report on findings.

5770. TOPICS: HOSPITAL AND HEALTH CARE ADMINISTRATION. (Cr ar; prereq hospital administration student or #) Staff
Selected readings in hospital and health care administration with discussion based on these readings.

5771. FINANCIAL MANAGEMENT IN HEALTH SERVICES ORGANIZATIONS. (4 cr; prereq one college-level [3 cr] accounting course) Carpenter
Total financial requirements needed to meet legislative, employer, and/or community demand for health care services; prepares students for operational, capital, and cash flow budget management. Seminars to reinforce course lectures.

5772. MULTIHOSPITAL SYSTEMS AND ACADEMIC HEALTH CENTERS. (3 cr; prereq hosp admin student or #) Johnson
Analysis of behavior of complex organizations, with emphasis on multi-institutional systems and academic health centers.

5773. MANAGEMENT AND ORGANIZATION WITHIN THE AMBULATORY CARE FACILITY. (15 cr; prereq current employment as ambulatory care administrator, #) Weckwerth, staff
Twelve-month program of on-campus (2 weeks) and independent study that includes periodic seminars and monthly sessions with clinical preceptors. Management, organizational behavior, problem solving, executive role, personnel management, financial management, governance, clinicians, productivity, and efficiency.

5774. ADMINISTRATIVE AND PROFESSIONAL RELATIONSHIPS WITHIN THE AMBULATORY CARE FACILITY. (15 cr; prereq 5773) Weckwerth, staff
Twelve-month program of on-campus (2 weeks) and independent study that includes periodic seminars and monthly sessions with clinical preceptors. Change theory, ethics, epidemiology, prepaid systems, legal aspects, planning.

5775. MANAGEMENT AND ORGANIZATION IN HOSPITAL AND HEALTH CARE FACILITIES. (15 cr; prereq current employment as health care facility administrator or #) Weckwerth, staff
Twelve-month program of on-campus (2 weeks) and independent study that includes seminar and monthly sessions with program preceptors. Principles of management, executive role, hospital development and organization, functions of personnel, financial control, business office, and patient care services.

5776. ADMINISTRATIVE AND PROFESSIONAL RELATIONSHIPS WITHIN THE HEALTH CARE FACILITY. (15 cr; prereq 5775) Weckwerth, staff
Twelve-month program of on-campus (2 weeks) and independent study that includes periodic seminars and monthly classes under program preceptors. Board of trustees, medical staff, nursing, hospital law, medical records, planning, community health systems, continuing health education, change theory.

5778. PATIENT CARE MANAGEMENT AND ORGANIZATION WITHIN THE HOSPITAL AND HEALTH CARE ORGANIZATION. (25 cr; prereq current employment as admin of patient care [dir of nursing or equiv] or #) Weckwerth, staff
Twelve-month program of on-campus residential and independent study that includes seminars and monthly sessions with clinical preceptors. Management, organizational behavior, problem solving, executive role, personnel management, financial management, governance, labor relations, and patient care services.

5779. MANAGING MULTIPLE FORCES: INTERNAL AND EXTERNAL ASPECTS OF PATIENT CARE ADMINISTRATION. (25 cr; prereq current employment as admin of patient care [dir of nursing or equiv], 5778 and #) Weckwerth, staff
Twelve-month program of on-campus and independent study with residential session. Seminars on planning, organizing and staffing, directing, and controlling. Students return to campus the following summer to share and demonstrate the research projects they have prepared with their peers.

5785. MANAGEMENT AND ORGANIZATION WITHIN MENTAL HEALTH-RELATED ORGANIZATIONS. (15 cr; prereq current employment as mental health admin or #) Weckwerth, staff
Twelve-month program with on-campus residential session and off-campus independent study that includes seminars and monthly dialogue with program preceptors. Principles of management, organizational behavior, personnel, problem solving and decision making, financial management, mental health professionals and paraprofessionals, and mental health programs and services.

5786. ADMINISTRATIVE AND PROFESSIONAL RELATIONSHIPS WITHIN MENTAL HEALTH-RELATED ORGANIZATIONS. (15 cr; prereq 5785) Weckwerth, staff
Twelve-month program with on-campus residential session and off-campus independent study that includes seminars and monthly dialogue with program preceptors. Governance, legal aspects, public education and information, evaluation of mental health programs, prevention and primary treatment in mental health, current trends, and concepts, public relations, and legislative process.

5790. SOCIOLOGY OF MEDICINE AND HEALTH CARE: AN INTRODUCTION TO MEDICAL SOCIOLOGY. (4 cr, §Soc 5855) Litman
Social and psychological components of health and medical care. Organization and delivery of health care services, their problems and perspectives; focus on the patient, provider of care, and environment in which health care services are dispensed.

5791. PUBLIC HEALTH AND MEDICAL CARE ORGANIZATION. (3 cr; prereq public health students or grad) Resnick
Sociopolitical, economic, and moral/ethical issues confronting public health and medical care system in U.S. 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 hosp admin student) Henry
Lectures about and on-site visits to health services organizations; emphasis on role of organization and administrator.

5793. ECONOMIC ASPECTS OF HEALTH CARE. (3 cr; prereq hospital administration student or #) Christianson
Economic analysis of America's health care sector, emphasizing problems of pricing, production, and distribution. Contributions of health care services to the nation's health.

5794. PUBLIC POLICY IN HEALTH CARE. (3 cr; prereq hospital administration 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.

5795. PLANNING AND MARKETING HEALTH SERVICES. (3 cr; prereq hospital administration student or #)
Planning for delivery of health services, dynamics of planning process at the regional and community level; policy and values, analytical measurement.

5796. LEGAL CONSIDERATIONS IN HEALTH SERVICES ORGANIZATIONS. (3 cr; prereq hospital administration student or #) McInerney
Laws affecting administration of hospitals and other health care 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.

5803. PREVENTION OF MENTAL DISORDERS. (3 cr; prereq grad student in public health, health sciences, social and behavioral sciences) Williams
Methods of preventing specific mental disorders, based on epidemiological research; ways likely to promote and enhance competency and mental health. Primary (including health promotion), secondary, and tertiary prevention of mental disorders.

5804. FUNDAMENTALS OF HEALTH BEHAVIOR CHANGE. (3 cr; prereq #) Hung
Principles, applications, and translation of early and existing paradigms and theories of learning into principles of health behavior change. Role of motivation, specific behavior change approaches (e.g., self-reinforcement, contingency contracting, modeling, biofeedback and self-regulation).

5806. PRINCIPLES OF PUBLIC HEALTH RESEARCH. (3 cr; prereq grad or Public Health student in statistics or vital statistics 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.

5807. CROSS-CULTURAL PERSPECTIVES ON HEALTH BEHAVIORS. (3 cr; offered when feasible) Williams
Cross-cultural issues (both international and sub-cultural) that influence health behaviors of people. What constitutes culture, how cross-cultural factors are studied.

5852. PROGRAM EVALUATION IN HEALTH AND MENTAL HEALTH SETTINGS. (4 cr; prereq grad or public health student, 5806 or equiv research methods course, basic statistics course) 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.

5853. BEHAVIORAL MEDICINE I: THEORY, RESEARCH, AND PRACTICE. (3 cr; prereq psychology grad student or professional in health-related discipline; offered alt yrs) Hung
Survey of the history of and current issues in behavioral medicine and health psychology. Emphasis on stress and its management, life-style intervention, preventive measures for public health, psychology of health behavior; self-management, and health education.

5854. BEHAVIORAL MEDICINE II: SELECTED TOPICS. (3 cr; prereq 5853 and #) Hung
In-depth treatment of two or three of the following topics each quarter: prevention/management of cardiovascular diseases and coronary-disease-prone behavior; biofeedback; life-style interventions for persons who are obese, who smoke, or who are chemically dependent; chronic pain; compliance with medical regimens. Guest lecturers.

5900. PUBLIC HEALTH NUTRITION: PRINCIPLES AND PROGRAMS. (3 cr; prereq public health nutrition student or #) Staff
Experience in nutrition aspects of public health programs. Exploration of public health nutrition field, roles and functions of public health nutritionists, programs and delivery mechanisms for promoting nutritional status of population.

5901. SEMINAR: PUBLIC HEALTH NUTRITION. (1-6 cr; prereq public health nutrition major) Krinke, Leonard
Student/faculty seminar exploring research and practice issues of current relevance to public health field and role of public health nutritionists.

5902. MATERNAL AND CHILD NUTRITION. (3 cr; prereq 3xxx-level nutrition course or equiv or #) Brown
Nutrient functions and requirements throughout pregnancy, lactation, infancy and childhood.

5903. NUTRITIONAL ASSESSMENT. (1-3 cr; prereq 3xxx-level nutrition course or equiv or #) Buzzard, Himes
Methods used to assess nutritional status of populations and individuals throughout various stages of the life cycle.

5904. FACTORS AFFECTING NUTRITION BEHAVIOR. (3 cr; prereq Soc 3201 or equiv or #; offered when feasible)
Basic factors involved in formation of food habits; methods used to modify food habits and to promote and maintain nutritional health of individuals or groups.

5906. FIELD EXPERIENCE: PUBLIC HEALTH NUTRITION. (1-8 cr; prereq public health nutrition student) Krinke
Placement in an approved agency with opportunity for experience in nutritional aspects of public health programs. For students desiring more than one concurrent field placement.

5908. CURRENT NUTRITION ISSUES IN PUBLIC HEALTH. (3 cr; prereq FScN 5622 or #; offered when feasible)
Current national and international nutrition issues and prevention or resolution of problems through various disciplines of public health.

5909. TOPICS: PUBLIC HEALTH NUTRITION. (1-12 cr; prereq public health nutrition student or #) Staff
Independent study in research topic.

5914. NUTRITION INTERVENTION. (3 cr; 1 nutrition course or #) Mullis
Selecting appropriate nutrition intervention strategies for health programs, applying them to specific target audiences, and evaluating their usefulness in relation to program objectives.

5915. MARKETING APPLICATIONS FOR PUBLIC HEALTH PROGRAMS. (3 cr; prereq grad standing or #; offered when feasible)
Assists public health program administrators and practitioners in planning, developing, and implementing effective programs through application of selected marketing concepts, perspectives, and skills. For strengthening professional perspective, rather than preparing marketing experts.

5932. NUTRITION: ADULTS AND THE ELDERLY. (3 cr; prereq 3xxx nutrition course or equiv or #) Krinke, Mullis
Review of current literature and research on nutrient needs and factors affecting nutritional status of adults and the elderly.

5933. NUTRITION AND HEALTH/DISEASE RELATIONSHIPS. (3 cr; prereq normal and clinical nutrition, epidemiology fundamentals, statistics, biochemistry) Brown
Controversies in nutrition; nutrition as factor in development of leading causes of morbidity and mortality in U.S.; relationships among nutrition and infant mortality, heart disease, cancer, hypertension, diabetes, obesity, and other diseases. Emphasis on current nutrition research.

5935. ADOLESCENT NUTRITION. (3 cr; prereq 1 advanced course in nutrition) Story
For students and professionals in nutrition and related disciplines. Psychological, social, and cultural factors that influence food behavior and nutrient intake of adolescents; how these factors affect nutritional needs.

5936. MANAGEMENT AND ORGANIZATION OF NUTRITION PROGRAMS. (15 cr; prereq current employment in management of nutrition program or #) Splett
Twelve-month program of on-campus residential and off-campus independent study that includes seminar and monthly classes under program preceptors. Theoretical and conceptual basis for management and its application to nutrition program delivery. Management process, organizational behavior, nutrition executive, problem solving, computers, financial management, human resource management, quality assurance, nutrition service delivery, and communications.

5937. FORCES AFFECTING NUTRITION PROGRAM ADMINISTRATION. (15 cr; prereq 5936) Splett
Twelve-month program of on-campus residential and off-campus independent study that includes seminar and monthly classes under program preceptors. Nutrition programs as part of health care system. Food and nutrition policy, legislation, management of change, marketing, evaluation, finance, strategic planning, grants, public relations, and applied nutrition research.

8150. RESEARCH: ENVIRONMENTAL HEALTH. (1-6 cr; prereq #) Staff
Opportunities to pursue research in the importance of environmental stresses on human health.

8185. ANALYSIS OF TOXICANTS. (3 cr; prereq #) Swackhamer
Application of principles of analytical chemistry to analysis of toxic chemicals in tissues and fluids, environment, workplace, and environmental health research; survey of instrumental methods (gas and liquid chromatography, mass spectrometry, and atomic and molecular spectroscopy); interpretation of results; analytical quality control.

8261. MOLECULAR TOXICOLOGY FOR THE ENVIRONMENTAL SCIENTIST. (3 cr, §Phcl 8214; prereq 5261 or #) Stevens
Toxic effects and mechanisms of environmental chemicals; emphasis on current animal model research.

8263. PATHOPHYSIOLOGY FOR THE ENVIRONMENTAL SCIENTIST. (3 cr; prereq env hlth student 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.

8269. SEMINAR: ENVIRONMENTAL AND OCCUPATIONAL TOXICOLOGY. (1 cr; prereq 8261 or #) Stevens
Scientific evaluation of toxicological studies that deal exclusively with animal model research; class presentations.

8330. RESEARCH: EPIDEMIOLOGY. (1-8 cr; prereq epidemiology 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 epidemiology 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 epidemiology major, #) Staff
Readings in current research articles on epidemiology.

8378. ADVANCED SEMINAR IN EPIDEMIOLOGY. (2 cr; prereq epidemiology major) Staff
Discussion of one or more major research areas of current epidemiologic interest.

8379. SEMINAR IN EPIDEMIOLOGY. (2 cr; prereq epidemiology or physiological hygiene major) Mandel
Discussion of selected current epidemiologic problems.

8389. SEMINAR: TOPICS IN HEALTH BEHAVIOR SCIENCE. (3 cr; prereq physiological hygiene major and #) Lando
Current theoretical measurement and research issues in behavioral medicine with emphasis on cardiovascular diseases. Topics drawn from physiological hygiene, psychology, sociology, anthropology, and medicine.

8400. SEMINAR IN BIOMETRY. (Cr ar)

8420f. ADVANCED BIOMETRIC METHODS I: SURVIVAL ANALYSIS. (3 cr; prereq 5454 or equiv, 5459 or equiv, knowledge of FORTRAN) Le
Theory and applications of statistical methodologies in survival analysis, from actuarial lifetable to Cox's proportional hazards multiple regression model. Parametric and non-parametric techniques used and, if necessary and feasible, compared by Monte Carlo investigations.

8421w. ADVANCED BIOMETRIC METHODS II: CATEGORICAL ANALYSIS IN PUBLIC HEALTH. (3 cr; prereq 5454 or equiv, 5459 or equiv, knowledge of FORTRAN) Goldman
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 Monte Carlo investigations.

8422s. ADVANCED BIOMETRIC METHODS III: CLASSIFICATION, SEQUENTIAL METHODS. (3 cr; prereq 5454 or equiv, 5459 or equiv, knowledge of FORTRAN)
Linear, quadratic, and nearest neighbor discriminant models; design problems for estimating parameters for non-linear models; sequential evaluation of clinical trial data. Topics introduced and compared by Monte Carlo investigations.

8430-8431-8432. ADVANCED BIOMETRIC ANALYSIS, II, III. (3 cr per qtr; prereq 8422, advanced calculus, theoretical statistics; offered when feasible) Louis, Smith
Randomization theory in clinical and laboratory trials. Biometric theory of epidemiologic case control and cohort studies. Nonparametric and parametric survivorship analysis including censoring and competing risks. Biometric models in demography, medical genetics, and screening and detection of disease. Radioimmunoassay and generalized bioassay models.

8443w. ADVANCED BIOMETRIC METHODS FOR EPIDEMIOLOGIC RESEARCH. (3 cr; prereq 5330, 5420, 5454, 5461, or #) Le
Advanced biometric topics in epidemiology and environmental and occupational health; methods and applications of survival analysis, including Cox's proportional hazards multiple regression model; analysis of categorical data with emphasis on log-linear model and inferences from observational data.

8449. TOPICS IN BIOMETRY. (Cr ar; prereq 5450 and #) Staff
Special topics for advanced students.

8450. RESEARCH IN BIOMETRY. (Cr ar) Staff
Opportunity for qualified students to pursue research work.

8510. DIRECTED RESEARCH. (Cr ar; prereq #) Staff
Guided study in research designs.

8511. DIRECTED RESEARCH. (3 cr; prereq #) Staff
Guided completion of a research study.

8597. RESEARCH: INJURY PREVENTION IN THE WORKPLACE, COMMUNITY, AND HOME. (3-6 cr; prereq basic epidemiology and statistics, 5594 or #) Gerberich
Independent and comprehensive research efforts relevant to injury problems.

8750. SEMINAR: ALTERNATIVE PATTERNS OF HEALTH CARE. (4 cr; prereq student in hospital administration or in hlth servs res, pol, & admin, or #) Litman, Resnick
Alternative approaches to organization, financing, and delivery of ambulatory care, long-term care, maternal and child care, and mental health.

8752f. SEMINAR: COMPARATIVE HEALTH CARE SYSTEMS. (3 cr; prereq grad or public health student or PhD student in hlth servs res, pol, & admin; offered even yrs) Litman
Origin and development of various national systems of health care and their relationship to the social, political, economic, and cultural characteristics of the countries involved.

8760. TOPICS: HOSPITAL AND HEALTH CARE ADMINISTRATION. (3 cr; prereq PhD student in hlth servs res, pol, & admin) Staff
Independent study under tutorial guidance of selected problems and current issues in health and health care.

8761. READINGS IN THEORY AND PRINCIPLES OF HOSPITAL AND HEALTH CARE ADMINISTRATION. (3 cr; prereq PhD student in hlth srvs res, pol, & admin or #) Staff

8762. CONTEMPORARY PROBLEMS OF HOSPITAL AND RELATED HEALTH SERVICES. (3 cr; offered winter of even-numbered yrs) Weckwerth
Current concepts, problems, principles, and future developments in health and health care.

8763. EXTERNAL FORCES AFFECTING HEALTH SERVICES DELIVERY. (3 cr; prereq PhD student in hlth srvs res, pol, & admin 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.

8770s. SEMINAR: HEALTH AND HUMAN BEHAVIOR. (3 cr; prereq 5790 or Soc 5855 or #; offered alt yrs) Litman
Sociology of health and health care; 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 health care services.

8780. ADVANCED STATISTICAL METHODS IN HEALTH CARE RESEARCH. (3 cr; prereq 1 qtr each of applied and theoretical statistics) Weckwerth
Survey and analysis of application of nonparametric statistics to health care research.

8781. SEMINAR: RESEARCH STUDIES IN HEALTH CARE. (3 cr; prereq PhD student in hosp & hlth care admin or in hlth srvs res, pol, & admin or #) Dowd, Finch, Kralewski, Moscovice
Review and appraisal of design, measuring instruments, research methodology, and findings of contemporary studies.

8782. RESEARCH PRACTICUM. (3 cr per qtr [6 cr max]; prereq PhD student in hosp & hlth care admin or in hlth srvs res, pol, & admin or #) Litman, Weckwerth
Field experience in health care research. Supervised independent and team research on selected topics and problems in the field of health care.

8790.* SEMINAR: POLITICAL ASPECTS OF HEALTH CARE. (3 cr; prereq PhD student in hlth servs res, pol, & admin, or #; offered winter of odd-numbered yrs) Litman
Interrelationships between government, politics, and health care; the political and social basis of health legislation and community decision making in provision and modification of health services.

8795. SEMINAR: ADVANCED HEALTH ECONOMICS. (3 cr; prereq 5793 or equiv or #; non-PubH students expected to have passed microecon prelim exam in Econ dept or equiv) Feldman
Application of microeconomic theory to health services research through selected reading from published and unpublished health economics literature.

8796. TOPICS IN HEALTH ECONOMICS. (3 cr; prereq hosp admin student or #) Dahl
General principles of health economics applied to current issues in health. Implications for health policy derived and discussed.

Quaternary Paleoecology

Regents' Professor: Margaret B. Davis (ecology and behavioral biology); Eville Gorham (ecology and behavioral biology)

Professor: Dwight A. Brown (geography); Edward J. Cushing (ecology and behavioral biology); Peter S. Wells (Center for Ancient Studies)

Associate Professor: Robert C. Bright (ecology and behavioral biology, Bell Museum); Guy E. Gibbon (anthropology); Janet D. Spector (anthropology)

Assistant Professor: Christine A. Hastorff (anthropology)

Course of Study—Minor in quaternary paleoecology, applicable to either master's or doctoral programs.

Prerequisites for Admission—Admission to the quaternary paleoecology minor program is contingent upon prior admission to the Graduate School and to a master's or doctoral program in a degree-granting department.

Curriculum—This minor offers a formal, structured interdisciplinary graduate curriculum for students specializing in quaternary paleoecology. 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 paleoecology. 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.

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 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 departmental standards.

Language Requirements—None specific to the minor program.

For Further Information—Contact the director of graduate studies, Quaternary Paleoecology, 300 Bell Museum of Natural History, University of Minnesota, 10 Church Street S.E., Minneapolis, MN 55455.

Core Courses

EBB 5008. QUATERNARY ECOLOGY

EBB 5016. 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. ADVANCED CLIMATOLOGY

Soil 5240. MICROCLIMATOLOGY

Soil 5424. APPLIED CLIMATOLOGY

Paleoecological Methods

Bot 8301. POLLEN MORPHOLOGY AND QUATERNARY PALYNOLOGY

EBB 8014. PLANT MACROFOSSILS, ANATOMY, MORPHOLOGY, AND IDENTIFICATION

Geo 5155. VERTEBRATE PALEONTOLOGY II

Geo 5156. ZOOARCHAEOLOGY

Systematics

Bot 5205. FLORA OF MINNESOTA

Bot 5211. SURVEY OF ANGIOSPERM FAMILIES

Bot 5212. PRINCIPLES OF ANGIOSPERM PHYLOGENY

EBB 5129. MAMMALOGY

EBB 5136. ICHTHYOLOGY

Ent 5020. TAXONOMY OF INSECTS

PlPa 5105. INTRODUCTION TO THE STUDY OF FUNGI

PlPa 5106. MYCOLOGY

Community Ecology

EBB 5014. ECOLOGY OF PLANT COMMUNITIES

Ecosystem Ecology

EBB 5608. ECOSYSTEMS: FORM AND FUNCTION

Limnology

EBB 5601 or Geo 5601. LIMNOLOGY

EBB 5812. COMPARATIVE LIMNOLOGY (at Itasca)

Geology

Geo 5255. GLACIOLOGY

Geo 5311. GENERAL GEOCHEMISTRY

Geo 5541. GEOMAGNETISM

Geo 5651. SEDIMENTOLOGY

Archaeology

Anth 5116. CULTURAL ECOLOGY

Anth 5176. ENVIRONMENTAL ARCHAEOLOGY

Anth 8520. PALEOECOLOGY AND ARCHAEOLOGY

Radiology (Rad)

Professor: Kurt Amplatz; Wilfrido Castaneda-Zuniga; Samuel B. Feinberg; Rex B. Shafer

Associate Professor: Robert J. Boudreau, *director of graduate studies;* Marvin E. Goldberg; Donovan B. Reinke

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

Degree Offered—M.S.Rad. (Plan A only).

Prerequisites for Admission—Applicants must hold an M.D. degree from an approved medical school. Individuals accepted for post-residency training in a particular subspecialty of radiology are encouraged to enroll as candidates for the M.S. degree and should expect to be enrolled in the program for two calendar

years. This program normally will not be offered as an integral part of the regular residency training program in radiology. Under special circumstances, however, an entering resident may be considered for graduate training with the understanding that the program will extend at least one year beyond the required residency training period of four calendar years.

Master's Degree Requirements—Courses for the major should be selected from those listed below. The student must also earn a minimum of 8 credits in one or more related fields in the basic medical sciences (e.g., biometry, biophysics, biochemistry, and biomedical engineering). A final oral examination is required.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Department of Radiology, Box 382 Mayo, University of Minnesota Hospitals, 420 Delaware Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Diagnostic Roentgenology

0120f,w,s. X-RAY CONFERENCE. Staff
Weekly department meetings at which important cases seen in University Hospitals, Hennepin County Medical Center, St. Paul-Ramsey Medical Center, Veterans Administration Medical Center, and most of the private hospitals of the Twin Cities are reviewed.

0121f,w,s,su. MEDICAL ROENTGENOLOGIC CONFERENCE. (No cr) Staff

0122f,w,s,su. PEDIATRIC ROENTGENOLOGIC CONFERENCE. (No cr) Staff

0123f,w,s,su. SURGICAL ROENTGENOLOGIC CONFERENCE. (No cr) Staff

0124f,w,s,su. NEUROSURGICAL ROENTGENOLOGIC CONFERENCE. (No cr) Staff

0125f,w,s,su. CARDIOVASCULAR ROENTGENOLOGIC CONFERENCE. (No cr) Staff

0126f,w,s,su. ROENTGENOLOGIC CONFERENCE ON CHEST DISEASES. (No cr) Staff

0127f,w,s,su. ROENTGEN SURGICAL PATHOLOGY CONFERENCE. (No cr) Staff

5110. RESEARCH PROBLEMNS IN RADIOLOGY. (4½-9 cr)
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).

5140f,w,s,su. SPECIAL PROBLEMS IN ROENTGENOLOGY. (Cr ar) Staff

5174s. PHYSICS OF DIAGNOSTIC RADIOLOGY. (3 cr) Staff
Physics of diagnostic imaging; CAT scanning and ultrasound.

8100f,w,s,su. GASTROINTESTINAL ROENTGENOLOGY. (Cr ar) Staff
In-service training in roentgenological evaluation of the gastrointestinal system.

8101f,w,s,su. UROLOGIC ROENTGENOLOGY. (Cr ar) Staff
In-service training in roentgenological evaluation of the genitourinary system.

8102f,w,s,su. NEUROLOGICAL ROENTGENOLOGY. (Cr ar) Staff
In-service training in roentgenological evaluation of the central nervous system.

8103f,w,s,su. CARDIOVASCULAR ROENTGENOLOGY. (Cr ar) Staff
In-service training in roentgenological evaluation of the cardiovascular system.

8104f,w,s,su. PEDIATRIC ROENTGENOLOGY. (Cr ar) Staff
In-service training in roentgenological evaluation of infants and children.

8105f,w,s,su. PULMONARY ROENTGENOLOGY. (Cr ar) Staff
In-service training in roentgenological evaluation of the pulmonary system.

8110f,w,s. NEURORADIOLOGY. (2 cr; offered alt yrs) Staff
Roentgen diagnostic procedures and roentgen findings in study of the head, including diseases of skull, orbits, and intracranial conditions, and in study of spine and spinal canal.

8150f,w,s,su. RESEARCH IN ROENTGENOLOGY. (Cr ar) Staff
Problems in roentgen diagnosis.

Nuclear Medicine

0220f,w,s,su. NUCLEAR MEDICINE CONFERENCE. (No cr) Boudreau
Weekly presentations of informative nuclear medicine cases seen in University and affiliated hospitals.

5170f. BASIC RADIOLOGICAL PHYSICS. (3 cr; prereq #) Staff
Theoretical and experimental aspects of radiological physics.

5171w. PHYSICS OF NUCLEAR MEDICINE. (3 cr; prereq 5170 or #) Staff
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.

5173. PHYSICS OF RADIATION THERAPY. (3 cr; prereq 5170 or #) Khan
High energy and teletherapy machines.

5240f,w,s,su. SPECIAL PROBLEMS IN NUCLEAR MEDICINE. (Cr ar) Staff

5510w,s,su. BASIC PRINCIPLES OF RADIOLOGICAL PHYSICS. (1 cr) Staff

5540w,s,su. SPECIAL PROBLEMS IN RADIOLOGICAL PHYSICS. (Cr ar) Staff

8200f,w,s,su. NUCLEAR MEDICINE. (Cr ar) Staff
In-service training in uses of radioisotopes in diagnosis and treatment of disease.

8210f,w,s. FUNDAMENTALS OF NUCLEAR MEDICINE. (1 cr; prereq 1st-yr resident) Staff
Lectures and demonstrations on nuclear instrumentation and applications of radionuclides in medicine.

8250f,w,s,su. RESEARCH IN NUCLEAR MEDICINE. (Cr ar) Staff

For additional coursework in radiology, see Therapeutic Radiology.

Recreation, Park, and Leisure Studies

See Physical Education and Recreation.

Religious Studies (RelS)

Professor: Robert B. Tapp (humanities, South and Southwest Asian studies), *director of graduate studies;* Josef L. Altholz (history); Frederick M. Asher (art history, South and Southwest Asian studies); Bernard S. Bachrach (history); Ayers L. Bagley (social and philosophical foundations of education); Muhammad A. Barker (South and Southwest Asian studies); Ernest G. Bormann (speech communication); Roland A. Delattre (American studies); Caesar E. Farah (history); Jasper Hopkins (philosophy); Bruce Lincoln (humanities, South and Southwest Asian studies); Marilyn Schneider (French and Italian); Geneva H. Southall (Afro-American and African studies); Theofanis G. Stavrou (history); James D. Tracy (history)

Associate Professor: William W. Malandra (Classical and Near Eastern studies), *chair;* Jonathan Paradise (Classical and Near Eastern studies); Riv-Ellen Prell (anthropology); L. Earl Shaw, Jr. (political science); Gayle G. Yates (American studies); Tzvee Zahavy (Classical and Near Eastern studies)

Assistant Professor: Philip H. Sellew (Classical and Near Eastern studies)

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—Religious studies is an interdisciplinary program consisting of courses offered through the religious studies program and a variety of other departments. The following areas of concentration are available: comparative religious thought and symbols; religious expresssion in literature and art; social science perspectives on religion; history and teachings of Eastern religions; history and teachings of Western religions.

Prerequisites for Admission—None.

Special Application Requirements—Applicants should submit a statement of purpose, scores from the verbal section of the General (Aptitude) Test of the Graduate Record Examination, and three letters of recommendation.

Master's Degree Requirements—Students must complete a body of coursework comprising select core courses in the discipline and others appropriate to their area(s) of concentration. Since the program is interdisciplinary, a minor or related field is not required. An oral final examination is required.

Language Requirements—A reading knowledge of one foreign language appropriate to a student's area(s) of concentration is required before completion of the program.

Minor Requirements for Students Majoring in Other Fields—RelS 5890 is required; other courses are selected from a list approved by the religious studies program.

For Further Information—Contact the director of graduate studies or the student

adviser, Religious Studies Program, 183 Klaeber Court, University of Minnesota, 320 16th Avenue S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

5001. APPROACHES TO THE STUDY OF RELIGION. (4 cr) Lincoln
Religious ideas and institutions; myths, rituals, cosmologies, and systems of salvation. Methods for the objective study of religion, historical and sociocultural dimensions.

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.

5072. THE NEW TESTAMENT. (4 cr, §Clas 3072, §Clas 5072)
First-century Israel under Roman rule; Jesus of Nazareth; earliest Christian communities; mission to gentiles; Paul the Apostle; beginnings of New Testament.

5101. RELIGION AND AMERICAN CULTURE. (4 cr, §AmSt 5101)
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 #) Lincoln
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, Mesoptomia, 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.

5113. EXPERIENCES, MYSTICAL AND OTHER. (4 cr; prereq jr or sr or #) Tapp
Cross-disciplinary and cross-cultural examination of worship, mysticism, meditation, visions, auditions, sacralizations, alterations of consciousness; inferences based on these experiences; attempts at systematic study, theoretic and social scientific.

5151. RELIGIOUS ETHICS IN AMERICA. (4 cr; prereq jr, sr, or #)
Representative range of contemporary approaches and traditions, with special attention to selected issues and historical background of major options.

5890. SEMINAR IN RELIGIOUS STUDIES. (5 cr for undergrad, 3 cr for grad; prereq sr major or #) Tapp
Conceptual and methodological issues in contemporary religious studies.

5960. TOPICS IN RELIGIOUS STUDIES. (4 cr; prereq #)

8970. DIRECTED STUDIES. (2-5 cr; prereq △)

Russian Area Studies

Professor: Thomas S. Noonan (history), *chair;* John S. Adams (geography); Anatoly Liberman (German); Herbert L. Pick, Jr. (child development); Richard Rudolph (history); Theofanis Stavrou (history); Rudolph Vecoli (history, IHRC); William E. Wright (history)

Associate Professor: Russell B. Adams (geography); Iraj Bashiri (Russian and East European studies); Miranda Beaven (Slavic bibliographer, University Libraries); Jeffrey P. Brooks (history); Adele K. Donchenko (Slavic languages); Gary R. Jahn (Slavic languages); Carol Urness (Bell Library)

Assistant Professor: Leonard A. Polakiewicz (Slavic languages), *director of graduate studies;* Irina Corten (Slavic languages); Tatiana Prokopov (Slavic languages)

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 two seminars.

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. Prospective students should contact the department for further information. Applications to begin the program in the fall quarter of any given year should reach the department by the preceding March 1.

Degree Requirements—Plan B students must (1) take required courses in Russian literature (two courses, Russ 5421-5422), Russian history (two courses, Hist 5132-5133), and social science (two courses from AgEc 5740, Geog 5181, PolSci 5471); (2) 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; (3) take an introductory proseminar and the two-quarter interdisciplinary seminar; (4) demonstrate third-year level proficiency in the Russian language by passing a special examination; and (5) pass a final oral examination. Plan A students must fulfill these same five requirements, except that they may take one less course in their area of concentration.

Plan A students must submit an acceptable 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.

For Further Information—Contact the director of graduate studies, Department of Russian and East European Studies, 253 Elliott Hall, University of Minnesota, 75 East River Road, Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Russian (Russ)

5021. SOVIET UNION STUDY TOUR. (6-18 cr; prereq △ based on oral, written exams)
Intensive language study program at the University of Leningrad. Six-week summer program for students with minimum of two years of college Russian; 14-week semester program for students with minimum of three years of college Russian.

5104. INTRODUTION TO LITERARY ANALYSIS: SHORT STORIES. (4 cr; prereq 3106 or equiv)
Development of advanced language skills through reading and analyzing short stories using structural and psychological approaches. Taught in Russian.

5105. READING OF RUSSIAN POETRY AND NOVEL. (4 cr; prereq 3106 or equiv)
Trends in development of Russian novel and poetry; analysis of major works. Development of advanced language skills; taught in Russian.

5106. CURRENT SOVIET SCENE. (4 cr; prereq 3 yrs college Russian or equiv)
Current cultural and social issues in Soviet Union; analysis of literary works and texts from Soviet newspapers and periodicals. Development of advanced language skills; taught in Russian.

5205. SOLZHENITSYN IN TRANSLATION. (4 cr)
Novels and short stories of Alexander Solzhenitsyn.

5211. SOVIET LITERATURE IN TRANSLATION. (4 cr)
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.

5301. 19TH-CENTURY RUSSIAN POETRY IN TRANSLATION. (4 cr) Prokopov

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
Historical survey of Russian literature from about 1000 A.D. to mid-19th century, concurrent development of Russian literary language from Old East Slavic origins through Pushkin.

5422. LITERATURE: TOLSTOY TO SOLZHENITSYN 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.

5425. EARLY 19TH-CENTURY RUSSIAN LITERATURE: PUSHKIN, LERMONTOV, GOGOL IN TRANSLATION. (4 cr) Prokopov
Major poetry and prose works significant for (1) high artistic form and place in "The Golden Age" of Russian poetry and (2) introduction of characteristic elements of literary prose leading to "Age of Realism."

5701, 5702. STRUCTURE OF MODERN RUSSIAN. (4 cr per qtr; prereq 1106 or #) Donchenko

5704, 5705. HISTORY OF RUSSIAN LANGUAGE. (4 cr per qtr; prereq 1106 or equiv)
Linguistic analysis of historical development of Russian language.

5970. DIRECTED READINGS. (1-3 cr per qtr; prereq #, △, CLA approval)

8211. PROSEMINAR: INTRODUCTION TO RUSSIAN AREA STUDIES. (2 cr; prereq grad)

Plsh 5900. TOPICS. (4 cr)
Topics specified in *Class Schedule.*

Plsh 5970. DIRECTED READINGS. (1-4 cr per qtr; prereq #, △, CLA approval)

Serb 5970. DIRECTED READINGS. (1-4 cr per qtr; prereq #, △, CLA approval)

Slav 5701-5702. OLD CHURCH SLAVIC. (4 cr per qtr; prereq Ling 3005 or #)
Introduction to Slavic linguistics.

Slav 5900. TOPICS IN RUSSIAN AND EAST EUROPEAN STUDIES. (4 cr per qtr [max 12])
Topics specified in *Class Schedule.*

Slav 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 from year to year. Must be completed in same academic year

Required Distribution Courses

(Offered through other departments)

AgEc 5740. AGRICULTURAL POLICY IN PLANNED ECONOMIES. (3-4 cr; prereq 3101 or Econ 3101 or #) K Brooks

Geog 5181. U.S.S.R. REGIONS AND PLANNING. (4 cr) R Adams

Hist 5132. RUSSIAN HISTORY FROM THE ORIGINS TO PETER THE GREAT. (4 cr, §3636; offered alt yrs) Noonan

Hist 5133. RUSSIAN HISTORY FROM PETER THE GREAT TO THE PRESENT. (4 cr, §3637; offered alt yrs) Stavrou

Pol 5471. GOVERNMENT AND POLITICS OF THE SOVIET UNION. (4 cr, §5443; prereq 3051 or non-political science grad or #) Turner

Scandinavian Studies (Scan)

Professor: David Cooperman (sociology); Poul Houe; Anatoly Liberman (German); Marion J. Nelson (art history); John G. Rice (geography); J. Allen Simpson; Göran Stockenström

Associate Professor: Kaaren Grimstad, *director of graduate studies;* Michael F. Metcalf (history); William Mishler; K. Börje Vähämäki

Assistant Professor: Michael G. Karni (independent study); 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 four tracks: Scandinavian visual arts, Scandinavian immigration studies, Scandinavian society and culture, and Scandinavian language and literature. Students in the language and literature track of 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 literature or other topics on the undergraduate level. Students lacking some or all of the necessary background must take one of the advanced language and literature sequences offered by the department; the amount of preparation will be determined by the student's adviser and the graduate faculty. Graduate credit will not be granted for this work.

Special Application Requirements—Three letters of recommendation from individuals qualified to discuss the

candidates's academic performance and likely success in graduate study, Graduate Record Examination scores, and a statement of purpose of about one typewritten page are required. Prospective students may apply at any time; entry may be in fall, winter, or spring quarter.

Master's Degree Requirements—Students are expected to acquire a thorough knowledge of the Scandinavian or Finnish languages and literatures or other relevant areas through seminars and courses and through the aid of a department reading list. Specific requirements for the language and literature track include a knowledge of old Norse equivalent to the two quarters offered by the department, bibliography and research methods, and the history of the Scandinavian languages. A written and an oral final examination are required.

Doctoral Degree Requirements—In consultation with an advisory committee, the doctoral student in Scandinavian language and literature develops five general topics or fields of inquiry. One of these topics will be the projected thesis topic. Students must complete a course in literary criticism (which may be taken as part of the master's program), approved by the graduate faculty.

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 modern Icelandic is acceptable if the primary language is a Scandinavian one; any modern Scandinavian language if Finnish is the primary one. For the doctoral degree, two modern 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—Requirements are designed in consultation with the student's major adviser according to the individual student's needs.

For Further Information—Contact the director of graduate studies, Department of Scandinavian Studies, 210 Folwell Hall, University of Minnesota, 9 Pleasant Street S.E., Minneapolis, MN 55455.

Courses identified by the §§symbol do not require knowledge of the Scandinavian languages except for majors in Scandinavian.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5118. SCANDINAVIA IN THE MIDDLE AGES. (4 cr, §Hist 5118, §Geog 5178) Metcalf, Rice
Interdisciplinary examination of economic, political, and social history of Scandinavia from late Viking period until 1500. Agrarian and urban societies; peasant and elite perspectives; growth of economic, political, religious, and social institutions.

5173. GEOGRAPHY OF NORDEN. (4 cr, §Geog 5173) Rice
Physical and human geography of Sweden, Finland, Denmark, Norway, and Iceland, especially population change and settlement patterns.

5201. §§SCANDINAVIAN LITERATURE FROM THE LATE MIDDLE AGES TO THE ENLIGHTENMENT. (4 cr; prereq grad, reading knowledge of a Scandinavian language) Houe
Representative literary works from the 14th century to Bellman and Holberg.

5202. FROM ROMANTICISM TO THE MODERN BREAKTHROUGH. (4 cr; prereq grad, reading knowledge of a Scandinavian language) Houe
Romantic and early realistic authors.

5252. DEVELOPMENT OF THE SCANDINAVIAN WELFARE STATE. (4 cr, §Hist 5252) Metcalf
Political, social, and economic development in Scandinavia between 1870 and 1980. Why Scandinavian states have led in developing "welfare-state" policies and programs.

5404. §§HISTORY AND STRUCTURE OF FINNISH. (4 cr) Vähämäki
History and structure (phonology and syntax) of modern Finnish.

5421. FINNISH FOLKLORE: THE KALEVALA. (4 cr) Vähämäki
Finnish national epic from a folkloristic point of view. All readings in translation.

5463. GOVERNMENT AND POLITICS OF SCANDINAVIAN COUNTRIES. (4 cr, §Pol 5463; prereq Pol 3051 or non-political science grad student or #) Kvavik
Scandinavian political institutions and behavior; Scandinavian party politics, interest groups, and legislative behavior. Voting patterns and voter alignments. Emergence of social democratic state.

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
Literary study of the saga literature, its origins and development. All readings in translation.

5511. SKALDIC POETRY, ITS METHOD. (4 cr; prereq a reading knowledge of Old Icelandic) Grimstad
Analysis of a representative selection of Skaldic poetry and its forms and method.

5512. §§THE POETIC EDDA. (4 cr; prereq knowledge of Old Icelandic) Grimstad
Reading and analysis of poems from the Poetic Edda.

5602. FICTION AND FILM. (4 cr) Mishler
Film adaptations of classical Scandinavian literary texts. All readings in translation.

5611. §§SCANDINAVIAN LITERATURE IN ITS EUROPEAN CONTEXT: REALISM. (4 cr) Stockenström
Representative European literary texts from the 19th century—dramas, novels, and criticism—read in translation.

5613. §§CONTEMPORARY SCANDINAVIAN LITERATURE. (4 cr) Mishler
Works of authors representing major trends after 1945. All readings in translation.

5614. §§THE DRAMA OF IBSEN AND STRINDBERG. (4 cr; prereq majors with #, open to nonmajors) 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. All readings in translation for nonmajors.

5615. §§IBSEN AND BEGINNINGS OF MODERN DRAMA. (4 cr) Stockenström
Critical study of plays of Ibsen; his role as the founder of modern European drama.

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) Stockenström
Representative European literary texts from late 19th and early 20th century—dramas, novels, and criti cism—read in translation.

5618. §§MODERN SCANDINAVIAN DRAMA. (4 cr) Stockenström
Reading and discussion of Scandinavian plays from the 20th century. All readings in translation for nonmajors.

5619. §§SCANDINAVIAN POETRY SINCE 1890. (4 cr; prereq grad, reading knowledge of a Scandinavian language) Houe, Mishler
Representative poets since 1890.

5631. §§19TH-CENTURY SCANDINAVIAN NOVEL. (4 cr) Simpson
Development of the novel in Scandinavia from its beginnings to the end of the 19th century. Readings in translation for non-majors.

5632. §§20TH-CENTURY SCANDINAVIAN NOVEL. (4 cr) Simpson
Novels of Hamsun, Undset, Lagerkvist, others. All readings in English for non-majors.

5641. SCANDINAVIAN ART OF THE 19TH AND 20TH CENTURIES. (5 cr, §ArtH 5641; prereq art history course or #)
Painting, sculpture, architecture, and decorative arts; rise of expressionism in fine arts and of "Scandinavian modern" in design.

5644. MEDIEVAL ART OF SCANDINAVIA. (4 cr, §ArtH 5644; prereq art history course or #)
Migration, Viking, and Christian art in Scandinavia from 5th through 15th centuries. Architecture, sculpture, painting, with emphasis on minor arts.

5645. FOLK ARTS OF SCANDINAVIA. (4 cr, §5645; prereq art history course or #)
Woodcarving, metalwork, decorative painting, weaving, stitchery, and domestic architecture of rural Scandinavia; origins in pagan and medieval art.

5670. §§TOPICS IN SCANDINAVIAN STUDIES. (4 cr)
Topic announced in advance of first class period. Readings in English for non-majors.

5701-5702. OLD NORSE LANGUAGE AND LITERATURE. (4 cr per qtr) Grimstad
Acquisition of a reading knowledge of Old Icelandic: introduction to the linguistic, philological, and literary study of Old Norse language and literature.

5703. OLD NORSE: SAGA READING AND ANALYSIS. (4 cr; prereq 5702) Grimstad
(Continuation of 5702) Emphasis on reading of prose narratives in Old Norse and discussion of 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.

5712. SCANDINAVIAN HISTORICAL LINGUISTICS. (4 cr; prereq introductory course in linguistics or #)
Internal history of Danish, Norwegian, and Swedish. Readings in translation for nonmajors.

5721-5722. MODERN ICELANDIC. (1 cr per qtr; prereq knowledge of Old Icelandic or ¶5701-5702; offered when feasible)
Modern Icelandic phonology and grammar; reading of texts.

5772, 5773. SCANDINAVIAN HISTORY. (3 cr per qtr, §Hist 5772, 5773; prereq reading knowledge of one Scandinavian language or Finnish, #) Metcalf
Topics and chronological emphasis vary from year to year.

5970. DIRECTED STUDIES. (1-15 cr; prereq #, △, CLA approval)
Topics not covered by regular courses. Readings in Scandinavian literature in the original.

8201. PROSEMINAR IN SCANDINAVIAN BIBLIOGRAPHY AND LITERARY METHODOLOGY. (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, 8502. SEMINAR: MEDIEVAL SCANDINAVIAN LANGUAGES AND LITERATURE. (3 or 4 cr per qtr; offered when feasible)

8511, 8512. SEMINAR: SCANDINAVIAN LINGUISTICS. (3 or 4 cr per qtr; offered when feasible)

8601, 8602. SEMINAR: SCANDINAVIAN NOVEL. (3 or 4 cr per qtr; offered when feasible)

8611, 8612. SEMINAR: SCANDINAVIAN DRAMA. (3 or 4 cr per qtr; offered when feasible)

8621, 8622. SEMINAR: SCANDINAVIAN POETRY. (3 or 4 cr per qtr; offered when feasible)

8631, 8632. SEMINAR: SCANDINAVIAN CRITICISM. (3 or 4 cr per qtr; offered when feasible)

8702. PHILOLOGICAL PROSEMINAR II: INTRODUCTION TO PHILOLOGY WITH SPECIAL EMPHASIS ON METHODS. (2-4 cr)

8801. THE COMPUTER AND THE HUMANITIES: SNOBOL
Especially for humanities students. Introduction to the nonnumeric programming language SNOBOL. Application of the computer in the humanities; separate laboratory/discussion groups in literature, linguistics, creative arts, general topics.

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)
Introduction to research opportunities in the field of Scandinavian immigrant languages and literatures. Presentation of sources and methodology.

Social and Administrative Pharmacy (SAPh)

Professor: Albert I. Wertheimer, *director of graduate studies;* Judith M. Garrard; Laël C. Gatewood; Theodor J. Litman; Vernon E. Weckwerth; Darwin E. Zaske

Associate Professor: David M. Angaran; Daniel M. Canafax; Thomas Choi; James C. Cloyd; Ronald S. Hadsall; Darwin Hendel

Assistant Professor: Harvey M. Arbit; Charles E. Daniels; Jinnet Fowles; Barton W. Galle, Jr.; Cynthia R. Gross; William Hodapp; James K. Marttila; Thomas M. McKennell; David McLean; John K. Middleton; Thomas S. Rector; Norrie A. Wilkins; Jean M. Woodward; Daniel K. Zismer

Adjunct Assistant Professor: Mark W. Banks; Thomas A. Kellenberger; Bruce E. Scott

Senior Research Associate: Stanley A. Edlavitch

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 utilizes 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 not required but are helpful to the admissions committee.

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 approximately 16 credits of other coursework in the department are required.

For Further Information—Contact the director of graduate studies, Department of Social and Administrative Pharmacy, College of Pharmacy, University of Minnesota, 308 Harvard Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5235. PHARMACEUTICAL ECONOMICS. (3 cr; prereq #) Hadsall
Economic aspects of pharmaceutical industry and retail pharmacy. Market structure, demand, cost curves, pricing structure, regulation, innovation, and social responsibility.

5840. PRINCIPLES OF HEALTH BEHAVIOR. (2 cr; prereq PubH 5795 or #)
Review and evaluation of theoretical, conceptual, and experimental approaches in the behavioral sciences contributing to an understanding of health attitudes and behaviors, and of motivational and educational approaches to changes of attitude and subsequent health behaviors. Topics include extent and kinds of health beliefs possessed by various segments of the population, cultural and psychosocial determinants of health attitudes, appraisal of the relationship between attitudes and behaviors, methods used in research on health-related attitudes, concepts and models to explain individuals' health-related perceptions and behaviors, influence processes, and attempts to modify health attitudes and behaviors.

8100. SEMINAR. (1 cr per qtr) Staff

8200. RESEARCH PROBLEMS. (Cr ar) Staff

8210, 8220, 8230. EXPERIMENTAL PHARMACOTHERAPEUTICS I, II, III. (2 cr per qtr; prereq #) Canafax, Rector
Theory of advanced methodologies, applications, and evaluation techniques used to determine efficacy and toxicity of new drug therapies. 8210: Advanced theoretical approaches; problems in drug research, with emphasis on and applications to pharmacotherapeutic problem solving. 8220: Advanced techniques for collecting and evaluating data. 8230: Newly developing methodologies.

8235. LEGISLATIVE CONTROL. (3 cr; prereq #) Fredrickson
Historical development; social and economic causes and consequences; federal and state drug, cosmetic, and narcotic laws. Development of state pharmacy laws, dangerous drug laws, and their regulation. Current legislation affecting the practice of pharmacy.

8255. DRUG MARKETING. (3 cr; prereq #; offered alt yrs) Staff
Historical development of distributive systems, underlying economic principles, marketing channels, agencies, institutions, functions, policies, and practices as they relate to the pharmaceutical industry.

8265. ADVANCED DRUG MARKETING. (3 cr; prereq #) Wertheimer
Specialized problems involved in marketing of health care products and services. Quantitative, statistical techniques used in contemporary pharmaceutical marketing and marketing research methodologies and strategies.

8270. CLINICAL CONFERENCES. (2 cr per qtr [max 6])
Monitoring of patient drug therapy in a clinical setting.

8280. ADMINISTRATIVE CLERKSHIP. (Cr ar; prereq △) Staff
Coordinated clerkship with the student assisting in ongoing work and projects at local health agencies, planning boards, and legislative staff to gain experience in and appreciation of the planning and implementation of health policy. Emphasis on pharmaceutically related work where possible. Supervision by departmental faculty members in conjunction with agency staff.

8290. CLINICAL CLERKSHIP. (2-5 cr; prereq 8270) Staff
Supervised study of pharmaceutical services at University Hospitals or affiliated institutions.

8301, 8302. CLINICAL THERAPEUTICS. (3 cr per qtr) Canafax
Clinical lectures on diagnosis and treatment of common diseases.

8400. SPECIAL CLINICAL PROBLEMS. (Cr ar) Staff
Medication errors, drug distribution systems, patterns of drug utilization, cost-benefit analysis of prescribed medication according to diagnosis, age, dosage form, effectiveness, side effects, incidence of adverse effects, or drug use and misuse.

8420. SOCIAL AND BEHAVIORAL ASPECTS OF PHARMACY PRACTICE. (3 cr; prereq #) Wertheimer
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; prereq #; offered alt yrs) Wertheimer
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; prereq #)
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 and #)
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) Bouchard
Research issues, ideas, design, findings, and interpretations presented by students and faculty for discussion.

8700. HOSPITAL ADMINISTRATION. (2 cr; prereq #; offered alt yrs)
History, classification, organization, and functions of hospital departments in relation to the pharmacy service.

8701. HOSPITAL PHARMACY ADMINISTRATION I. (3 cr; prereq #)

8702. HOSPITAL PHARMACY SURVEY. (1 cr; prereq 8701, #) Daniels

8703. HOSPITAL PHARMACY ADMINISTRATION II. (3 cr; prereq #)
Continuation of 8701.

8810. SOCIAL PSYCHOLOGY OF HEALTH CARE. (3 cr; prereq #) 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.

8820. ADVANCED SEMINAR IN THE SOCIAL PSYCHOLOGY OF HEALTH CARE. (3 cr; prereq #) Staff
In-depth assessment of one or more specific topics related to behavioral and social aspects of health care. Possible topics include relations among members of the health care team, patient counseling, causal attributions as they affect well-being and self-care by patient, and diagnosis and treatment of the health care expert; pain and suffering, positive and negative placebo effects; and problems of the "difficult" and dying patient.

8840. SOCIAL MEASUREMENT. (3 cr; prereq #) 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.

Social and Philosophical Foundations of Education

See Educational Policy and Administration.

Social Work (SW)

Professor: C. David Hollister, *director;* Michael Baizerman; Jerome Beker; Richard S. Bolan; Neil F. Bracht; Clarke A. Chambers; Miriam Cohn; Burton R. Galaway; Diane Hedin; George Hoshino; Rosalie Kane; Rama Pandey; Robert Spano; Esther Wattenberg; Shirley Zimmerman

Associate Professor: Irl E. Carter, *director of graduate studies*; Jeffrey Edleson; Donald E. Maypole[1]; Jean K. Quam; Ronald Rooney; Byron Schneider; Robert W. Schwanke

Assistant Professor: Jane F. Gilgun; Linda Jones; Annalee Stewart; Sara M. Taber

Instructor: Nancy Abramson; Nancy Johnston; Maura Sullivan

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 three areas: 1) family and children, 2) health, mental health, and aging, and 3) management, planning, and development. Four dual programs are also available: M.S.W./master of public health, M.S.W./master of arts in public affairs, M.S.W./M.Plan. in planning, and M.S.W./master of arts in family social science. The doctoral program is designed to prepare students for advanced levels of scholarship and research and to provide intellectual leadership for the profession; it is not designed to 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, i.e., sociology, political science, economics, psychology, history, and anthropology. Applicants must also have completed a course in statistics. 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. GRE scores are not required for admission to the master's program, but applicants who wish to be considered for nomination for a Graduate School Fellowship must submit the scores by January 15. GRE scores are required for admission to the doctoral program. The application deadline is February 1 for the master's program. Priority consideration for the doctoral program is given to applications received by December 15; late applicants to the doctoral program are considered on a space-available basis. Applications to the doctoral program are not accepted after April 15. Beginning students in either program are admitted only for fall quarter.

Master's Degree Requirements—The master's degree requires the equivalent of two years of graduate study. A part-time program is available. A total of 81 credits is required for the two-year M.S.W. degree; a 69-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 of study. A maximum of

[1]*University of Minnesota, Duluth*

40 quarter credits may be transferred toward the 81-credit M.S.W. degree from the following sources with the approval of the School of Social Work: 1) up to 12 credits of graduate-level coursework from Continuing Education and Extension at the University of Minnesota; 2) up to 12 credits of work at graduate level and quality completed as an adult special student at the University of Minnesota; 3) up to 40 credits from another regionally and professionally accredited school of social work, if the student was registered as a graduate student in the program; and 4) up to 12 credits of non-social work electives taken as a graduate student in another university.

For the 69-credit program, a maximum of 27 quarter credits may be transferred from the following sources with the approval of the School of Social Work: credits completed as a graduate student in another M.S.W. program and up to 12 credits of non-social work electives taken as a graduate student in another university. No credits earned before admission to the 69-credit program may be transferred from Continuing Education and Extension at the University of Minnesota or as an adult special student at the University.

Doctoral Degree Requirements—Programs are designed by the student and adviser to develop appropriate skills in research and scholarship. Students must complete basic courses in statistics and research methods. Required components of the program are seminars in research methods, statistics, social welfare history, social policy, and social work practice. The doctoral program gives preference to applicants with at least two years of postmaster's degree work.

Language Requirement—None.

For Further Information—Contact the director of admissions, School of Social Work, 400 Ford Hall, University of Minnesota, 224 Church Street S.E., Minneapolis, MN 55455.

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Core M.S.W. Degree

5111. CONTEMPORARY POLICY AND PROGRAMS IN SOCIAL WELFARE. (3 cr for grad, 4 cr for undergrad students; 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, 4 cr for undergrad students; 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. (3-4 cr, §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, 4 cr for undergrad students; prereq 1001)
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 required]; hrs ar)

8020. FIELD INSTRUCTION II. (4 cr or cr ar [max 12 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.

8300. ORGANIZATIONS AND COMMUNITY SYSTEMS. (3 cr)
Basic theories of organizations and communities; implications of theories for professional practice.

8400. A FRAMEWORK FOR SOCIAL WORK INTERVENTION. (3 cr)
Development of conceptual understanding of, and skill in, problem identification and assessment in social work situations utilizing systems theory and problem-solving approach as framework for analysis. Advanced concepts of communication and interviewing.

8401. SOCIAL WORK METHODS WITH INDIVIDUAL CLIENTS. (3 cr; prereq 8400)
Development of conceptual understanding of, and skill in, use of various social work roles and treatment modalities in direct practice of social work. Development of advanced skills in assessment and principles of intervention.

8414. SOCIAL WORK METHODS WITH GROUPS. (3 cr, §5414; prereq 8401 or #)
For description, see 5414.

8901. SCIENTIFIC INQUIRY IN SOCIAL WORK. (3 cr; incl 1-hr lab)
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.

Other Social Work Courses

5010. SEMINAR: SPECIAL TOPICS. (Cr ar)
Topics specified in *Class Schedule*.

5013. INTERDISCIPLINARY TEAM TRAINING IN HEALTH SERVICES DELIVERY. (3 cr, §HSU 5001, §PubH 5013; prereq #)
Interpersonal, group communications with application to team health projects, organization, function, and membership. Experiential methods and activities to develop attitudes and skills essential to team goal setting, decision making, problem solving, and task accomplishment.

5020. PUBLIC HEALTH SOCIAL WORK INTEGRATIVE SEMINAR. (2 cr, §PubH 5020; prereq beginning level MSW/MPH major)
Helps students in dual degree program develop integrated public health social work identity. Synthesis: common historical and philosophical developments, roles and functions, trends, professional values, and knowledge and research bases.

5021. HUMAN SEXUALITY FOR HEALTH AND HELPING PROFESSIONALS I. (3-4 cr, §HSU 5025, §PubH 5021, §FSoS 5240)
Multidisciplinary approach to human sexuality from perspective of public and social health and well-being of community, society, and individuals. Develops personal skills for imparting sexual knowledge to other health professionals and consumers.

5022. HUMAN SEXUALITY FOR HEALTH AND HELPING PROFESSIONALS II. (3 cr, §HSU 5027, §PubH 5022, §FSoS 5240; prereq 5021)
Examination of rationales for sexual health care and methods of interventions into sex-related problems of various publics. Focus on methods of assessment, creation of comfortable climate for exploration of sexual concerns, provision of sex-related information, techniques for behavior change, and referrals to specialized resources for treatment.

5023. IMPLEMENTATION OF SEXUAL HEALTH PROGRAMS AND POLICIES. (3 cr, §FSoS 5240, §HSU 5028, §PubH 5023; prereq 5021 or PubH 5021, HSU 5025 or FSoS 5240 or #)
Issues, controversies, and alternative approaches to preventive programs and policies. Ethical/legal aspects, sexual normalcy, variants/deviance, and health care. Emphasizes sexual health education for adults and children.

5024. MULTIDISCIPLINARY PERSPECTIVES ON AGING. (4 cr, §CPsy 5305, §Educ 5440, §HSU 5009, §Phar 5009, §PA 5671, §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.

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 U.S.

5228. RURAL ISSUES IN SOCIAL WORK PRACTICE. (3 cr)
Practicing social work in rural environment. Rural service system, public policies affecting rural service delivery, and professional concerns.

5404. BEGINNING CHILD WELFARE PRACTICE. (4 cr for undergrad, 3 cr for grad; prereq 1001, 3005)
For exploring, organizing, and applying knowledge related to demands typical of child welfare practice. Analysis and intervention into problems and cases, with special attention to worker functioning.

5414. FUNDAMENTALS OF SOCIAL GROUP WORK. (3 cr grad, 4 cr undergrad, §8414; prereq 3005)
Analysis of basic principles of social group work practice applicable to both task and treatment groups. The 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, with individual members, and with systems external to small group.

8102. POLICY ISSUES IN SOCIAL WELFARE. (3 cr)
Major policy issues in social welfare and development of beginning technical proficiency in their attempted solution.

8104. CHILD WELFARE AND THE LAW. (3 cr)
Introduction to the legal system in the context in which social workers come into contact with it most frequently: neglect and delinquency proceedings, adoption, and divorce custody contests.

8111. INTERNATIONAL SOCIAL WELFARE. (3 cr; prereq #)

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.

8132. COMMUNITY MENTAL HEALTH: HISTORY, LEGISLATION, AND POLITICS. (3 cr; prereq 8300 or equiv and #)

8150. SPECIAL TOPICS IN SOCIAL POLICY. (Cr ar)

8203. FAMILY STRESS. (3 cr)
Family theories as they relate to family development, family structure, and family behavior in response to social and psychological stress. Normal and dysfunctional family behavior.

8206. DISORDERED HUMAN BEHAVIOR. (3 cr; prereq 5201 or #)
Current concepts of and approaches to problems of disordered behavior.

8301. ORGANIZATIONAL ANALYSIS, MANAGEMENT, AND ADMINISTRATION. (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 unifunctional and local organizations.

8307. THEORIES OF SOCIAL PLANNING AND SOCIAL CHANGE. (3 cr)
Principles of working with multifunctional, complex social structures in social planning, community action and development.

8311. ISSUES AND INTERVENTIONS IN CHILD SEXUAL ABUSE. (3 cr)
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 8400 or #)
Methods and models in various child-serving agencies: family courts, child protection, foster care, and mental health settings.

8415. COMPARATIVE GROUP MODALITIES. (3 cr; prereq 8401 or #)
Examination of group modes of practice through comparative analysis of commonalities and differences in group- related variables across therapeutic systems.

8416. GROUP PSYCHOTHERAPY. (3 cr; prereq 8401 or #)
Conceptual base for group treatment in social work practice, including a frame of reference for interventive actions, specific interventions, and analysis of problems and issues in group therapy.

8417. THE MANAGEMENT OF TEAM AND STAFF. (3 cr; prereq #)
The management of team and staff relationships. Application of selected interpersonal and group process constructs in the development of team and staff relationships. Group behavior as related to management, team, and staff roles in social work.

8421. SOCIAL WORK PRACTICE: PSYCHOPATHOLOGY AND INTERVENTION. (3 cr)
Roles and intervention strategies of social workers in variety of service settings. Problems frequently presented, treatment alternatives, interdisciplinary practice, and ethical issues.

8422. SOCIAL WORK PRACTICE WITH THE CHRONICALLY MENTALLY ILL. (3 cr; prereq 8400, 8401, 8122, or #)
Specialized training and conceptual frameworks for understanding chronic illness. De-institutionalization and community-based care.

8423. CHRONIC ILLNESS—IMPACT ON FAMILIES. (3 cr; prereq 8400, 8401, 8122, or #)
How family members are affected by chronic illness. Psychological, social, and coping strategies of families and patients.

8424. SOCIAL WORK WITH INVOLUNTARY CLIENTS. (3 cr; prereq 8401)
Analysis of involuntary transactions in variety of settings. Theory, ethics, 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. DOMESTIC VIOLENCE. (3 cr)
Current theories, research, and social work practice in domestic violence. Physical abuse of women, children, and elderly. Examined at levels of human ecology ranging from individual to sociocultural systems.

8450. SPECIAL TOPICS: PRACTICE WITH INDIVIDUALS, FAMILIES, AND GROUPS. (1-4 cr; prereq 8401 or #)

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.

8950. SPECIAL TOPICS IN SOCIAL WORK RESEARCH. (Cr ar; prereq #)

8970. DIRECTED STUDY. (Cr ar; prereq #)
Independent study under tutorial guidance.

8990. RESEARCH PROJECTS. (Cr ar [max 6])
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. (4 cr per qtr, §Hist 5821; prereq Hist 5349 for 8130, #)
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.

8140. SEMINAR: SOCIAL WORK EDUCATION. (Cr ar [max 6]; for doctoral students only; prereq #)
Description and analysis of current problems and issues in education for social work and implications for curriculum development and design: impact on classroom teaching.

8180. SOCIAL POLICY FORMULATION AND ANALYSIS. (4 cr; prereq doctoral 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.

8460. SPECIAL TOPICS IN THE PERSONAL SOCIAL SERVICES. (Cr ar; for doctoral students only; prereq 8401 and #)

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.

8991. RESEARCH SEMINAR. (3 cr; prereq doctoral student)

8992. RESEARCH SEMINAR. (3 cr; prereq 8991, doctoral student)
Continuation of 8991.

8993. RESEARCH SEMINAR. (3 cr; prereq MSW degree)
Continuation of 8992.

Youth Studies (YoSt)

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]; 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.

5201-5202-5203. YOUTH WORK PRACTICE: INTERNSHIP AND SEMINAR. (4 cr per qtr; prereq acceptance into youth studies 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.

5330. CHILD AND ADOLESCENT PSYCHOLOGY FOR PRACTITIONERS. (3 cr; prereq courses in educational psychology, child or adolescent psychology)
Application of 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 and work experience 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.

5332. UNDERSTANDING AND WORKING WITH SPECIAL POPULATIONS OF YOUTH. (3 cr; prereq 5331 or #)
Range of treatment methods and their rationale for working with adolescents with a variety of special problems from a normalizing, developmental perspective.

5401. COMMUNICATING WITH ADOLESCENTS ABOUT SEXUALITY. (3 cr; prereq 6 cr social sciences, experience in youth work or #)
Sexual development and experience; emphasis on effective communication between adults and youth. Sexual patterns, variations, roles, power, exploration, education.

5402. SERIOUS ADOLESCENT SEXUALITY PROBLEMS: SEXUAL ABUSE, RAPE, INCEST, PROSTITUTION, AND UNPLANNED PREGNANCY. (3 cr; prereq 6 cr social sciences, experience in youth work or #)
Serious sexuality problems of some adolescents; knowledge and skills needed by adults to prevent or respond helpfully to problems.

5403. INTERVENTION AND COUNSELING WITH ADOLESCENTS AND FAMILIES REGARDING SERIOUS SEXUALITY PROBLEMS. (3 cr; prereq 5402, experience working with adolescents on serious sexuality problems or #)
Social and psychological dynamics of serious sexuality problems and the available methods of intervention.

5631. HEALTH NEEDS AND PROBLEMS OF ADOLESCENT FEMALES. (4 cr)
Major health concerns, behaviors, and problems of adolescent females. Current and alternative approaches to service delivery and intervention. Assessment of needs of specific groups (parents, abused youth, etc.) and local program response.

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 experience 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.

8001, 8002, 8003. ADVANCED SEMINAR IN YOUTH STUDIES. (3 cr per qtr; prereq #)
Examination and discussion of scholarly and practice literatures dealing with youth and youth work. Individual study of a relatively focused population of youth using literature in all relevant disciplines.

Sociology (Soc)

Professor: Joseph Galaskiewicz, *chair:* Joel I. Nelson, *director of graduate studies;* Theodore R. Anderson; Roy E. Carter, Jr.; John P. Clark; David Cooperman; George A. Donohue; Barry C. Feld; Gary Alan Fine; Harold Finestone; Robert Fulton; Guillermina Jasso; David Knoke; Barbara Laslett; Robert K. Leik; Theodor J. Litman; Carl Malmquist; Margaret M. Marini; Donald G. McTavish; Jeylan T. Mortimer; Ira L. Reiss; Paul D. Reynolds; Roberta G. Simmons; Richard E. Sykes; David A. Ward

Associate Professor: Ronald R. Aminzade; Ronald E. Anderson; Shirley M. Clark; Robert E. Kennedy; Candace Kruttschnitt; Karen S. Louis; Dario Menanteau; Stephan P. Spitzer

Assistant Professor: Rose M. Brewer; Jeffrey P. Broadbent; William Brustein; Michael D. Finch

Other: Michael Q. Patton

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: family, gender and sexuality; law, criminology and deviance; social self and life course; organizations and occupations; demography and population studies; community; historical and comparative. Although these are the main substantive areas, individual programs can be developed in other spe-

cialties such as death education, gerontology, and rural sociology. Training for students interested in both academic and applied employment is generally available.

Prerequisites for Admission—A background in basic sociology, usually consisting of 18 quarter credits in undergraduate work, 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 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. Applicants must submit the following: Graduate Record Examination scores; a complete set of transcripts in addition to that required by the Graduate School; two letters of recommendation (three with an application requesting financial aid); a copy of a term paper, written in English; and a statement of professional objectives. Applicants for the master's degree are evaluated and admitted separately from applicants for the doctoral degree. For fall admission, the final application deadline is April 25. For financial aid, the final application deadline is January 15.

Master's Degree Requirements—The department offers both a general academic program (general M.A.) and a more specialized program in policy, research, and evaluation (PREP M.A.). A final oral examination is required for both degrees.

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 four subfields.

For Further Information—An informational brochure covering specific admission and degree requirements is available from the Graduate Office, Department of Sociology, 978 Social Sciences Building, University of Minnesota, 267 19th Avenue South, Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Criminology and Deviance

5101. SOCIOLOGY OF LAW. (4 cr; prereq 3101-3102 or #; 5705 recommended)
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 #) Clark
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, §CJS 5113; 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, §CJS 5121; prereq 3102 or #) Ward
Theories of crime causation and operation of criminal justice agencies in other countries.

5108. CURRENT ISSUES IN CRIME CONTROL. (4 cr, §CJS 5207; prereq 3102 or #) Kruttschnitt
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.

5111. SOCIOLOGY OF DEVIANT BEHAVIOR. (4 cr; prereq 3101-3102 or #) Finestone
Nature of deviant behavior, social processes associated with careers of deviants, and relationship of deviancy to problems of social control.

5114. THE SOCIAL CONTROL OF WOMEN OFFENDERS. (4 cr, §CJS 5114; 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) Clark, Sykes
Police organizations and operations from a social science perspective. Formal and informal policing; role and functions; legal bases; accountability and restraints; relations with policed populations, emphasizing minorities, youth, and recognized violators; use of violence, unethical and illegal practices; civil liberties; intraorganizational and interorganizational relations; social theory and change.

5135. WHITE-COLLAR CRIME. (4 cr; prereq 3101-3102 or #; 5161, 5162 recommended; offered alt yrs) Clark
Types of white-collar crime, broadly construed; roots in American society; responses offered by theoreticians and amateur and professional politicians.

5141. JUVENILE DELINQUENCY. (4 cr; prereq 3101-3102 or #; 5161, 5162 recommended) Finestone
Advanced study of definition and origins of juvenile delinquency and societal response to it through regulatory agencies; special characteristics of juvenile justice institutions.

5142. JUVENILE JUSTICE LAW AND ORGANIZATION. (4 cr, §CJS 5103; 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, 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, §CJS 5205; 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.

5161. CRIMINAL LAW IN AMERICAN SOCIETY. (4 cr, §CJS 5101) 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, §CJS 5102) 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.

8101, 8102, 8103. SEMINAR: RESEARCH IN SOCIAL DEVIANCE. (3 cr per qtr) Clark, Finestone, Spitzer, Ward

8105. SEMINAR: CRIMINAL POLICY. (3 cr, §CJS 8207)
Formulation of criminal policies by courts and legislatures; role of community, interest groups, press, and commissions in criminal policy formulation; implementation of policy by criminal justice bureaucracies; theories and methods applied to criminal justice policy evaluation.

8111, 8112, 8113. SEMINAR: RESEARCH PROBLEMS IN JUVENILE DELINQUENCY. (3 cr per qtr; offered when feasible)

8125. POLICE IN SOCIETY. (3 cr, §CJS 8201; prereq #)
Role of police from several perspectives: historical, anthropological, sociological, public policy. Models of police behavior, role in society and community, misconduct, professionalization, politicization.

8135. SEMINAR: WHITE COLLAR CRIME. (3 cr, §CJS 8135)
Relationship between American political, economic, and social structure and various types of white collar crime, especially legal and social systems.

8148. LAW, SOCIETY, AND THE MENTAL HEALTH SYSTEM. (3 cr, §CJS 8205; prereq grad student, 5148, or #) Malmquist
Intensive survey of psychopathology, with reference to criminal behavior and the criminal justice system.

8161. SEMINAR IN CRIMINAL JUSTICE. (3 cr, §CJS 8002; prereq 5161, 5162, or #)
General aims and purposes of criminal law, means employed to attain them.

8162. SEMINAR IN CRIMINAL JUSTICE. (3 cr, §CJS 8001)
Current basic literature concerning administration of criminal justice.

Sociology of Religion

5151. RELIGION AS A SOCIAL INSTITUTION. (4 cr; prereq 8 cr social sciences or #)
Structure and function of religious organizations in various types of societies, nature of religious leadership, type of religious participation, and relationship of religion to other social institutions.

8151, 8152, 8153. SEMINAR: SOCIOLOGY OF RELIGION. (3 cr per qtr; prereq 5151 or #)
Intensive study of a major social institution; methodological techniques, problems, theoretical models, and specialized areas in sociological study of religion.

Social Psychology

5201. INTRODUCTION TO SOCIAL PSYCHOLOGY. (4 cr [no cr for sociology majors]; prereq 8 cr sociology, anthropology, economics, political science or psychology) Fine, Mortimer, Reynolds, Spitzer
Research and theory regarding relation of individual to social groups. Emphasis on socialization processes; effects of social interaction and isolation; individual behavior under conditions of social organization and disorganization; cultural influence and its limits.

5205. SYMBOLIC INTERACTION. (4 cr; prereq 3201 or 5201 or equiv or #) Finestone
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) R Anderson, Reynolds
Small group research and theory focusing on both laboratory and nonlaboratory investigation of interpersonal exchange, communication structures, status and power relations, coalition formation, reference groups, role differentiation, group uniformity, social influence, and problem-solving behavior. Laboratory arranged.

5215. SELF-CONCEPT IN THEORY AND RESEARCH. (4 cr; prereq jr, sr or grad student, 16 cr in social sciences and/or education or #; offered alt yrs) Simmons, 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.

8201, 8202, 8203. SEMINAR: RESEARCH IN PROBLEMS IN SOCIAL PSYCHOLOGY. (3 cr per qtr; offered when feasible) Fine, Spitzer

8208. SOCIAL LINGUISTICS. (3 cr; prereq #) Sykes
Social communication in groups, organizations, and institutions.

8211, 8212, 8213. SEMINAR: RESEARCH IN SMALL GROUPS. (3 cr per qtr) Leik

8215. THEORIES OF SOCIAL PSYCHOLOGY. (4 cr; prereq 1st-yr sociology grad student or #) Fine, Mortimer, Spitzer
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.

Social Change and Social Movements

5301. SOCIAL MOVEMENTS IN A CHANGING SOCIETY. (4 cr; prereq 3401 or 5401 or equiv or #) Aminzade
Factors underlying social change in modern mass society. Recent research on social movements, reform and revolution, culture contact, impact of rapid technological change. Individual and social structure under conditions of rapid social change.

5311. SOCIOLOGY OF CONFLICT. (4 cr; prereq 3401 or 5401 or equiv or #) Cooperman
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.

8305. SEMINAR: PERSPECTIVES OF SOCIAL AND ECONOMIC DEVELOPMENT—LATIN AMERICA. (3 cr; prereq #) Ellenbogen
Evolution of an "orientation" toward development in Latin America. Strategies for and tactics of planned change at national, regional, and community levels. Selected methodological and conceptual issues related to development.

8308. MODERNIZATION AND SOCIAL CONFLICT: A CROSS-NATIONAL APPROACH. (5 cr; prereq #) Ellenbogen
Several perspectives in modernization. The comparative approach. Seminar exercise in developing a macro comparative study on conflict and modernization.

Popular Culture and Public Opinion

5351. SOCIOLOGY OF POPULAR CULTURE. (4 cr; prereq 16 cr in sociology or #; offered alt yrs) Fine
Social preconditions and social effects of popular culture; popular vs. nonpopular culture; selected popular arts.

5355. OPINION AND COMMUNICATION: SOCIAL FACTORS. (4 cr; prereq 16 cr sociology or #; offered alt yrs) R Carter
Opinion formation and change in relation to individual characteristics and social structure; flow of public communications through society and impact of communication on particular audiences.

5371. SOCIOLOGY OF SPORT. (4 cr; prereq 1001, 3201 or #) Fine
Sport within and among societies and nations; social organization—socioeconomic 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.

8351, 8352, 8353. SEMINAR: RESEARCH PROBLEMS OF MODERN MASS SOCIETY. (3 cr per qtr; offered when feasible)

8361. SEMINAR: RESEARCH AND THEORY ON THE SOCIOLOGY OF CULTURE. (3 cr; prereq #) Fine
Theory and research in culture, subculture, and group culture as these concepts are employed by sociologists. Relationships between high culture, popular culture, and folklore.

Social Organization and Social Structure

5401. SOCIAL ORGANIZATION. (4 cr [no cr for sociology majors], §3401; prereq 8 cr sociology, anthropology, economics, political science or psychology) Galaskiewicz, Nelson
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 statistics recommended; offered alt yrs) 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) Reynolds
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.

5415. COMPARATIVE SOCIAL STRUCTURE. (4 cr; prereq 20 cr sociology, economics or political science or #; offered alt yrs) Cooperman
Comparative analysis of selected societies such as Western European, African, Middle Eastern. Changing social class, status, cultural patterns, and institutions. Regional and cross-national social patterns and social movements.

5421. OCCUPATIONAL SOCIOLOGY. (4 cr; prereq 3201 or 3401 or 3405 or 5201 or 5401 or equiv or #; offered alt yrs) Mortimer
Individual motivations and reactions to work; nature of professions and other occupational types; relation between occupational and organizational norms and values, relationships between occupations and social structure, including stratification system, family, political system, and technological change; changes in composition of labor force.

5441. WORK-FAMILY LINKAGES. (4 cr; prereq 8 cr sociology or #) Mortimer
Theoretical and methodological approaches to the work-family interface; effects of spouses' work characteristics on the family, including child socialization; family's influence on male and female labor force participation and occupational attainment; changes in work organizations related to increasing prevalence of female employment and dual earner families.

5481. COMPARATIVE ASIAN DEVELOPMENT. (4 cr, §EAS 5481; prereq sociology of development, Asian related courses, or #)
Comparison of political-economical and sociocultural institutions creating high speed growth and other social and political effects in East Asian area, focusing on Japan and "four little tigers": Taiwan, South Korea, Hong Kong, and Singapore.

8405. SEMINAR: RESEARCH PROBLEMS IN SOCIAL STRATIFICATION. (3 cr; prereq 5405 or #) Nelson
Problems of research in social stratification with attention to theory and methodology for understanding stratification as a structural or organizational variable.

8411. SEMINAR: RESEARCH IN LARGE-SCALE ORGANIZATION. (3 cr; prereq 5411) T Anderson

8415. THEORIES OF SOCIAL ORGANIZATION. (4 cr; prereq 1st-year sociology grad student or #) Galaskiewicz, Knoke, Nelson
Survey of social organization; presentation and critical analysis. Major social organizational concepts, theoretical perspectives, and current theoretically relevant literature.

8421. SOCIOLOGY OF WORK. (3 cr [may be repeated for cr]) Mortimer
Sociological analysis of work and occupations, with emphasis on contemporary theory and research. Topics vary for each seminar, e.g., work and social change, life course perspectives in sociology of work, and work and family linkages.

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.

8484. SEMINAR IN MARXIST SOCIOLOGY. (4 cr; prereq #) Aminzade
Comprehensive overview of Marxist sociology, focusing on logic of core concepts of Marxist theory, recent debates within Marxist sociology, and current sociological research that addresses issues raised in these debates.

Family Sociology

5505. FAMILY DEVELOPMENT. (5 cr; prereq 1001, 3201 or 5201 or equiv, CPsy 1301 or #) Fischer, 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.

5511. COMPARATIVE GENDER ROLES. (3 or 4 cr; prereq 8 cr sociology or #; offered alt yrs) Laslett, Reiss
Comparison of gender roles in various parts of the world. Reliance on sociological and anthropological research outside the Western world with comparisons to Western systems. Place of gender roles in overall kinship systems and among other major institutions (economic, political, religious).

5524. SOCIOLOGY OF HUMAN SEXUALITY. (3 or 4 cr; prereq 8 cr sociology or #) Reiss
Human sexuality from a social perspective. How sexual preferences develop; trends in sexual relationships in various parts of society; social factors affecting sexual permissiveness.

5939. AGING AND INTERGENERATIONAL DYNAMICS. (4 cr; prereq 3937) Fischer
Relationships between adult children and their parents. Topics include variations in intergenerational relations, development and linked life course, kinship vs. friendship, and aging families in past times.

8501, 8502. SEMINAR: CONTEMPORARY RESEARCH ON MARRIAGE AND THE FAMILY. (4 cr per qtr; offered when feasible) Fischer, Reiss

8505. SEMINAR: THEORY DEVELOPMENT AND THE FAMILY. (4 cr; prereq #) Leik, Reiss
Theory and strategies for developing theory with particular reference to family areas.

8514, 8515, 8516. SEMINAR: RESEARCH PROBLEMS IN THE FAMILY. (3 cr per qtr; offered when feasible) Laslett, Leik, Reiss

8521, 8522, 8523. SEMINAR: SOCIAL PSYCHOLOGY OF MARRIAGE. (3 cr per qtr; prereq #) Leik
Same as Psy 8214, 8215, 8216.

8524. SEMINAR: SOCIOLOGY OF HUMAN SEXUALITY. (3 cr) Reiss
Methodological and theoretical examination of major research studies on premarital, marital, and extramarital sexuality.

Demography

5555. POPULATION THEORY. (4 cr; prereq 3551 or #; offered alt yrs) Kennedy
Critical evaluation of what social science theory is, and systematic evaluation of various writings in population as theoretical works.

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.

5571. HISTORY OF THE AMERICAN INDIAN POPULATION. (4 cr, §Hist 5009) Thornton
Demographic history of American Indians in area of United States. Pre-European contact size, decline to 20th century, and recent partial recovery.

8551, 8552, 8553. SEMINAR: PROBLEMS IN POPULATION RESEARCH. (3 cr per qtr) Kennedy

Urban Sociology

5601. URBAN SOCIOLOGY. (4 cr; prereq 3401 or 3405 or 5401 or equiv or #; some statistics recommended) T Anderson, Cooperman
Cities; urban ecology; urban institutions and urban way of life.

5605. URBANIZATION AND SOCIAL POLICY. (4 cr; prereq 5601 or #) Cooperman
Contemporary changes in urban processes that are considered problematic and the responses and policies of public groups. Interrelationships of social, cultural, economic, and political factors in development of urban problems. Models of urban systems and social policy formation. Methods of social cost analysis and formation of policy alternatives.

8601, 8602. SEMINAR: RESEARCH IN URBAN SOCIOLOGY. (3 cr per qtr)

Rural Sociology

5651. RURAL SOCIAL INSTITUTIONS. (4 cr; prereq any 3xxx sociology course or equiv or #; offered alt yrs) Donohue
Factors in the rural environment that condition the functioning of rural social institutions—family, school, church, local government, health, and welfare.

5661. RURAL COMMUNITY ANALYSIS. (4 cr; especially for those interested in rural community organization, rural teaching, extension work, and related fields; prereq any 3xxx sociology course or equiv or #; offered alt yrs) Donohue
Tools, techniques, and methods of making community field studies.

5675. WORLD FOOD SUPPLY PROBLEMS. (3 cr, §AgEc 5790, §FScN 5643, §Agro 5200, §LACS 5280; prereq major in agriculture, veterinary medicine, nutritional sciences, social science field or #...grad students by △ only) Ellenbogen
Multidisciplinary approach to examining social, economic, and technical problems of feeding the world's growing population. Principles sought from the social and economic sciences, animal sciences, plant sciences, and nutritional sciences for their application to food problems.

8651, 8652, 8653. SEMINAR: RURAL SOCIOLOGY. (3 cr per qtr; offered when feasible) Donohue

8661. SEMINAR: RESEARCH METHODS IN RURAL SOCIOLOGY. (3 cr; offered when feasible)

Social Theory

5701. ANALYTICAL SOCIAL THEORY. (4 cr; prereq 8 cr social science or #) Cooperman, Jasso
Major problems of sociological theory; main types of sociological theory (positivistic, rationalistic, idealistic); major theoretical concepts.

5703 (formerly 5305). SOCIAL LIFE AND CULTURAL CHANGE. (4 cr; prereq 8 cr social science or #) Donohue
Theories of social change; methodological problems. Comparative social thought and structure of antiquity as basic data for analysis.

5705. BACKGROUNDS OF MODERN SOCIAL THOUGHT. (4 cr; prereq 8 cr social science or #) Laslett
Major trends of social thought from Renaissance to 19th century; origins of sociology.

5711. ELEMENTS OF SOCIOLOGICAL ANALYSIS. (4 cr; prereq 8 cr social science or #) Broadbent, Reynolds
Premises upon which social theories are developed. Construction of social theories.

8701. SEMINAR: SOCIAL THEORY. (4 cr; prereq 1st-yr sociology grad student or #)

8702, 8703. SEMINAR: SOCIAL THEORY. (3 cr per qtr) Cooperman, Laslett

8711, 8712†. SEMINAR: PRINCIPLES OF SOCIOLOGY. (3 cr per qtr)

8714, 8715, 8716. COMPARATIVE SOCIOLOGY: PERSPECTIVES IN THEORY AND RESEARCH. (3 cr per qtr; offered when feasible) Ellenbogen

8721. SEMINAR: SOCIOLOGY OF KNOWLEDGE. (3 cr) Cooperman
Social factors concerning acquisition, production, growth, and diffusion of knowledge (ideas, belief systems, ideologies, artistic and scientific productions).

8724. SEMINAR: SOCIOLOGY OF SCIENCE. (3 cr; offered when feasible)

8725. SEMINAR: THEORY CONSTRUCTION. (4 cr; prereq 1st-yr sociology grad student or #)
Provides basic tools for critiquing and building substantive sociological theories in preparation for empirical research necessary to test them.

Sociology of Political and Legal Institutions

5755. SOCIAL STRUCTURE AND POLITICAL BEHAVIOR. (4 cr; prereq 3401 or 5401 or equiv or #) Aminzade, Galaskiewicz
Structural and ideological conditions influencing legitimation of political institutions and relationships of this process to political participation, political apathy, and the rise of mass movements.

8755. SEMINAR: RESEARCH IN POLITICAL SOCIOLOGY. (4 cr; prereq 5755 or #)
Problems of research in political sociology and political economy; theory and methodology for explaining relationships at micro and macro levels. Individualized research projects.

8761. SEMINAR: SOCIOLOGY OF LAW. (3 cr) Cooperman
Theory of relationship between social structure, variables, and legal systems. Analysis of classical theorists: Weber, Durkheim, Maine, others. Law and social change, social control and policy. Empirical research in law and deviance, legal professions.

Methodology

5801. COMPUTER METHODS IN SOCIAL RESEARCH. (4 cr; offered alt yrs) R 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.

5821. EVALUATION RESEARCH. (4 cr; prereq 3801, 3802, 3803 or #) Eustis, Patton, Reynolds
Evaluation methodology, steps involved in conducting evaluations of education and social action programs, special problems posed for social scientists engaged in evaluation research, and the differences between evaluation research and basic research. Prepares students to conduct actual evaluation research.

8801, 8802, 8803. SEMINAR: RECENT DEVELOPMENTS IN SOCIOLOGICAL RESEARCH TECHNIQUES. (3 cr per qtr; offered when feasible) Jasso, McTavish

8811. METHODS OF SOCIAL RESEARCH. (4 cr; prereq 3802, 3803 or #) T Anderson, McTavish, Simmons
Survey of methods; advantages and limitations of major methods when applied to specific types of problems.

8812. INTERMEDIATE STATISTICS FOR SOCIOLOGISTS. (4 cr; prereq 3801, 3802, 3803 or #) T Anderson, Jasso, McTavish
Intermediate-level bivariate and multivariate correlation and regression, analysis of variance, analysis of covariance and dummy variable techniques.

8813. DATA ANALYSIS. (4 cr; prereq 8812 or #) T Anderson, Jasso, McTavish
Application of multivariate techniques using the computer. Factor analysis, methods of causal analysis, elementary stochastic models, and problems in measurement.

8814, 8815. SEMINAR: DESIGN OF SOCIOLOGICAL RESEARCH. (3 cr per qtr)

8816. SEMINAR: DESIGN OF QUALITATIVE RESEARCH. (3 cr) Finestone

8817-8818. FIELDWORK AND LABORATORY TRAINING IN SOCIAL RESEARCH. (5 cr per qtr)
Direct experience with a variety of research techniques.

8831, 8832, 8833. MEASUREMENT. (3 cr per qtr; prereq 3803 or equiv) R Anderson
Nature of measurement and its role in theory and research measurement models and techniques of scaling; special problems in measurement analysis.

8852, 8853. SEMINAR: METHODS FOR THE EVALUATION OF SOCIAL ACTION PROGRAMS. (3 cr per qtr)

8892. SEMINAR: FUNDING AND ADMINISTRATION OF RESEARCH. (3 cr) Reynolds
Review of issues associated with development, funding, and administration of research projects. Experience in preparing research proposals.

Sociology of Health and Health Care

5855. SOCIOLOGY OF MEDICINE AND HEALTH CARE: AN INTRODUCTION TO MEDICAL SOCIOLOGY. (4 cr, §PubH 5790; prereq jr, sr or grad student) Litman
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.

8855. SEMINAR: HEALTH AND HUMAN BEHAVIOR. (3 cr, §PubH 8770; prereq 5855 or #; offered when feasible) Litman
Social ecology of health; social and personal components of illness; health and the community; social and cultural aspects of health care services.

8861. SEMINAR: SOCIOLOGY OF MENTAL HEALTH AND MENTAL DISORDERS. (3 cr) Spitzer
Social factors in the etiology of mental disorders. Epidemiology of mental disorders. Mental health programs and their effectiveness. Family influences on the mental patient. Public images of the mental patient.

Other Areas

5938. AGING AND THE LIFE COURSE. (4 cr; prereq 3937 or 5937 and 3201, 3401 or 5201, 5401 or equiv or #; offered alt yrs) Fischer, McTavish
Theories of aging, age stratification, generational change; organization and individual level. Lecture and discussion.

5952. YOUTH IN MODERN SOCIETY. (4 cr, §SPFE 5125; prereq 1001 or equiv or #) S Clark
Youth in advanced societies; youth as a social entity; functions of youth in industrialized societies, their roles in family, education, politics and government, economy and work world, welfare and religion; youth organizations, social movements, and subcultures; empirical research and cross-cultural perspectives.

5953. SOCIOLOGY OF EDUCATION. (4 cr, §SPFE 5190; prereq 1001 or equiv or #) S Clark
Advanced study of school as socialization process, social structure of education, role of school in social change, and other topics. Theory and empirical research.

5954. SOCIOLOGY OF GENDER. (4 cr; prereq 8 cr social science; offered alt yrs) Laslett
Analysis of social organization and construction of gender roles and relationships; historical and feminist perspectives on contemporary organization of gender relations; alternative conceptions and approaches.

5956. SOCIOLOGY OF DEATH. (4 cr; prereq jr or sr, 8 cr sociology or #) Fulton
Issues and problems that mortality presents in contemporary society.

5958. SOCIOLOGY OF HIGHER EDUCATION. (4 cr, §SPFE 5192; prereq 1001 or equiv or #) S Clark
Advanced studies in social aspects of higher education including socialization of students, comparative institutional organization, role structure, and others. Emphasis on theory and empirical research.

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. (1-15 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.

8938. SEMINAR: SOCIAL GERONTOLOGY. (3 cr) McTavish
Health, economic, social welfare, housing, recreational, and mental problems of older people. Demography of the aging. Mental health and mental outlook of the elderly. Continued social integration, disengagement, and group consciousness. The subculture of aging. Social trends affecting the elderly in American society.

8941. SOCIAL RESEARCH AND SOCIAL POLICY. (4 cr; prereq grad student) Reynolds
Sociological theories that have informed major social policy studies in selected substantive areas.

8955. SEMINAR: TEACHING SOCIOLOGY ON THE COLLEGE LEVEL. (3 cr; prereq 2nd- or 3rd-yr sociology grad student or #) Kennedy
Purposes; new developments. Relevant learning theories; opportunity to develop a plan for teaching a course, either individually or as part of a team.

8956. DEATH, GRIEF, AND BEREAVEMENT. (3 cr; prereq #) Fulton
Issues and problems that mortality presents to contemporary society.

8960, 8961. SOCIOLOGY OF SPORT. (3 cr; prereq #)
Sport from the standpoint of its socioeconomic history, contemporary social organization, and social psychology.

8971. SEMINAR: MORAL DILEMMAS IN THE CONDUCT OF SOCIAL SCIENCE. (3 cr) Reynolds
Major moral dilemmas (e.g., use of human subjects for research that may benefit the common good) confronting social scientists, related philosophical perspectives, and existing mechanisms for resolving these issues.

Soil Science (Soil)

Professor: William E. Larson, *chair, director of graduate studies;* Russell S. Adams, Jr.; Raymond R. Allmaras; Donald G. Baker; Paul R. Bloom; Charles E. Clapp; Robert H. Dowdy; Samuel D. Evans; William E. Fenster; Peter H. Graham; David F. Grigal; Satish C. Gupta; Jean A. Molina; Wallace W. Nelson; Gyles W. Randall; George W. Rehm; Donald C. Reicosky; Richard H. Rust; James B. Swan; Ward B. Voorhees

Associate Professor: James L. Anderson; Terence H. Cooper; William C. Koskinen; Dennis R. Linden; Gary L. Malzer; John F. Moncrief; Michael P. Russelle; Mark W. Seeley

Assistant Professor: John A. Lamb; Pierre C. Robert; Carl J. Rosen

Research Associate: George R. Benoit

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, 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. 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 applicants.

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 course in three of the five areas of soil chemistry-fertility, soil genesis-classification, soil physics, soil microbiology and biochemistry, or 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 course in three areas of soil science listed under the M.S. degree requirements, one additional seminar, and two additional colloquia, and should normally have completed an acceptable master's degree thesis.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Department of Soil Science, University of Minnesota, 1991 Upper Buford Circle, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5022. BASIC SOIL SCIENCE FOR TEACHERS. (4 cr, §1122 or equiv; prereq one course in college chemistry and education degree or #)
Basic physical, chemical, and microbiological properties of soils. Soil genesis, classification, and principles of soil fertility.

5104. AGRICULTURAL SYSTEMS ANALYSIS, MODELING. (4 cr, §PlPa 5104; prereq Math 1142 or #)
Introduction to biological modeling as preparation for interdisciplinary agricultural-systems analysis. Basic concepts; FORTRAN and simulation languages; deterministic and stochastic models; delays, feedbacks, and clockwork; data acquisition, model verification and validation; role of models for agroecosystem management.

5114. SPECIAL PROBLEMS IN SOILS. (1-5 cr per qtr [max 10]; prereq 1122 or #)
Research, readings, instruction.

5228. SEMINAR: CLIMATOLOGY, METEOROLOGY, AND AGRICULTURE. (1 cr per qtr [max 3 cr]; prereq #)
Roundtable discussions and assigned readings.

5230. SOIL-PLANT-WATER RELATIONS. (3 cr; prereq 1122, Biol 1103)
Water flow in soil-plant-atmosphere continuum, with emphasis on soil-root interface. Influence of soil physical and biological properties on growth and function of plant root systems; transpiration and factors affecting water transport. Dynamic properties of soils affecting water flow and soil water management.

5232. SOIL PHYSICS. (5 cr; prereq Math 1142, 2 qtr physics or #)
Basic physical laws governing processes occurring in soils and their quantification. Physical basis for water, air, and heat transport processes. Lectures, laboratory demonstrations, and problem-solving help sessions.

5240. MICROCLIMATOLOGY (SOILS). (3 cr [4 cr with paper]; prereq Math 1111 or 10 cr in physics or #)
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. (4 cr; prereq 1122, Chem 3100 or #)
Composition of soil mineral and organic matter. Solubility models applied to mineral stability. Oxidation reduction, acidity, pH, and ion exchange.

5340. ORGANIC AND PESTICIDAL RESIDUES. (5 cr; prereq 1122, sr or #)
Fate of crop residues, animal wastes, sewage materials, petroleum hydrocarbons, detergents, and pesticides in soils with emphasis on the chemical, physical, and biological factors of the soil that influence decomposition or persistence.

5360. SOIL CLAY MINERALOGY. (4 cr; prereq sr standing or grad student; offered alt yrs)
Origin, extent, importance, and identification of soil clay minerals. Crystalline and non-crystalline. Pedologic implications.

5416. SOIL FERTILITY. (4 cr, §3416; prereq 1122; does not carry grad cr in soil science)
Fundamental concepts in soil fertility evaluation. Dynamics of mineral elements in soil, evaluation and interpretation of plant and soil relationships. Diagnostic techniques, measurement of specific soil fertility parameters. Lectures, laboratory, and discussion.

5424. APPLIED CLIMATOLOGY. (3 cr; prereq 5240 or Geo 3421 or #)
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. MORPHOLOGY, CLASSIFICATION, AND GENESIS OF SOILS. (4 cr, §3520; prereq 1122; not open to soil science and soil and water sciences majors; does not carry grad cr in soil science)
Field observation and identification of morphological characteristics of soils. Interpretation of soil profiles for water-related characteristics. 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 3520 or #)
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 1122 or #)
Formation, properties, and management of peatlands important to crop, forestry, and energy production in Minnesota and world. Lectures.

5610. SOIL BIOLOGY. (4 cr; prereq 1122, PlPa 1001 or #; knowledge of organic chemistry/biochemistry desirable)
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, discussions, and laboratory.

5710. ADVANCED FOREST SOILS. (3 cr [4 cr with paper]; prereq 1122 or FR 3220)
Factors affecting tree growth; estimation, modification, and management effects on site productivity; regeneration.

8111f,w,s. COLLOQUIA IN SOIL SCIENCE. (1-4 cr; prereq major or minor in soil science or #)
Informal colloquia on recent advances and specialized areas of soil science. Instrumentation and techniques; specialty areas in chemistry, microbiology, genesis, or physical aspects of soil; literature review.

8124.* RESEARCH PROBLEMS IN SOILS. (2-5 cr; hrs ar)
Individual fieldwork laboratory 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)
Assigned readings, reports, and discussions on soil topics.

8250. ADVANCED SOIL PHYSICS. (3 cr; prereq 5232, differential equations or #)
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. SOIL PHYSICAL CHEMISTRY. (3 cr; prereq physical chemistry, 8322 or #; offered alt yrs)
Selected topics. Charge characteristics of clays, electric double layer theory, thermodynamics of the soil solution for exchange and molecular adsorption.

8456. MINERAL ABSORPTION AND NUTRITION. (4 cr; prereq 3416, 5416, PlPh 3131, PlPh 5131, or #)
Nutrient availability in soils; uptake, transport, and function of nutrients in plants; rhizosphere effects on and genetic aspects of mineral nutrition.

8630. CURRENT TOPICS IN BIOLOGICAL NITROGEN FIXATION. (2 cr; prereq 5610 or 8632 or #; offered alt yrs)
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.

8632. SOIL MICROBIOLOGY. (3 cr; prereq gen micro course with lab, gen soils or #)
Lectures, readings, and discussions on microbiological component of soil, impact on development, use, and properties of soil.

South and Southwest Asian Studies

Professor: Joseph E. Schwartzberg (geography), *chair;* Muhammad A. Barker, *director of graduate studies;* Frederick M. Asher; Caesar E. Farah (history); Indira Y. Junghare; David Kopf (history); Robert B. Tapp (humanities)

Associate Professor: Iraj Bashiri; William W. Malandra; Rocky V. Miranda (linguistics); Martin W. Sampson (political science)

Assistant Professor: Paul W. Staneslow

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, Persian, Sanskrit, and Urdu. Programs focus on languages, literatures, cultural traditions, and contemporary problems of the Middle East (including Southwest Asia, Soviet Central Asia, and North Africa) and 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 ex-

pected 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—Contact the director of graduate studies, Department of South and Southwest Asian Studies, 192 Klaeber Court, University of Minnesota, 320 16th Avenue S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Hindi (Hndi)

5131-5132-5133. INTERMEDIATE HINDI. (5 cr per qtr, §3031-3032-3033; 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.

5701-5702. STRUCTURE OF HINDI. (4 cr per qtr; 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; prereq # for nonmajors) Junghare, Staneslow
Specialized topic in either the linguistic structure of Hindi or Hindi literature. Topic varies with student and faculty interest.

5970. DIRECTED READINGS. (Cr ar; prereq #)

5990. RESEARCH. (Cr ar; prereq #)
Guided reading of specialized material.

8990. RESEARCH. (Cr ar; prereq #)

Marathi (Mar)

5970. DIRECTED READINGS. (Cr ar; prereq #)

8990. RESEARCH. (Cr ar; prereq #)

Middle Eastern Studies (MidE)

5505 (formerly MESA 5505). SURVEY: THE MIDDLE EAST. (4 cr, §3505, §Hist 3505) Farah
Cultural, religious, and scholarly achievements of Middle Eastern peoples from pre-Islamic times to present.

5508 (formerly MESA 5508). ISLAM: IRAN TO INDIA. (4 cr, §3508) Barker
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.

5521 (formerly MESA 5521). THE MIDDLE EAST IN WORLD AFFAIRS: OTTOMAN-PERSIAN SPHERE, 1300-1789. (4 cr) Farah
Rise and efflorescence of Il-Khanid, Timurid, and Safawid civilizations in Persia and of Ottoman in West Asia: historical, institutional, cultural, socioeconomic development; contacts with West.

5523 (formerly MESA 5523). THE MIDDLE EAST IN WORLD AFFAIRS: THE 19TH CENTURY. (4 cr) Farah
Structure of society; cultural and political impact of the West; revivalist and nationalist trends; reformist and separatist movements.

5525 (formerly MESA 5525). THE MIDDLE EAST IN WORLD AFFAIRS: THE ARAB WORLD, TURKEY AND IRAN, 1915 TO THE PRESENT. (4 cr) Farah
Struggle for independence; rise of Turkey and Iran; problems of social, cultural, economic, and political development; modernizing trends; role in international affairs.

5546 (formerly MESA 5546). THEOLOGICAL AND MYSTICAL DOCTRINES OF ISLAM. (4 cr) Farah
Classical works of scholastics and mystics; jurists and philosophers; landmarks of Islamic religious beliefs and institutions. Content analysis, commencing with Qur'an and the traditions.

5601 (formerly MESA 5601). PERSIAN FICTION IN TRANSLATION. (4 cr, §3601) Bashiri
Major Persian works: *The Blind Owl* by Hedayat, *The Patient Stone* by Chubak, and *The Wedding* by Se'edi.

5602 (formerly MESA 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 Forugh Farrokhzad.

5940. TOPICS PROSEMINAR. (1-4 cr; prereq #)
Selected topics on language, literature, or civilization.

5960. TOPICS IN MIDDLE EASTERN STUDIES. (4 cr)
Topics specified in *Class Schedule*.

5970. DIRECTED STUDIES. (Cr ar; prereq #)
Guided individual reading or study.

5990. DIRECTED RESEARCH. (Cr ar; prereq #)

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]; prereq 3013 or #) Bashiri, Malandra
Reading and discussion of selected pre-medieval and medieval Iranian texts.

5970. DIRECTED READINGS. (Cr ar; prereq 3013 or #) Bashiri
Special problems for advanced students; readings and periodic consultations.

5990. DIRECTED RESEARCH. (4 cr per qtr [max 12]; prereq 3013 or #) Bashiri
Application of modern analytical techniques to the study of medieval and modern Persian texts.

Sanskrit (Skt)

5131-5132-5133. BEGINNING SANSKRIT. (5 cr per qtr) Malandra

5161-5162-5163. ADVANCED SANSKRIT. (4 cr per qtr; prereq 5133) 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) Malandra
Readings in representative texts.

5710. TOPICS IN SANSKRIT LANGUAGE AND LITERATURE. (5 cr) Malandra
Specialized topics in the linguistic structure of Sanskrit or Sanskrit literature. Topic varies from quarter to quarter.

5970. DIRECTED READINGS. (Cr ar; prereq #)

5990. DIRECTED RESEARCH. (Cr ar; prereq #)

8990. RESEARCH. (Cr ar; prereq #)

South Asian Studies (SoAS)

5011 (formerly MESA 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.

5090 (formerly MESA 5090). INSTRUCTION IN SOUTH ASIAN LANGUAGES. (Cr ar; offered when feasible) Staff

5201 (formerly MESA 5201). ANCIENT INDIAN LITERATURE IN TRANSLATION. (4 cr) Malandra
Literary achievement of Indian civilization from ancient period. All readings are in English.

5202 (formerly MESA 5202). MODERN INDIAN LITERATURE IN TRANSLATION. (4 cr) Junghare
Literary achievement of Indian civilization from modern period. All readings are in English.

5203 (formerly MESA 5203). COMPARATIVE INDIAN LITERATURE IN TRANSLATION. (4 cr) Junghare
Comparative Indian literature of modern period. All readings are in English.

5411 (formerly MESA 5411). INTRODUCTION TO INDIAN PHILOSOPHY. (4 cr, §3411) Junghare
Major concepts; principal schools of Indian Philosophy; traditional and contemporary views.

5520 (formerly MESA 5520). STUDIES IN THE RELIGIONS OF INDIA. (Cr ar) Junghare, Malandra
Topics in India's religious history.

5710 (formerly MESA 5710). SEMINAR IN SOUTH ASIAN LANGUAGES AND LITERATURES. (Cr ar; prereq #) Staff

5833. INDIA'S GODS AND GODDESSES. (4 cr, §Hum 5833; prereq 1504 or Hum 1211 or RelS 1031 or equiv, jr or sr, or #) Tapp
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.

5970 (formerly MESA 5970). DIRECTED STUDIES. (Cr ar; prereq #)
Guided individual reading or study.

5990 (formerly MESA 5990). DIRECTED RESEARCH. (Cr ar; prereq #)

8710 (formerly MESA 8710). SEMINAR: SOUTH ASIAN LANGUAGES AND LITERATURE. (Cr ar; prereq #)

8720 (formerly MESA 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 (formerly MESA 8730). TEACHING SOUTH ASIAN LANGUAGES AND LITERATURE. (4 cr; prereq #) Barker, Staneslow
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 (formerly MESA 8990). RESEARCH. (Cr ar; prereq #)

Urdu

5131-5132-5133. INTERMEDIATE URDU. (5 cr per qtr, §3031-3032-3033; prereq 1103 or Hndi 1103, 5103 or #) Barker

5161-5162-5163. ADVANCED URDU. (4 cr per qtr; prereq 3033, 5133 or #) Barker

5970. DIRECTED READINGS. (Cr ar; prereq #) Barker
Guided individual reading or study.

5990. RESEARCH. (Cr ar; prereq #) Barker

8110. 19TH- AND 20TH-CENTURY URDU LITERATURE. (Cr ar; prereq 5163 or #) Barker
Selected Urdu texts dealing with political, social, and religious developments in the Indo-Pakistani subcontinent from the upheavals and struggle in 1857 to the end of colonial rule in 1947.

8990. RESEARCH. (Cr ar; prereq #) Barker

Spanish

See Hispanic and Luso-Brazilian Literatures and Linguistics.

Speech-Communication (Spch)

Professor: Robert L. Scott, *chair;* Richard E. Sykes, *director of graduate studies*; Ernest Bormann; Donald R. Browne; Karlyn Kohrs Campbell; Sheldon Goldstein; Dean E. Hewes; William S. Howell (emeritus); J. Vernon Jensen; Josef A. Mestenhauser; Harold A. Miller; Gene L. Piché; George L. Shapiro; Robert P. Sonkowsky

Associate Professor: Rosita Albert; Judith Martin; Marshall Scott Poole; David L. Rarick

Assistant Professor: Judine Mayerle

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 radio-television broadcasting (including history, 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 and a written statement of academic and occupational objectives. Letters of recommendation are optional. 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 30 credits in speech-communication completed at Minnesota, including 15 credits in department seminars, are required. Students must acquire research competence by completing three of the following courses: 8201, 8202, 8203, 8204; and at least 8 additional credits in statistics or in another approved methodology, 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—Contact the director of graduate studies, Department of Speech-Communication, 317 Folwell Hall, University of Minnesota, 9 Pleasant Street S.E., Minneapolis, MN 55455. A brochure detailing admission procedures and M.A. and Ph.D. programs is available.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

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.

5204. WRITING RADIO AND TELEVISION DRAMA. (4 cr; prereq 3201, #) Browne, Goldstein, Mayerle
Physical, psychological, and sociological aspects of radio and television and their influence on the writer. Scriptwriting in various forms from dramatic commercials to dramas and documentaries.

5211. CONTEMPORARY PROBLEMS IN AMERICAN BROADCASTING. (4 cr; prereq 3211 and sr status) Browne, Mayerle, 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 #) Mayerle
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 U.S.

5220. STUDIES IN TELEVISION GENRE. (4 cr [8 max]; prereq 3211 or #) Mayerle
In-depth study of specific television genres: drama, news and documentary, television comedy, variety show, and western; first appearance on television, artistic development, commercial success, growth as program type, key persons.

5222. EDUCATIONAL TELEVISION PROGRAMMING AND ADMINISTRATION. (4 cr; prereq 3211 or #) Goldstein
Television applied to educational needs; current practices; significant research findings; relative effectiveness of differing types of television utilization; 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, Soviet, 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, U.S.S.R., 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 #; offered when feasible)
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) 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 #) 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, 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 #) Piché
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) Sykes
Nonverbal (extralinguistic) elements and dimensions of interpersonal communication. Nonverbal categories examined include gesture, facial expression, posture, clothing, and environment.

5411. SMALL GROUP COMMUNICATION THEORY. (4 cr; prereq 3411 or #) Bormann, Hewes
Theories of communication within small, task-oriented group. Group cohesiveness, leadership, role structure, information processing, decision making.

5412. GROUP AND ORGANIZATIONAL COMMUNICATION. (4 cr; S-N regis only; prereq 5411) Bormann
Theory and practice of intra- and inter-group communication. Communication of the small task-oriented group in the organizational context. Applied small group and organizational communication.

5414. AUTHORITY AND POWER IN TASK-ORIENTED COMMUNICATION. (4 cr; S-N regis only; prereq 3411 or #) Shapiro
Authority and power in task-oriented groups. Tavistock-type small group, intergroup and large group laboratory 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 #) 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 in social science or #) Miller, 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, Psy 1001)
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 science, 3441 or #) Hewes, Poole, Shapiro
Communication in organizational settings. Organizational structure and dynamics and their effect upon communication process. Individual projects.

5442. THE ANALYSIS OF ORGANIZATIONAL COMMUNICATION. (4 cr; prereq Spch 5441) Hewes, Poole
Methodological approaches to analyzing organizational communication. Application and theoretical foundations of survey (communication audits and communication flow), interpretive, and message analysis techniques.

5451. PROCESSES OF INTERCULTURAL COMMUNICATION. (4 cr; prereq 3401, Anth 1102 or other course in cultural anthropology or #) Albert
Factors important to successful interpersonal communication across cultures. Adapting communication theory to intercultural context. Linguistic and nonverbal variables, analytic and holistic procedures. Emphasis on North Americans abroad, communication with host nationals.

5452. WORKSHOP IN INTERCULTURAL COMMUNICATION. (4 cr; prereq #; 5451 recommended, S/N only) Albert
Small group training for foreign and U.S. students in the process of communicating across cultures using group discussions, role playing, simulations, lectures, as methods.

5602. CONTEMPORARY POLITICAL PERSUASION. (4 cr; prereq 1101 or 1101H, 5431 or #) Campbell
Ideologies in political persuasion.

5607. RHETORIC IN ASIA. (4 cr; prereq 3601 or #) Jensen
Survey of ancient roots of rhetoric in Buddhist, Confucian, and other religious/cultural contexts; public speaking in East Asia since World War II; cross-cultural studies dealing with East Asian contexts.

5611. CLASSICAL RHETORIC. (4 cr; prereq 1101 or 1101H; offered when feasible) Scott
Greek and Roman theories of speechmaking; historical and philosophic context; influence on education.

5613. EXPLORATIONS INTO ARGUMENTATION. (4 cr; prereq 1101 or 1313 or #) Jensen
Argumentation in variety of contexts (law, science, management, religion, diplomacy, political campaigning, arts, informal conversation, and folk literature); issues in collegiate debate and contributions in argumentation theory.

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.

5616. PUBLIC ADDRESS IN BRITAIN AND THE COMMONWEALTH. (4 cr; prereq 1101 or 1101H or #) Jensen
History and criticism of British oratory from 1750 to present.

5617. HISTORY AND CRITICISM OF AMERICAN PUBLIC ADDRESS. (4 cr; prereq 1101 or 1101H, Psy 1001) Bormann
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) Bormann
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 U.S., 1835-1925.

5622. CONTEMPORARY FEMINIST RHETORIC. (4 cr; prereq 5615 or #) Campbell
History and criticism of rhetoric of contemporary feminist movement in U.S., 1945-present.

5625. ISSUES IN COMMUNICATION ETHICS. (4 cr; prereq 3625 or #) Jensen
Issues in ethical dimension in interpersonal, small group, public, and mass communication, clustered around communicator, receiver, message, medium, situation, and effects.

5970. READINGS IN SPEECH. (Cr ar; prereq 9 upper division speech cr, #, △)
Directed reading and preparation of reports on selected subjects.

8110-8120-8130. SEMINAR: ADVANCED SPEECH PROBLEMS. (3 cr per qtr; prereq undergrad major in speech or equiv, #)
Evaluation of research methods in speech and communication.

8201. INTRODUCTION TO SURVEY RESEARCH IN SPEECH-COMMUNICATION. (3 cr; prereq Jour 8001 or #) Browne, 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.

8202. QUANTITATIVE RESEARCH IN SPEECH-COMMUNICATION. (3 cr; prereq 8101 or Jour 8001 or #; Spch 8201 recommended) Browne, 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.

8203. HISTORICAL AND DESCRIPTIVE RESEARCH IN SPEECH-COMMUNICATION. (3 cr) Browne, Jensen, Rarick
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.

8204. SEMINAR IN RHETORICAL CRITICISM. (3 cr) Bormann, Campbell, Jensen, Scott
Theories of rhetorical criticism; methods of criticizing rhetorical discourse. Rhetoric as applied to literary studies and the growth of hermaneutics as vantage points for reassessing rhetorical methods.

8210. SEMINAR: SELECTED TOPICS IN AMERICAN BROADCASTING. (3 cr [may be repeated for cr]; prereq 5211 or #; offered when feasible) Browne, Rarick
Readings and research in current problems and issues of American radio and television broadcasting. Focuses each year on one of following topics: regulation, economics, programming, social effects, public broadcasting, and cable/new technology.

8231. SEMINAR: NATIONAL AND INTERNATIONAL SYSTEMS OF BROADCASTING. (3 cr; prereq 5231 or 5232 or #) Browne
Historical and contemporary aspects of national and international broadcasting systems. Roles of national and international broadcasting systems. Roles of national and international regulatory bodies. Approaches to broadcast programming and evidence of programming effectiveness.

8261. SEMINAR: COMMUNICATION AND DECISION MAKING IN BROADCASTING ORGANIZATIONS. (3 cr; prereq 5261, 5412 or 5441 or #; offered when feasible)
Theory and research in broadcast organizations. Emphasis on role of communicative behavior in organizational decision making and its influence on broadcast programming content.

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) 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) Bormann
Research problems and methods.

8421. SEMINAR: COMMUNICATION AND NEGOTIATION. (3 cr; prereq 5411, 5441, 5403 or #; offered when feasible)
Influence of communication patterns on bargaining outcomes. Formal negotiation as a model for situations of partial conflict.

8431. SEMINAR IN PERSUASION. (3 cr; prereq 5431)
Literature of persuasion, methods in study of persuasion.

8441. SEMINAR: ORGANIZATIONAL COMMUNICATION. (3 cr; prereq 5441 or #; offered alt yrs) Shapiro
Direct 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.

8455. CURRENT RESEARCH IN INTERCULTURAL COMMUNICATION. (3 cr; prereq 5451 or #) Martin
Survey of theoretical and methodological issues.

8603. SEMINAR: ARGUMENTATION. (3 cr; prereq 3615, 5613 or #) Jensen
Research in argumentation theory and practice.

8606. SEMINAR: RHETORICAL ANALYSIS OF CAMPAIGNS AND MOVEMENTS. (3 cr; prereq 5431, 5617 or 5618, 10 cr in social science or #) Bormann, 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 △) Bormann, Campbell, Scott
Methods of rhetorical criticism. Application of method in individually selected research projects.

8631. SEMINAR: PUBLIC ADDRESS IN BRITAIN AND THE COMMONWEALTH. (3 cr; prereq 5616 or #) Jensen
Individual research projects in the theory, practice, or criticism of British public address.

8990. RESEARCH. (Cr ar, prereq #, △)
Open to graduate students engaged in research on special problems.

Statistics (Stat)

Professor: Seymour Geisser, *director, School of Statistics;* Donald A. Berry, *chair, Department of Theoretical Statistics;* R. Dennis Cook, *chair, Department of Applied Statistics;* David A. Lane, *director of graduate studies;* Christopher Bingham; Robert J. Buehler; James M. Dickey; Morris L. Eaton; Douglas M. Hawkins; Kinley Larntz; Bernard W. Lindgren; Thomas A Louis (biometry); Christopher Sims (economics); William D. Sudderth; Sanford Weisberg

Associate Professor: Kathryn M. Chaloner; Frank B. Martin; Christopher J. Nachtsheim (management sciences); Gary Oehlert; Ronald R. Regal[1]; Philip J. Smith (biometry); Luke Tierney

Assistant Professor: Sharon L. Lohr; Ronald C. Pruitt

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 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, some 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.

Master's Degree Requirements—For Plan B, which is ordinarily taken, the following courses in statistics are required: 5022, 5131-5132-5133, 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

[1]*University of Minnesota, Duluth*

the material in 8151-8152-8153, 8311-8312, 8161-8162-8163, and Math 8656-8657-8658. In addition, students must complete a minimum of 21 credits in advanced statistics courses, distributed in at least three areas, as well as 3 credits in 8801 and two credits in 8900, the latter involving preparation and delivery of two seminar talks (including one on 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 5131-5132-5133) and familiarity with various statistical methods (e.g., 5022, 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—Contact the director of graduate studies, School of Statistics, 352 Classroom Office Building, University of Minnesota, 1994 Buford Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5021. STATISTICAL ANALYSIS I. (5 cr, §3012; prereq college algebra)
Intensive version of 3011-3012, designed for graduate students needing statistics as research technique.

5101. INTRODUCTION TO DECISION THEORY. (4 cr; prereq Econ 5111 or Math 1142 or Math 1211 or #; offered when feasible)
Elements of probability; basic concepts in statistical decision theory; relationship to game theory and other types of decision problems; prediction and inference.

5121-5122. THEORY OF STATISTICS. (4 cr per qtr, §5131-5132-5133; prereq Math 1231 or 1331 or 1621)
Univariate and multivariate distributions, law of large numbers, sampling, likelihood methods, estimation and hypothesis testing, regression and analysis of variance and covariance, confidence intervals, distribution-free methods.

5131-5132-5133. THEORY OF STATISTICS. (4 cr per qtr, §5121-5122; prereq Math 3211 or 3611 or #)
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.

5161-5162-5163. APPLIED STATISTICAL METHODS. (4 cr per qtr; prereq ¶5022 or 5131, admission to graduate study in statistics or #)
5161: Sampling methodology; estimation from sample surveys; simple and multiple regression; use of statistical packages. 5162: Advanced topics in linear regression; nonlinear models; generalized linear models; categorical data analysis; logistic regression. 5163: Variance reduction designs for experiments; factorial, fractional, and confounded designs; optimal designs; analysis of covariance; unbalanced data analysis.

5201. SAMPLING METHODOLOGY IN FINITE POPULATIONS. (4 cr , §5161-5162-5163; prereq 3091 or 5021 or 5121 or #)
Simple random, systematic, stratified, and unequal probability sampling. Ratio and regression estimation. Multistage and cluster sampling.

5211. THEORY OF SAMPLE SURVEYS. (4 cr; prereq 5122 or 5133; offered when feasible)
Mathematical treatment of survey sampling, including stratified and multistage sampling, models for nonsampling errors.

5271-5272. BAYESIAN DECISION MAKING. (4 cr per qtr, §Econ 5271, 5272; prereq ¶5122 or ¶5132 for 5271...Econ 1002, Stat 5122 or 5132 for 5272...5271 recommended for 5272)
5271: Axioms for personal probability and utility. Elements of statistical decision theory. Bayesian analysis of linear models. 5272: Expected utility models of economic decisions under uncertainty. Applications to portfolio selection, forward and futures trading, betting, contingency markets, business planning.

5301. DESIGNING EXPERIMENTS. (5 cr, §5163; prereq 3012 or 5021 or 5133 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)
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 5301 or 5302 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 #)
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, 5913. 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 #, advanced calculus and 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.

8161, 8162, 8163. APPLIED STATISTICAL METHODS. (4 cr per qtr; prereq 8312 or #)
Experimental designs and analyses. Description and analysis of survey sampling procedures. Simulation and computer techniques. Data analysis of variance, categorical data; jackknife, gaps, outliers, robust estimation; multivariate analysis of variance; factor analysis; clustering; transformations, residuals. Data analysis. Statistical consultation.

8171-8172-8173. 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.

8191-8192. LARGE-SAMPLE THEORY. (3 cr per qtr; 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.

8311-8312. LINEAR MODELS AND EXPERIMENTAL DESIGN. (3 cr per qtr; prereq 5122 or 5133, matrix theory)
Theory and applications of the general linear model, regression, analysis of variance, randomization and design of experiments.

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 8163 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.

8501-8502. INTRODUCTION TO STOCHASTIC PROCESSES WITH APPLICATIONS. (3 cr per qtr; prereq 5131 or #)
Markov chains, Markov processes, Poisson process, Brownian motion, and other stochastic models encountered in applications.

8511-8512. TIME SERIES ANALYSIS. (3 cr per qtr; prereq linear algebra, 5133 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.

8611-8612. NONPARAMETRIC INFERENCE. (3 cr per qtr; 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.

8731-8732. STATISTICAL DECISION THEORY. (3 cr per qtr; 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.

8751-8752. SEQUENTIAL ANALYSIS. (3 cr per qtr; 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 #)
Topics in data analysis and/or consulting with members of University research community through Statistical Center.

8900. STUDENT SEMINAR. (1-3 cr; prereq #)
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])
Topics vary according to student needs and available staff.

Math 5681-5682-5683. INTRODUCTION TO PROBABILITY

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.

Econ 8111-8112-8113. INTRODUCTION TO MATHEMATICAL ECONOMICS

Econ 8114-8115-8116. DECISION MAKING AND OPERATIONS ANALYSIS

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

IEOR 5531. INDUSTRIAL SAMPLING TECHNIQUES

IEOR 5550. DESIGN AND ANALYSIS OF EXPERIMENTS I

IEOR 5551. DESIGN AND ANALYSIS OF EXPERIMENTS II

PubH 5450. BIOMETRY I

PubH 5452. BIOMETRY II

PubH 5454. BIOMETRY III

PubH 5462. CLINICAL TRIALS I

PubH 8400. SEMINAR IN BIOMETRY

DSci 8530. STATISTICAL METHODS AND APPLICATIONS I: REGRESSION ANALYSIS

DSci 8632. STATISTICAL METHODS AND APPLICATIONS III: ANALYSIS OF VARIANCE AND EXPERIMENTAL DESIGN

DSci 8641. MATHEMATICAL PROGRAMMING METHODS AND APPLICATIONS I: LINEAR PROGRAMMING

Studio Arts (ArtS)

Professor: Karl Bethke (printmaking); Curtis C. Hoard (ceramics and glass); Warren MacKenzie (ceramics and glass); Thomas A. Rose (sculpture); Herman Rowan (drawing and painting)

Associate Professor: Wayne E. Potratz (sculpture), *chair;* Guy A. Baldwin (sculpture) *director of graduate studies*; 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); Diane Katsiaficas (drawing and painting); Jerald Krepps (printmaking and papermaking); Thomas J. Lane (ceramics and glass); Susan M. Lucey (sculpture); William N. Roode (drawing and painting)

Assistant Professor: Joyce Lyon (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. 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 and glass (blowing, cold working); drawing and painting; photography; printmaking (intaglio, lithography, silkscreen, relief); papermaking; and sculpture (metal casting, metal construction, kinetics and electronics, and wood and stone).

Prerequisites for Admission—A bachelor of fine arts or its equivalent, or an undergraduate major in studio arts, is required.

Special Application Requirements—Applicants must submit from 10 to 20 color slides of work completed in their chosen medium to the director of graduate studies in studio arts. Printmaking applicants must submit a minimum of 4 matted original prints in addition to slides. Photography applicants are required to submit a minimum of 8 finished prints.

All applications and portfolios are reviewed during a limited screening period each winter quarter. Completed Graduate School applications (including transcripts) should be received by the Graduate School by January 15. Slides and other materials should be received by the director of graduate studies not later than January 15. Students may apply for admission for either term of the summer session or for fall quarter. Students submitting applications or portfolios after the specified deadlines will be considered only if program space is available.

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. Minor requirements may be satisfied by completing either (a) 15 credits in art history or (b) 9 credits in art history plus 6 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.

For Further Information—Contact the director of graduate studies, Department of Studio Arts, 208 Art Building, University of Minnesota, 216 21st Avenue South, Minneapolis, MN 55455.

Drawing and Painting

Some studio space is provided by the department. Students choose professors and make arrangements for personal consultation and for participation in regularly scheduled courses for group interaction. Students may work in any drawing and painting medium consistent with their aims.

5110. DRAWING. (4 cr per qtr [max 16 cr]; prereq 12 cr 3110 or #) Caglioti, Cowette, Feinberg, Gray, Katsiaficas, Lyon, Roode, Rowan
Drawing in all mediums from life.

5120. PAINTING. (4 cr per qtr [max 16 cr]; prereq 12 cr 3120 or #) Caglioti, Cowette, Feinberg, Katsiaficas, Lyon, Roode, Rowan
Various media. Individual problems.

5160. WATERCOLOR. (4 cr per qtr [max 16 cr]; prereq 12 cr 3160 or #) Caglioti, Rowan
Advanced watercolor techniques, aesthetic directions. Individual concepts and development of sensibilities.

8110. DRAWING. (4 cr per qtr [max 12 cr]; prereq #) Caglioti, Cowette, Feinberg, Gray, Katsiaficas, Lyon, Roode, Rowan

8120. PAINTING. (4 cr per qtr [max 24 cr]; prereq #) Caglioti, Cowette, Feinberg, Katsiaficas, Lyon, Roode, Rowan

Sculpture

Students may work in individual studio spaces as well as open workshops. The sculpture area is equipped with complete gas and electric welding equipment, foundry, and a fully equipped machine shop and tool crib.

5310. SCULPTURE: DIRECT METAL. (4 cr per qtr [max 16 cr]; prereq 3301) Baldwin
Welding and brazing.

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], §3307; prereq 1401, 1302, 1301) 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]; prereq #) Baldwin

8320. SCULPTURE: SPATIAL PROJECTS AND PROBLEMS. (4 cr per qtr [max 12 cr]; prereq #) Rose

8330. SCULPTURE: CAST METAL. (4 cr per qtr [max 12 cr]; prereq #) Potratz

8340. SCULPTURE: WOOD AND STONE. (4 cr per qtr [max 12 cr]; prereq #) Lucey

8350. SCULPTURE: KINETICS. (4 cr per qtr [max 12 cr]; prereq #) Baldwin

Printmaking

Instruction in and facilities for all planographic relief, screen, and intaglio processes are offered. Offset and photomechanical work in all media can be pursued on an individual basis by arrangement.

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 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, Krepps
Screen processes and combined techniques.

5550. PRINTMAKING: EXPANDED APPROACHES. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3430 or 35xx or #) Krepps
Contemporary approach to printmaking that investigates variations of and departures from basic print processes, using handmade paper.

8510. PRINTMAKING. (4 cr per qtr [max 36 cr]; prereq #) Bethke, Krepps

8511. PHOTOMECHANICAL PRINTMAKING. (4 cr; prereq MFA candidate, print concentration or #; offered when feasible)
Application of photomechanical techniques to creative imagemaking in intaglio, litho, relief, and screen printing. All processes from the negative to print.

8512. PROBLEMS IN PHOTOMECHANICAL PRINTMAKING. (4 cr; prereq 8511 or #; offered when feasible)
Directed technical research in media of choice. In-depth visual work in at least one major medium covered in 8511. Creative application of photomechanical graphic qualities.

Photography

This area offers courses in the practice and theory of photographic image making. Innovative perspectives, critical ability, and articulate image work as well as familiarity with contemporary thought and historical perspective are encouraged. Work may be elected in a variety of photographic processes, as appropriate to the student's professional interests.

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]; prereq #) Hallman, Henkel

Ceramics and Glass

Studio space and complete facilities for stoneware, salt glaze, low-fire, and raku work are provided. Facilities for all types of offhand blowing of glass, and cutting, grinding, and polishing are available.

5810. CERAMICS. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3810 or #) Hoard, Pharis
Aesthetic awareness and development; techniques and materials.

5820. GLASSWORKING. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3820) Lane
Techniques in forming glass from its molten state. Creative expression with technical understanding.

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]; prereq #) Hoard, Pharis

8820. GLASSWORKING. (4 cr per qtr [max 24 cr]; prereq #) Lane

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 #, △)

5190. DRAWING AND PAINTING

5390. SCULPTURE

5590. PRINTMAKING

5790. PHOTOGRAPHY

5890. CERAMICS AND GLASS

General Courses

5360. PERFORMANCE ART. (4 cr; prereq 1401 or #) Lucey
Development of individual performance artworks and research on pioneers of this art form.

5430. PAPER: PULP TE PLASTIC EXPRESSION. (4 cr per qtr [max 16 cr]; prereq 12 cr of 3430 or #) Krepps
Creative and traditional approaches to papermaking.

5620. ADVANCED COMPUTER GRAPHICS AND ANIMATION. (3 cr; prereq 3602)
Using Amiga and other microcomputers, refinement of techniques, with emphasis on producing final project with superior graphics and animation.

5640. INTERDISCIPLINARY ELECTRONIC PROJECTS. (3 cr; prereq 3604)
Alternative approaches to creation of works using any combination of electronic arts (video, computers, audio, projected light) and possibly in conjunction with other art forms (theatre, dance, painting, sculpture). Conceptual concerns and experimentation with ways of creating and manipulating images and sounds. Several group or individual projects.

5970. DIRECTED STUDIES. (1-5 cr [max 12 cr]; prereq 24 cr in studio arts and #, △, CLA approval)

Seminars

All courses except 8100, 8300, 8400, and 8700: (2 cr; prereq ArtS major or #)

5100. PAINTING/DRAWING

5300. SCULPTURE

5500. PRINTMAKING

5700. PHOTOGRAPHY

5800. CERAMICS

8100. 20TH-CENTURY ART THEORIES IN PAINTING (2 cr; prereq #; required of painting majors)

8300. 20TH-CENTURY ART THEORIES IN SCULPTURE. (1 cr per qtr [6 cr required of sculpture majors]; prereq #)

8400. CONCEPTS IN CONTEMPORARY ART (required) (4 cr; prereq ArtS grad student or #)

8500. 20TH-CENTURY ART THEORIES IN PRINTMAKING

8700. 20TH-CENTURY THEORIES IN PHOTOGRAPHY. (2 cr; prereq grad or #)

8800. 20TH-CENTURY ART THEORIES IN CERAMICS AND GLASS

Surgery (Surg)

Professor: John S. Najarian, *chair*; Robert L. Goodale, *director of graduate studies;* Henry Buchwald; Frank B. Cerra; John P. Delaney; John Foker; Theodor B. Grage; Edward W. Humphrey; Stuart W. Jamieson; Michael P. Kaye; Arnold S. Leonard; Donald G. McQuarrie; John F. Perry; David E. R. Sutherland

Clinical Professor: Ronald H. Dietzman; Fletcher Miller; Earl G. Young

Associate Professor: Bruce L. Cunningham; David Fryd; J. Ernesto Molina

Assistant Professor: Melody O. Allen; David L. Dunn; John R. Mahoney, Jr.; Albert Mowlem; Robert D. Nelson

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 laboratory 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 master of science 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 master of science 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 master of science 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 laboratory credit may be interchangeable with surgical laboratory 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—Contact the director of graduate studies, Department of Surgery, Box 379 UMHC, University of Minnesota, Harvard Street at East River Road, Minneapolis, MN 55455 (mailing address).

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5524. BIOMEDICAL ETHICS. (4.5 or 9 cr; prereq # before regis)
Identification of health care ethics problem for study from clinical or public policy perspective. Time is spent in relevant institution or government setting, in twice-weekly seminars to discuss project, and in producing substantive papers.

5525. COLLOQUIUM IN BIOMETRY FOR SURGEONS. (2 cr; prereq regis med or grad)
Basic principles in experimental design and analysis. Application and interpretation of statistical procedures, including mean, standard deviation, standard error, t, chi square, life tables, p-values, power. Use of computers in medicine.

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, Simmons
Current clinical and research problems are presented for interdepartmental discussion and evaluation.

Technical Communication

Professor: Thomas E. Pearsall, *head;* Victoria M. Mikelonis, *director of graduate studies;* James E. Connolly; Earl E. McDowell; David Schuelke

Associate Professor: J. Michael Bennett; Richard W. Ferguson; Laurie S. Hayes; Arthur E. Walzer

Assistant Professor: Ann H. Duin

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—Two emphases are available in the master's program: theory and research in technical communication, and theory and practice in technical communication.

Prerequisites for Admission—All applicants are expected 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: writing/editing, oral communication, visual communication, organizational communication, communication theory; and 8 credits in computer science or management information systems, or demonstrated equivalent experience.

Special Application Requirements—Three letters of recommendation, scores from the General Test of the Graduate Record Examination, a writing sample, and a professional objective statement. Nonnative speakers of English will be required to take the Test of English as a Foreign Language (TOEFL) and have satisfactory scores. The letters of recommendation and writing sample may be used to support an application for financial aid. Admission to the M.S. program is granted only for fall quarter; materials should be submitted by July 15. 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 45 credits (normally 10 courses). For the master's degree with an emphasis on theory and research (Plan A), coursework must include Rhet 8510, 8110, 8210, 5180, 5500; 8 credits in a related field; 16 thesis credits; and additional Rhet credits totaling a minimum of 45 credits. For the master's degree with an emphasis on theory and practice (Plan B), coursework must include Rhet 8510, 8210, 8110, 5180; 8 credits in a related field; Rhet 8180; and additional Rhet credits totaling 44 credits.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Department of Rhetoric, 325 Haecker Hall, University of Minnesota, 1364 Eckles Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Rhetoric (Rhet)

5100. TECHNICAL COMMUNICATION: SPECIAL PROBLEMS. (Cr ar; prereq #, △) Staff
Supervised reading, research, and work on advanced technical communication projects not covered in regularly scheduled courses.

5160. COLLEGE READING. (4 cr) Bennett
Factors that make for successful college reading performance; application of psycholinguistic and cognitive theories of reading; opportunities for developing expertise in reading comprehension and retention, rapid reading, vocabulary power, and communication skills; completion of seminal reading theory textbook, seminar meetings, and paper are required.

5165. STUDIES IN ORGANIZATIONAL COMMUNICATION, CONFLICT, AND CHANGE. (4 cr; prereq freshman communication or equiv) 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 freshman communication or equiv) Hayes
Analysis of 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 TECHNICAL COMMUNICATION. (2-6 cr; prereq #, △) Staff
On-the-job experience at the University or in industry or government in technical communication.

5257. SCIENTIFIC AND TECHNICAL PRESENTATIONS. (4 cr; prereq 1222, 3562, or #) Connolly
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
Improvement of 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. DISSEMINATION AND UTILIZATION OF INFORMATION. (4 cr; prereq jr, sr or grad standing) Schuelke
Methods and processes of using specialized information. Study of cases and development of materials for application in professional fields. Emphasis on channels for dissemination and utilization.

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. TECHNICAL WRITING COURSE DEVELOPMENT. (2 cr; prereq 3562, sr status) Pearsall
Planning and development of technical writing course. Course objectives, syllabus, and bibiliography of readings on teaching of technical writing. Textbook selection discussed.

5541. READINGS IN SCIENTIFIC AND TECHNICAL PROSE. (2 cr; prereq sr status, △; S-N only) Ferguson, Hayes, Mikelonis, Pearsall, Walzer
Tutorial on books, essays, and reports that exemplify effective scientific and technical communication and that represent scientific and technical discourse as well as philosophical or historical discussions about science and technology.

5551. REPORT AND THESIS WRITING. (3 cr; prereq 3562 or #) Mikelonis, Pearsall
For graduate students and seniors working on reports or theses. Organization of reports and theses; library investigation; presentation of data; methods of documentation. Revision of manuscripts and improvement in writing style.

5561. ADVANCED EDITING SEMINAR: ELECTRONIC PUBLISHING. (2 cr; prereq 1500, 3562, 3572; A-F only) Mikelonis
Copy preparation for publication. Coding copy for electronic publishing, using telecommunications systems, coding and transmitting tables and charts, and editing copy and codes. Principles of composing and typesetting an article for publication and communicating with typesetters and printers electronically.

5571. WRITING FOR SPECIAL PURPOSES. (2 cr; prereq technical communication major or minor, freshman communication, 3562 or #) Ferguson, Mikelonis
Analysis of and writing practice in a specific genre of practical writing (e.g., grant proposal, procedures and policies manual, operations manual, newsletter). Content varies from quarter to quarter.

5581. DOCUMENT DESIGN. (4 cr; prereq 3562, sr status, #; A-F only) Mikelonis
Designing a document to meet user's need, completing draft, and evaluating effectiveness. Forms and software documentation (user guides, reference manuals, tutuorials, and input sheets) for data bases, decision aids, computer-aided instruction, on-line programs, or visual displays. Lab working with programmers, subject-matter specialists, and communication specialists.

5600. TRANSFER OF TECHNOLOGY. (4 cr; prereq work experience in scientific/technical communication 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.

5700. COMMUNICATION IN TECHNOLOGICAL AND ENVIRONMENTAL IMPACT ASSESSMENT. (4 cr; prereq sr or grad student, one course in statistics, #; offered when feasible) Connolly
Theories and processes involved in technological assessment and environmental impact statement preparation. Case studies of technology assessments and forecasts and environmental impact statements evaluated. Planning of process and project management in actual impact assessment constitutes term project.

8110. THEORY AND RESEARCH IN AUDIENCE ANALYSIS. (3 cr; prereq Tech Comm grad student) 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 5147 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 Tech Comm Plan B grad student) Mikelonis
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.

8210. THEORY AND RESEARCH IN MEDIA SELECTION. (3 cr; prereq Tech Comm grad student) Hayes
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.

8500. QUALITATIVE RESEARCH: STRATEGIES IN TECHNICAL COMMUNICATION. (4 cr; prereq Tech Comm grad student or #) McDowell
Qualitative methods of communication research, including qualitative observation and analysis, unobtrusive methods, focus group research, and organizational climate assessment. Students will develop, conduct, and report on systematic qualitative research project.

8510. THEORY AND PRACTICE IN DESIGNING MESSAGES. (3 cr; prereq Tech Comm grad student) Pearsall
Through case studies, how purpose and situation shape written discourse. Students will develop and carry out strategies for delivering specific information to specific audience for specific purpose.

Theatre Arts

Professor: Lee Adey; H. Wesley Balk; Wendell Josal; Robert D. Moulton; Charles Nolte

Associate Professor: Barbara Reid, *chair;* Glen W. Gadberry, *director of graduate studies;* Barbara M. Barker; C. Lance Brockman; Jean G. Congdon; Gail A. Crellin; Jean A. Montgomery; Elizabeth H. Nash

Assistant Professor: Stephen C. Kanee; James Norwood

Lecturer: M. Kent Neely

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.F.A., and Ph.D. in Theatre Arts.

Curriculum—Emphases in the M.A. and Ph.D. programs include theatre history and dramatic literature, oral interpretation, playwriting and dramatic theory, acting, directing, and design and technical production. Candidates for the M.F.A. degree specialize in acting, directing, or design and technical production. The M.F.A. degree is considered a terminal degree in these areas of theatre arts. Special facilities include the Performing Arts Archives and various language centers.

Prerequisites for Admission—For all programs, a minimum of 18 undergraduate credits or the equivalent in theatre arts is required. The master's degree is a prerequisite for admission to the Ph.D. program.

Special Application Requirements—Applicants must submit scores from the Graduate Record Examination. For the M.F.A. degree, an audition is required. Contact the director of graduate studies for further information.

Applications for all programs are screened once each year, in lateFebruary/early March. Deadline for this screening is January 15 (applications are processed after this date only if program space is available). Students are admitted for fall quarter only; they may enter the preceding summer if they notify the Graduate School by April 15.

General Degree Requirements—All graduate students are required to take Th 8101.

There are limits to the number of credits in practicum and performance courses (Th 5100, 5110, 5321, 8311, 8312, 8313, 8321-8322-8323, and 8326-8327-8328) that may be used to satisfy degree requirements. These limits are as follows: M.A., Plan A, 8 credits; M.A., Plan B, 12 credits; Ph.D., 24 credits. There is no limit for the M.F.A. degree. No more than one half of the credits that the Graduate School accepts for transfer to a master's degree may be in practicum and performance courses.

Master's Degree Requirements—For the M.A. degree, Plan A, general Graduate School requirements prevail. For the M.A. degree, Plan B, the minimum of 27 credits in the major field should be selected from the various areas. Program descriptions may be obtained from the director of graduate studies. Final written examinations are required for the M.A., Plan A, and Plan B; in addition, a final oral examination is required for Plan A.

For the M.F.A. degree, a minimum of 84 graduate credits is required. Written and oral final examinations are required for the M.F.A.

Doctoral Degree Requirements—Programs are designed by the student and adviser to develop appropriate skills in research and scholarship. The student will demonstrate special competence in theatre history and dramatic literature, in a performance area, and in an additional area agreed on by the student and adviser. 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. Of the minimum 20 credits required for the supporting program, as many as 12 credits may be completed in any of the theatre arts areas not represented in the major. The minimum for non-theatre arts courses is 8 credits in at least two different courses (preferably in a single outside field), each of which carries at least 3 credits.

Students are also expected to acquire a technique for carrying out thesis research, which requires completion of a minimum of 9 credits in relevant courses. Competence in a foreign language, statistics, historiography, or critical methods may be offered to fulfill this requirement. Candidates must pass comprehensive written and oral examinations demonstrating competence in all areas.

Language Requirements—For the master's degree, none. For the doctoral degree, one thesis-related language may be required. See Doctoral Degree Requirements above.

For Further Information—Contact the director of graduate studies, Theatre Arts Department, 208 Middlebrook Hall, University of Minnesota, 412 22nd Avenue South, Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Theatre Arts (Th)

History and Dramatic Literature

5171-5172-5173. HISTORY OF THEATRE. (4 cr per qtr)
Theatre as mirror of society. Aesthetics, philosophy, and techniques of theatre arts. 5171: Origins to 1642. 5172: Renaissance to 1875. 5173: Modern theatre in Western civilization, from Ibsen to present.

5177, 5178. SURVEY OF DRAMATIC LITERATURE. (4 cr per qtr; prereq 1504) Norwood
Selective examination of plays as part of the living theatre. Chronological, comparative study of development of theatrical elements in drama from its origins through the present. 5177: Origins through 18th century. 5178: 19th and 20th centuries.

5181. CONTEMPORARY BLACK THEATRE, 1960-PRESENT. (4 cr, §Afro 5181)
Essays, plays, playwrights, and theatres that have contributed significantly to contemporary black theatre, from beginning of Black Arts Movement to present.

5182. BLACKS IN AMERICAN THEATRE, 1820-1960s. (4 cr, §Afro 5182)
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.

5186. AMERICAN THEATRE. (4 cr; prereq sr or grad theatre major or #; offered alt yrs) Nolte
Theatre as an aspect of American culture from 1752 to present.

5191. MYTH AND THE PERFORMANCE OF MODERN DRAMA I. (4 cr; prereq 5173 or 5178 or #) Neely
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) Neely
Examination of construction, reinforcement, or destruction of myth in selected theatre performances.

8174, 8175. SEMINAR: EUROPEAN THEATRE HISTORY. (4 cr; prereq 5171, 5172, 5173 or #; offered when feasible) Gadberry, Norwood
Selected research topics in theatre of England and Europe. 8174: 16th, 17th, or 18th centuries. 8175: 19th or 20th centuries.

8176. SEMINAR: AMERICAN THEATRE HISTORY. (4 cr; prereq 5186 or #; offered when feasible) Nolte
Selected research topics from the 18th-, 19th-, or 20th-century American theatre.

8177, 8178, 8179. SEMINAR: THEATRE BACKGROUNDS. (4 cr; prereq 8101 or ¶8101; offered when feasible) Gadberry
Selected research topics on drama and selective examination of plays as part of the living theatre. Chronological, comparative study. 8177: Origins through 16th century; 8178: 17th, 18th, and mid-19th century; 8179: Late 19th, 20th century.

Oral Interpretation

5802. ORAL INTERPRETATION OF POETRY. (4 cr; prereq 3801 or grad) Congdon
Individual and group analysis, exploration, and performance of selected poems.

5805. GROUP PERFORMANCE THEORY AND PRACTICE. (4 cr; prereq 3801 or grad) Congdon
Staging of texts through readers' theatre, chamber theatre, and multimedia techniques.

5811. HISTORY OF ACTING AND INTERPRETATION. (4 cr; prereq 3321 or 3322, 3801 or grad student; offered when feasible) Norwood
Major traditions of theatre and literary performance from ancient times to the present.

5813. THEORIES OF ACTING AND INTERPRETATION. (4 cr; prereq 3321 or 3322, 3801 or grad student; offered alt yrs) Norwood
Aesthetics, literary, and psychological theories as they relate to acting and interpretation.

5823. ORAL INTERPRETATION OF SHAKESPEARE. (4 cr; prereq 1805, 3801 or grad student) Congdon
Solo and group analysis and performance of speeches and scenes from Shakespeare.

8801. SEMINAR: ORAL INTERPRETATION OF FICTION. (4 cr; prereq 5811 or #; offered when feasible)
Speech in relation to language and types of literature.

8802. SEMINAR: ORAL INTERPRETATION OF POETRY. (4 cr; prereq 5802 or #; offered when feasible)
Speech in relation to language and types of literature.

8803. SEMINAR: ORAL INTERPRETATION OF DRAMA. (4 cr; prereq #; offered when feasible)
Speech in relation to language and types of literature.

Playwriting and Dramatic Theory

5115-5116-5117. PLAYWRITING. (4 cr per qtr, §3115; prereq 1321 or # for 5115, 3115 or 5115 for 5116, 5116 for 5117; 5117 offered when feasible) Nolte
After evidence of thorough groundwork in the established techniques of the well-made play, the student is encouraged to use other, more experimental forms. 5115: One-act play. 5116, 5117: Full-length play.

8110. SEMINAR: PLAYWRITING. (2-6 cr; limited to students of exceptional promise; prereq 5117 and #; offered when feasible) Nolte
Advanced work in creative writing for the stage.

8157-8158-8159. DRAMATIC THEORY. (4 cr per qtr, §Engl 8690; prereq 5171, 5172, 5173 or #, 8 cr dramatic literature; offered when feasible)
History and principles of dramatic theory from Aristotle to 19th century, studied in relationship to issues and problems in aesthetics of drama.

Acting

5313. INTERMEDIATE VOICE PRODUCTION FOR THE THEATRE. (4 cr; prereq 3311, #, written permission) Nash
History and theories of singing; performance and analysis of voice techniques applied to songs for music theatre.

5314-5315. STAGE COMBAT. (2 cr per qtr; prereq 1326 or grad student, #)
History, techniques, and aesthetics of staging physical combat. 5314: Unarmed combat. 5315: Armed combat.

5321. PROBLEMS IN PROFESSIONAL ACTING. (4 cr; prereq 3321, 3322, or grad student) Adjunct faculty
Exploration by students and professional actor of types of acting techniques needed for professional careers.

5323. ACTING FOR THE CAMERA. (4 cr; prereq 3321 or grad, written #) Moore
Laboratory focusing on the differences between stage acting and acting for the camera. Scenes enacted and played back on videotape for class critiquing. Students operate cameras. Attendance mandatory.

5328. MIME AND MASK II. (4 cr; prereq 3328 or grad student) Adjunct faculty
More advanced mime training for actors; expressive masks.

5334-5335-5336. ACTING FOR MUSIC THEATRE. (4 cr per qtr; prereq 1326, 5313, 8313, or music major, written #) Kanee
Philosophy and techniques of music theatre as applied to spoken and sung dramatic literature,

8311-8312-8313. ADVANCED VOICE PRODUCTION FOR THE THEATRE. (4 cr per qtr; prereq written #) Nash
Professional training level. 8311: History of voice production; physiology; phonetics; voice techniques for the classical actor. 8312: Theories of theatre speech; analysis and performance of texts and voice techniques applied to works of Shakespeare. 8313: Theories of singing; performance and analysis of voice techniques applied to songs for theatre, 1600 to present.

8321-8322-8323. PROBLEMS IN ACTING. (4 cr per qtr; prereq 1st-yr MFA actor or by audition, written #) Adjunct faculty
Emphasis on intensive scene and character analysis and on skill in communicating character and concept to an audience in individual and group performances.

8326-8327-8328. HISTORY AND TECHNIQUE OF STAGE MOVEMENT. (4 cr; prereq written #) Moulton
Application of historical research in the areas of manners, games, and dances to techniques of body movement for the stage.

8331, 8332, 8333, 8334, 8335, 8336, 8337, 8338, 8339. PERFORMANCE THEORY AND TECHNIQUE. (7 cr per qtr; prereq MFA student in acting program) Balk, Berry, Congdon, Moulton, Nash, Norwood, Reid
Integrated study of theories and practices in acting, movement, textual analysis, and voice. 8331: 20th-Century British and European Drama. 8332: 19th-Century Realism. 8333: Shakespeare History and Tragedy. 8334: Ancient Greek and Roman Drama. 8335: Early American Drama. 8336: Medieval Drama. 8337: 18th-Century Drama. 8338: Modern American Drama. 8339: Shakespeare Comedy.

Design and Technical

5502. ADVANCED MAKEUP FOR THE STAGE. (2 cr; prereq 1502 or equiv or grad) Crellin
Facial casting, prosthetics, and hair ventilating.

5510. DRAWING AND RENDERING FOR THEATRE DESIGNERS. (2 cr; prereq 3513 or 3515 or grad student, #) Brockman, staff
Development of drawing and rendering skills necessary for presentation of scene and costume designs.

5511. SCENOGRAPHIC TECHNIQUES. (4 cr; prereq 5513, #) Brockman
Practical study of drafting skills for the theatre designer and interpretation of renderings for the stage.

5512. ADVANCED PROBLEMS IN COSTUMING. (4 cr; prereq 3515 or #) Crellin
Theory and design of costumes; special projects. Laboratory arranged.

5513. STAGECRAFT. (4 cr; prereq 3513, #) Brockman
In-depth study and practical application of scenic materials, tools, and construction materials currently used in theatre. Laboratory arranged.

5514. ADVANCED PROBLEMS IN SCENE DESIGN. (4 cr; prereq 3513 or #) Josal
Theory and design of stage scenery; special reports and projects. Laboratory arranged.

5516. ADVANCED PROBLEMS IN STAGE LIGHTING DESIGN. (4 cr; prereq 3515, 3711 or #) Montgomery
Theory of stage lighting design. Drafting and development of the lighting plot. Laboratory arranged.

5518. ADVANCED PROBLEMS IN STAGE PROPERTIES. (4 cr; prereq 3513 or #) Josal
Theory and design of stage properties. Special projects and reports. Laboratory arranged.

5519. SOUND FOR THE THEATRE. (2 cr; prereq 1504, #) Gwinup, Montgomery, staff
Theory and technique of producing and amplifying sound for the theatre. Laboratory arranged.

5520. COSTUMING CRAFTS AND TECHNIQUES. (4 cr per qtr [max 8 cr]; prereq 3415, 5512 or #) Crellin
Specialized theory and practice in costuming. Laboratory arranged.

5522. HISTORY OF COSTUME FOR THE STAGE. (4 cr; prereq 3515) Crellin
The history of clothing and theatrical costume, research methods in costume history, and problems of and solutions for transforming historical research into stage costume.

5540. SCENE PAINTING TECHNIQUES. (2-4 cr per qtr [max 12]; prereq 3513 or #) Brockman
Practical study of materials, layout, and painting techniques used in theatre. Emphasis on painting styles and texturing techniques.

5566. STAGE LIGHTING CRAFTS AND TECHNIQUES. (4 cr; prereq 3515 or #) Montgomery
The lighting technician's skills and crafts; wiring, splicing, dimmer functions, and equipment from a practical standpoint. Laboratory arranged.

5580. PROPERTIES CRAFTS AND TECHNIQUES. (4 cr; prereq 3513, 5518 or #) Brockman, Gwinup, staff
Specialized theory and practice in creating stage properties. Laboratory arranged.

8518. SEMINAR: VISUAL ARTS OF DRAMA. (4 cr; prereq theatre major or #; offered when feasible) Josal
Selected aesthetic theories of plastic and poetic arts; relationship to visual aspects of the dramatic production. Theory of art as a symbol.

8519. SEMINAR: THEATRE PLANNING. (4 cr; prereq 12 cr in 5xxx or higher design and technical courses , #; offered when feasible) Josal
Principles of planning and design of stages, auditoriums, and associated facilities, their application to the educational theatre. Both building and equipment analyzed.

8520. SEMINAR: STAGE COSTUMING. (4 cr; prereq 5512 or #; offered when feasible) Crellin
Research in specialized areas in costume design; projects and reports.

8540. SEMINAR: SCENE DESIGN. (4 cr; prereq 5514 or #; offered when feasible) Josal
Research in specialized areas in scene design; projects and reports.

8560. SEMINAR: STAGE LIGHTING. (4 cr; prereq 5516 or #; offered when feasible) Montgomery
Research in specialized areas in stage lighting; projects and reports.

Directing

5711. STAGE DIRECTION. (4 cr; prereq 3711 or grad student) Adey
Theory of direction: concept and analysis. Exercises in blocking scene analysis, and production of short scenes.

5712. STAGE DIRECTION. (4 cr; prereq 5711) Adey
Examination of dramatic forms. Theory of rehearsal and production problems and direction of two one-act plays.

5716. STAGE MANAGEMENT FOR THE THEATRE. (4 cr; prereq 3711 or ¶3711 or 5711 or ¶5711) 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) Neely
Introduction to theory, problems, and solutions of administrative planning, budgeting, advertising, and publicity for not-for-profit theatre.

5720. PLAYS IN PRODUCTION AND PERFORMANCE. (2-4 cr per qtr [max 6 for undergrads]; prereq 5712 and written #) 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) Neely
Practical analysis of audience and financial development problems in U.S. theatre. Concentrates on various solutions.

5734-5735-5736. DIRECTING THE SINGER-ACTOR. (4 cr per qtr; prereq 5712, #; concurrent regis in 5334, 5335, 5336 not permitted) Kanee
Directing and coaching the singer-actor in use of language and in music-theatre performance.

5760. ADVANCED STAGE MANAGEMENT. (1-3 cr per qtr [max 6 for undergrads]; prereq 5716 or ¶5716 and written #) 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

General

5100. THEATRE PRACTICUM. (1-6 cr; prereq △, 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]; S-N regis only; prereq written # after casting and/or assignment to a production) Montgomery
Participation in the rehearsals and performances of a University Theatre production. Credit given for the quarter the performance takes place.

5930. TOPICS IN THEATRE: THE COLLABORATIVE PROCESS. (4 cr; prereq written #)
Collaborative process in creating theatre; may include actors, directors, designers, writers, composers, artists, and others.

5950. TOPICS IN THEATRE. (1-5 cr per qtr [max 12 cr]; prereq #, △)
Selected topics. Topics listed in *Class Schedule*.

5970. DIRECTED READINGS. (1-6 cr per qtr; prereq 9 cr in theatre, #, △, CLA approval)
Directed reading and preparation of reports on selected subjects.

8101. INTRODUCTION TO RESEARCH. (4 cr; required of all majors in theatre arts; prereq theatre major or #) Gadberry
Graduate research in theatre arts; selection of topics and methods of investigation.

8980. DIRECTED INSTRUCTION. (1-3 cr; prereq △) 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 #, △) Staff
Open to graduate students engaged in research on special problems.

Dance (Dnce)

5100. DANCE PRACTICUM. (1-6 cr; prereq #, △)
Arranged individual creative projects in dance.

5110-5120-5130. ADVANCED MODERN TECHNIQUE. (2 cr per qtr [max 6 cr]; prereq 3130 or #)

5312. CHOREOGRAPHY I. (2 cr; prereq 3313 or equiv)
Emphasis on use of form in small ensemble choreography.

5313. DANCE CHOREOGRAPHY II. (2 cr; prereq 5312 or equiv)
Continued study and development of the craft for large ensemble choreography.

5314. CHOREOGRAPHY III. (2 cr [max 6 cr]; prereq #)

5485. DYNAMICS OF DANCE/MOVEMENT THERAPY. (4 cr; prereq 1012, Psy 1001, #)
Movement analysis and body image. Emphasis on individual movement behavior and its relationship to verbal communication and the ongoing process; includes fieldwork observation.

5486. ETHNIC DANCE TRADITION IN AMERICAN SOCIETY. (4 cr)
Survey of traditional dances as preserved and transformed by Asian Americans, Afro-Americans, American Indians, and Chicanos, with emphasis on interpretation of roles of dance in these subcultures.

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.

5550. TOPICS IN DANCE THEORY. (1 cr [max 3 cr]; prereq 1040)
Topics specified in *Class Schedule*.

5605. DANCE FOR CHILDREN. (4 cr; prereq 1012, 1024, #)
Movement vocabulary, movement exploration, form building, and composition studies for children, culminating in children's dance performance.

5616. TEACHING OF DANCE. (4 cr; prereq 3115, #)
Study and experimentation of methods, principles, and techniques of teaching dance.

5700. WORKSHOP: DANCE PERFORMANCE. (1-12 cr [max 12 cr]; prereq 1101 or #)
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]; prereq #, △)
Topics listed in *Class Schedule*.

5920. TOPICS IN DANCE PERFORMANCE. (1-3 cr [max 6 cr]; prereq #)
Discussion of various aspects of performance and performing.

5950. TOPICS IN DANCE. (1-5 cr per qtr [max 12 cr]; prereq #, △)
Topics listed in *Class Schedule*.

5970. DIRECTED STUDIES. (1-6 cr per qtr; prereq 9 cr in dance, #, △)
Guided individual reading or study in dance.

Therapeutic Radiology (TRad)

Professor: Seymour H. Levitt, *head;* Chang W. Song, *director of graduate studies;* John H. Kersey; Faiz M. Khan; Mark E. Nesbit

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

Degree Offered—M.S.Ther.Rad. (Plan A only).

Curriculum—Specialized study is available in clinical research and in radiobiology and radiation physics. Clinical research entails implementing new protocols of radiotherapy and analyzing the results. Research in radiobiology involves investigating the effects of ionizing radiations on biological systems, with emphasis on developing new means to control tumors. Research in radiation physics seeks the means to deliver radiation energy to tumors with minimal damage to normal tissues.

Prerequisites for Admission—Applicants must hold an M.D. degree from an approved medical school; they are eligible for appointment as medical fellows with a stipend in therapeutic radiology. Medical fellows without stipend are also accepted if places are available. Previous preparation in internal medicine, pathology, or both is highly desirable although not required. The course of study extends over three to four years, excluding any time devoted to other subjects. For those who have been away from medical practice for a considerable period, a preliminary program of studies in the laboratory sciences and general medicine is highly desirable.

Master's Degree Requirements—Students must take a minimum of 20 credits in therapeutic radiology and a minimum of 8 credits in one or more nonclinical fields to make up the minimum of 28 credits required. If students wish to complete a designated minor, they must take 9 or more credits in a single nonclinical field, making 29 credits the minimum requirement for a Plan A degree with a designated minor. A final oral examination is required.

Language Requirements—None.

For Further Information—Contact the Department of Therapeutic Radiology, Box 494 UMHC, University of Minnesota, Harvard Street at East River Road, Minneapolis, MN 55455 (mailing address).

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

5170f. BASIC RADIOLOGICAL PHYSICS. (3 cr; prereq #) Khan and 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 and 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 and 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.

5174s. PHYSICS OF DIAGNOSTIC RADIOLOGY. (3 cr; prereq 5170 or #) Loken
Physics of diagnostic X-ray imaging, X-ray production, image receptors, radiation exposure and protection. Special imaging modes including computerized tomographic scanning, ultrasound, and electron radiography.

5340f,w,s,su. SPECIAL PROBLEMS IN RADIATION THERAPY. (Cr ar) Kim, Lee, Levitt, Potish

5511. INTERDISCIPLINARY MEDICINE: OUTPATIENT DIAGNOSIS, EVALUATION, AND TREATMENT OF ADULTS AND CHILDREN WITH CANCER. (9 cr; prereq Med 5500)
Current concepts of management, results of therapy for common malignancies, and role of various disciplines in management of cancer patient.

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 and staff

5800. RADIATION ONCOLOGY PATHOLOGY. (Cr ar)

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 1/2- 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 1/2- 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.

8325f,w,s,su. RADIATION THERAPY PEDIATRICS ONCOLOGY. (1 cr) Staff
Weekly 1 1/2-hour seminar. Pediatric oncology radiation therapy problem situations discussed by pediatric oncology and therapeutic radiology staff. Case presentations and details of radiation therapy, chemotherapy, and instruction in combination therapy outlined. Offered in conjunction with pediatric oncology.

8350f,w,s,su. RESEARCH IN RADIATION THERAPY. (Cr ar)

8410f,w,s,su. SEMINAR: RADIATION BIOLOGY. (1 cr) Staff

8450f,w,s,su. RESEARCH IN RADIATION BIOLOGY. (Cr ar) Staff

8550f,w,s,su. RESEARCH IN RADIOLOGICAL PHYSICS. (Cr ar)

Theriogenology

See Veterinary Medicine.

Urology (Urol)

Professor: Ricardo Gonzalez, *director of graduate studies;* Elwin E. Fraley; Paul H. Lange

Associate Professor: Alexander S. Cass

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

Degree Offered—M.S.Urol. (Plan A only).

Curriculum—Four-year fellowships, approved by the Council on Medical Education, are offered. Graduate work is carried out at the University Hospitals and the Minneapolis Veterans Administration Medical Center.

Prerequisites for Admission—Applicants must hold an M.D. degree from an approved medical school and have completed two years of training in general study.

For Further Information—Contact the director of graduate studies, Department of Urologic Surgery, Box 394 Mayo, University of Minnesota, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address).

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

8250. UROLOGICAL SURGERY. (4 cr)

8251. CYSTOSCOPY AND UROLOGICAL DIAGNOSIS. (4 cr)

8252. UROLOGICAL CONFERENCE. (4 cr)

8253. RESEARCH IN UROLOGY. (4 cr)

8254. UROLOGICAL SEMINAR. (3 cr)

8255. UROLOGICAL-RADIOLOGICAL CONFERENCE. (3 cr)

8256. UROLOGICAL-PATHOLOGICAL CONFERENCE. (3 cr)

8257. SPECIAL TOPICS ON THE GENITOURINARY SYSTEM. (2 cr)
Advances in knowledge of genitourinary system; basic review and drug action.

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: veterinary biology; veterinary medicine; veterinary microbiology; veterinary parasitology; veterinary pathology; veterinary surgery, radiology, and anesthesiology; and theriogenology. An emphasis in veterinary public health is offered by the School of Public Health. For information about a major area, applicants should write to the director of graduate studies in the major field.

Theriogenology

Professor: Norm B. Williamson, *director of graduate studies;* Bo G. Crabo; M. L. Fahning; Edmund F. Graham; Alan G. Hunter; Han Soo Joo; Allen D. Leman; Bradley E. Seguin; Francis A. Spurrell; Jonathon E. Wheaton

Associate Professor: Shirley D. Johnston

Assistant Professor: Harry W. Momont

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. Applications are evaluated twice each year, March 1 and September 1; all application materials must be complete by February 10 and August 10, respectively.

Degree Requirements—For the master's degree, at least one quarter of LACS 8595 is required. For the doctoral degree, at least two quarters of LACS 8595 are 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—Contact the director of graduate studies, Theriogenology, 385E Animal Science/Veterinary Medicine, University of Minnesota, 1988 Fitch Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

LACS 5004. CLINICAL THERIOGENOLOGY. (6 cr; prereq #)
Laboratories devoted to application of principles and techniques of basic and clinical medical sciences in theriogenology.

LACS 5005. CLINICAL THERIOGENOLOGY. (1-12 cr; prereq #)
See 5004 for description.

LACS 5550. DIAGNOSTICS AND OBSTETRICS IN THERIOGENOLOGY. (2 cr; prereq regis vet med or grad or #) Fahning
Diagnostic, therapeutic, and obstetrical procedures in theriogenology.

LACS 5551. THERIOGENOLOGY DIAGNOSTICS LABORATORY. (1 cr; prereq regis vet med or grad or #) Fahning, Seguin, staff
Demonstrations and laboratory practices in diagnostic and therapeutic procedures in theriogenology.

LACS 5552. VETERINARY OBSTETRICS LABORATORY. (1 cr; prereq 5550 or #) Staff
Demonstrations and practices in application of obstetrical procedures.

LACS 5570. REPRODUCTIVE DISEASES OF DOMESTIC ANIMALS. (5 cr; prereq 5550 or #) Staff
Lectures covering physiology and pathology of reproduction, artificial insemination, abortive diseases, postpartum injuries, and breeding management in domestic animals.

LACS 5571. REPRODUCTION AND INFERTILITY IN THE HORSE. (1 cr; prereq 5570, regis vet med, or grad or #) Seguin
Lectures and demonstrations covering reproductive patterns, breeding practices, management, artificial insemination, economics of reproductive performance, and infertility in horses.

LACS 5572. REPRODUCTIVE PATTERNS AND INFERTILITY IN THE DOG AND CAT. (1 cr; prereq 5570, regis vet med, 3rd or 4th yr or grad or #) Johnston
Lectures on reproductive patterns, breeding management, artificial insemination, and infertility in dogs and cats.

LACS 5573. ADVANCED DAIRY CATTLE REPRODUCTION. (1 cr; prereq 5570, regis vet med, 3rd or 4th yr or grad or #) Fahning, Williamson
Lectures on pathology of reproduction, artificial insemination, and abortive diseases of dairy cattle. Evaluation of applied research on fertility, herd health problems, and management programs.

LACS 5574. REPRODUCTION AND INFERTILITY IN THE BULL. (1 cr; prereq 5570, regis vet med or grad or #) Staff
Lectures and demonstrations covering reproductive patterns, management, fertility, and infertility in the bull.

LACS 8590. ADVANCED DIAGNOSTIC METHODS. (Cr ar; prereq 5570 or #) Staff
Discussion and laboratory practices of methods for determination of fertility status of female and male animals.

LACS 8591, 8592, 8593. ADVANCED ENDOCRINOLOGY OF REPRODUCTION. (2 cr per qtr; prereq regis grad) Williamson
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.

LACS 8594. SPECIAL PROBLEMS IN ANIMAL REPRODUCTION. (Cr ar; prereq 5570 or #) Staff
Detailed discussion and laboratory study of specific reproductive disorders.

LACS 8595. SEMINAR. (1 cr) Seguin, staff

8596. HEREDITY IN ANIMAL DISEASE. (3 cr; prereq GCB 3022 or #)
Application of genetic principles of animal disease problems with emphasis on specific inheritable and familial conditions in domesticated species.

Veterinary Biology

Professor: Alvin J. Beitz, *director of graduate studies;* Caroline M. Czarnecki; Gary E. Duke; Robert H. Dunlop; Thomas F. Fletcher; Alice A. Larson; Charles F. Louis; Akhouri A. Sinha

Associate Professor: Victor S. Cox, Jr.; Esther M. Gallant; Edward F. Jankus; Sally E. Jorgensen; Mathur S. Kannan; Patrick T. Redig

Assistant Professor: David R. Brown; Lawrence J. Felice; Michael P. Murtaugh; Scott M. O'Grady; Lionel J. Rosenzweig; Ashok K. Singh

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 provides students with a broad base of knowledge in biomedical sciences, followed by advanced training in a specific area of expertise within the department. Students may specialize in veterinary anatomy, veterinary biochemistry, veterinary pharmacology, or veterinary physiology. Major research interests in the program focus on neurobiology and neuropharmacology, gastrointestinal physiology and pharmacology, muscle physiology, pharmacology and biochemistry, molecular cloning, cytogenetics, and cardiomyopathy.

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 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 speciality area and interest of the student. The final examination for the master's degree is oral. Additional information is available from the director of graduate studies.

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—Contact the director of graduate studies, Veterinary Biology, 295 Animal Science/Veterinary Medicine, University of Minnesota, 1988 Fitch Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

VB 5100. VETERINARY ANATOMY I. (6 cr; prereq #) Fletcher, Cox, 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 DEVELOPMENT ANATOMY. (3 cr; prereq #) Weber
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 #) Czarnecki, Beitz, Gallant
Light microscopic and relevant ultrastructural studies of cells, tissues, and organ systems.

VB 5110. CYTOGENETIC EVALUATION IN ANIMAL DISEASES. (1 cr; prereq regis vet med, 3rd or 4th yr or grad or #) Weber
Lectures on current information about use of cytogenetics in animal disease diagnosis, methods of laboratory preparation, and analysis of chromosomes. Laboratories devoted to preparing prophase spreads of chromosomes, staining and photographing them, and preparing karyotypes for analysis.

VB 5120. COMPARATIVE VERTEBRATE MORPHOLOGY. (6 cr; prereq Biol 1106 or #) Rosenzweig, Weber
Principles and patterns of vertebrate anatomy based on developmental and functional approach.

VB 5126. VETERINARY ANATOMY II. (5 cr; prereq 5100 or #) Cox, Rosenzweig
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 #) Weber
Microscopic structure, cytochemical, and functional aspects of cells, tissues, and organs of representative examples of vertebrates. Consists of four units: basic tissues (2 cr); G-I tract (1 cr); respiratory and integumentary systems (1 cr); excretory, reproductive, and endocrine system (2 cr). Depending on background and interest, students may register for any or all units.

VB 5149. TOPICS IN ORGANOLOGY. (1-5 cr per qtr [may be repeated for cr]; prereq 5104 or equiv, #) Staff
Lecture and laboratory presentations regarding selected organ systems of domestic and laboratory animals.

VB 5210f. VETERINARY BIOCHEMISTRY. (3 cr; prereq 1st-yr vet student or #) Jorgensen, Louis
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 #) Jorgensen, Louis
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, Olson, Louis
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. (5 cr; prereq regis vet med or #)
Physiology of digestive and body fluid systems of animals.

VB 5308s. ANIMAL PHYSIOLOGY. (5 cr; prereq regis vet med or #)
Physiology of circulatory, respiratory, and renal systems of animals; mechanisms of temperature regulation and heat production.

VB 5310f. ANIMAL PHYSIOLOGY. (3 cr; prereq regis vet med or #)
Physiology of endocrine and reproductive systems of animals.

VB 5320w. AVIAN PHYSIOLOGY. (5 cr; prereq 3301 or 6 cr systemic physiology or equiv, #; offered alt yrs) Duke
Physiology of various species of wild and domestic birds.

VB 5330. WILD BIRD MEDICINE. (2 cr; prereq regis vet med, 3rd yr, 4th yr or grad, or #) Duke, Redig
Brief summary of important aspects of avian anatomy and physiology. Survey of diseases common to wild birds and surgical repair of common injuries and fractures.

VB 5400f. VETERINARY PHARMACOLOGY. (5 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, local anesthetics, parenteral general anesthetics, tranquilizing agents, analeptics, anticonvulsants, and neuromuscular blockers.

VB 5401w. VETERINARY PHARMACOLOGY. (5 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. (3 cr; prereq 5401 or #) Stowe
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 bioc or physiology, #)
Introduction to physiology, biochemical regulation, and physical chemistry of muscle contraction.

VB 5460f. NEUROCHEMICAL COMMUNICATION. (5 cr, §MdBc 5460, §NSc 5460; prereq biochemistry)
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. Two objective short answer examinations.

VB 8110. MORPHOLOGY OF ANIMAL CELLS AND INTERCELLULAR SUBSTANCES. (3 cr; prereq 5105, #) Weber
Components of basic tissues of the animal body.

VB 8111. HISTOLOGICAL AND ULTRAHISTOLOGICAL TECHNIQUES. (3 cr; prereq 5105, #) Weber
Principles and methods in preparing animal tissues for histological and ultrahistological observation.

VB 8112-8113-8114. RESEARCH PROPOSITIONS IN MORPHOLOGY. (2 cr per qtr; prereq #) Staff
Each student defines an unsolved morphologic problem, hypothesizes a solution, and proposes an experimental approach to test the hypothesis. Written and oral presentation of proposition evaluated by departmental graduate faculty.

VB 8134-8135. COMPARATIVE VETERINARY NEUROLOGY. (4 cr per qtr; prereq 5100, #) Beitz, Fletcher
Correlated studies of central nervous system of domestic animals. Emphasis on relating neuroanatomy to neurophysiology.

VB 8136. EXPERIMENTAL COMPARATIVE VETERINARY NEUROLOGY. (3 cr; prereq 8135, #) Beitz, Fletcher
Principles, methods, and laboratory exercises in investigating central nervous system of domestic animals.

VB 8149. RESEARCH IN VETERINARY ANATOMY. (2-5 cr; prereq 5149 and #) Staff
Theoretical considerations of experimental approaches to research in veterinary anatomy in any of following areas: cytochemistry, embryology, gross anatomy, histology, neurology, tissue culture.

VB 8150. RESEARCH PROBLEMS IN VETERINARY ANATOMY. (1-5 cr; prereq #) Staff
Individual research projects under staff direction in selected areas of veterinary anatomy. Topics and species determined by consultation. Project may be a specialized aspect of a thesis problem or an independent problem of mutual interest to graduate student and adviser.

VB 8349. RESEARCH IN PHYSIOLOGY. (Cr ar; prereq #) Staff
Individual research under faculty direction. Topics determined by consultation and may be a specialized aspect of a thesis problem or an independent problem of mutual interest to graduate student and adviser.

VB 8448. PROBLEMS IN VETERINARY PHARMACOLOGY. (Cr ar; prereq 5401 or equiv or #) Brown, Larson

VB 8460w. NEUROCHEMICAL COMMUNICATION. (1 cr, §GCB 8460, §MdBc 8460, §NSc 8460, §Phcl 8460; prereq biochemistry and 5460 or ¶5460) Biochemistry of neuronal signaling, manipulation by pharmacological agents; context of current research papers. Information about most systems (e.g., autonomic and central nervous systems) delivered in context of specific transmitter systems wherever practical. Research-oriented paper or grant application in area discussed in 5460.

VB 8550. SEMINAR: VETERINARY BIOLOGY. (1 cr; prereq #)

Veterinary Medicine

Professor: Vaughn L. Larson, *director of graduate studies;* John F. Anderson; Stephen I. Bistner; Stanley L. Diesch; Robert H. Dunlop; Ralph J. Farnsworth; Donald W. Johnson; Han Soo Joo; Charles D. Knecht; Allen D. Leman; Phillip Ogburn; Carl A. Osborne; Michael M. Pullen; R. Ashley Robinson; Clarence M. Stowe (emeritus); David G. Thawley; Gilbert E. Ward; Ronald E. Werdin; Norman B. Williamson

Associate Professor: Trevor R. Ames; Robert M. Hardy; Shirley D. Johnston; Jeff S. Klausner; Frank B. Martin; Patrick J. McKeever; William G. Olson; Carlos Pijoan; Richard E. Shope, Jr.

Assistant Professor: Lawrence J. Felice; Thomas W. Molitor; Robert B. Morrison; Michael J. Murphy; David J. Polzin; Ashok K. Singh; Thomas E. Stein

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 large, small, and comparative animal medicine. Emphasis can further be directed toward specific systems such as pulmonary, urinary, or skin.

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 LACS or SACS 8291 and of LACS 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—Contact the director of graduate studies, Veterinary Medicine, 225E Veterinary Hospitals, University of Minnesota, 1365 Gortner Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

LACS 5000. CLINICAL LARGE ANIMAL MEDICINE. (6 cr; prereq #)
Laboratories. Application of principles and techniques of basic and clinical medical sciences to diagnosis, prognosis, treatment, prevention, and eradication of disease in food-producing animals and the horse.

SACS 5000. CLINICAL SMALL ANIMAL MEDICINE. (6 cr; prereq #)
Laboratories. Application of principles and techniques of basic and clinical medical sciences to diagnosis, prognosis, treatment, prevention, and eradication of disease in companion animals.

LACS 5001. CLINICAL LARGE ANIMAL MEDICINE. (1-12 cr; prereq #)
See LACS 5000 for description.

SACS 5001. CLINICAL SMALL ANIMAL MEDICINE. (1-12 cr; prereq #)
See SACS 5000 for description.

SACS 5004. CLINICAL SMALL ANIMAL SPECIALTIES. (6 cr; prereq #)
Laboratories. Application of principles and techniques of basic and clinical medical sciences, with emphasis on cardiology, dermatology, and ophthalmology.

SACS 5005. CLINICAL SMALL ANIMAL SPECIALTIES. (1-12 cr; prereq #)
See SACS 5004 for description.

LACS 5006. CLINICAL HERD MEDICINE. (6 cr; prereq #)
Application of principles and techniques of basic and clinical medical sciences in herd medicine.

LACS 5007. CLINICAL HERD MEDICINE. (1-12 cr; prereq #)
See LACS 5006 for description.

LACS 5009. VETERINARY PUBLIC HEALTH. (4 cr; prereq #)
Laboratories. Application of principles and techniques of basic and clinical medical sciences in veterinary public health.

LACS 5010. VETERINARY MEDICINE EXTERNSHIP. (1-12 cr; prereq #)
Practice setting involving large, mixed, small, equine, specialty practice, or other fields approved by externship program director.

LACS 5151. DIAGNOSTIC AND THERAPEUTIC TECHNIQUES I. (1 cr; prereq CVM 5150 or #) Ames, Larson
Application of general physical examination procedures, special diagnostic techniques, and therapeutic procedures to large animals.

LACS 5153. DIAGNOSTIC AND THERAPEUTIC TECHNIQUES II. (1 cr; prereq #) Ames, Larson
Demonstration and practice of restraint and diagnostic and therapeutic techniques for large animals.

LACS 5160. LARGE ANIMAL MEDICINE. (6 cr; prereq 5151 or #) Olson, Ames
Diseases of ruminants covered on a system basis.

LACS 5161. LARGE ANIMAL MEDICINE. (5 cr; prereq 5160 or #) Ames, Larson
Continuation of study of ruminant diseases and equine diseases on a system basis.

LACS 5162. LARGE ANIMAL MEDICINE. (6 cr; prereq 5161 or #) Larson, Pijoan, staff
Continuation of equine diseases and porcine diseases.

VDI 5164. TOXICOLOGY OF POISONOUS PLANTS. (1 cr; prereq VB 5401 or #) Murphy
Toxicology and identification of poisonous plants.

LACS 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.

VDI 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 #) McKeever, Ogburn, Hardy, Bistner, Osborne, Klausner
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 #) Osborne, Ogburn, Hardy, Bistner, Klausner, McKeever
(Continuation of 5170.)

SACS 5172. SMALL ANIMAL MEDICINE. (5 cr; prereq 5171 or #) Osborne, Ogburn, Hardy, Bistner, Klausner, McKeever
(Continuation of 5171.)

LACS 5180. INTRODUCTION TO HERD HEALTH AND DAIRY HERD HEALTH MANAGEMENT. (2.5 cr; prereq regis vet med, 3rd or 4th yr or grad or #) Farnsworth, Williamson
Herd health management, general epidemiology, disease surveillance, and economics of farming. Dairy cattle genetics and breeding, reproduction, applied nutrition, housing, preventive medicine programs, and management practices.

LACS 5181. BEEF HERD HEALTH MANAGEMENT. (2 cr; prereq regis vet med, 3rd or 4th yr or grad or #) Ames, Haggard
Beef cattle breeds and breeding, reproduction, applied nutrition, housing, preventive medicine programs, and management practices.

LACS 5182. SHEEP AND GOAT HERD HEALTH MANAGEMENT. (1 cr; prereq regis vet med, 3rd or 4th yr or grad or #) Robinson and staff
Sheep and goat breeds and breeding, reproduction, applied nutrition, housing, preventive medicine programs, and management practices.

LACS 5183. EQUINE HERD HEALTH MANAGEMENT. (1 cr; prereq regis vet med, 3rd or 4th yr or grad or #) Staff
Equine breeding, reproduction, applied nutrition, housing, preventive medicine programs, and management practices.

LACS 5184. EQUINE NEONATOLOGY. (1 cr; prereq 3rd or 4th yr regis vet med student or #) Ames
Instruction, emergency duty, and practical application of principles in evaluating and treating sick equine neonates. Seasonal participation in clinical management of hospitalized foals and periodic review of past cases.

LACS 5185. SWINE HERD HEALTH MANAGEMENT I. (Cr ar; prereq rgis vet med, 3rd or 4th yr or grad or #) Morrison, Pijoan
Swine genetics and breeding, reproduction, applied nutrition, housing, ppreventive medicine programs, and management practices.

LACS 5186. PREVENTION AND CONTROL OF BOVINE MASTITIS. (1 cr; prereq regis vet med, 4th yr or grad) Farnsworth
Principles and procedures used to prevent and control mastitis in dairy cattle. Role of milking machine and laboratory procedures in solving herd problems.

LACS 5187. SWINE HERD HEALTH MANAGEMENT II. (1 cr; prereq 5185, regis vet med, 3rd or 4th yr or grad or #) Morrison, Pijoan, staff
Continuation of 5185.

LACS 5188. ADVANCED TOTAL ANIMAL HEALTH CARE: ENVIRONMENTAL AND MANAGEMENT SYSTEMS FOR DAIRY CATTLE. (1 cr; prereq regis vet med, 4th yr or grad) Anderson, Bates
Relationship of environment to disease, applied clinical epidemiology and assessment of herd improvements.

LACS 5189. ADVANCED HERD HEALTH MONITORING. (2 cr; prereq regis vet med, 4th yr or grad with #, 5180 or 5185) Williamson
Analysis and interpretation of herd records for monitoring and assessing production and financial performance of study herds. Herds evaluated, opportunities for improvement identified. Recommendations to advise farmers on strategies to improve herd performance and profitability developed.

LACS 5190. COMPUTERS IN ANIMAL HEALTH. (3 cr; prereq regis vet med or grad student or #) Marsh, Stein
Seminar and directed study covering current computer technology and operations with special reference to veterinary applications. Principles and practice of developing computer systems for processing, analyzing and interpreting various categories of animal health data, with examples.

SACS 5250. SMALL ANIMAL DERMATOLOGY. (1-2 cr; prereq regis vet med, 3rd or 4th yr or grad or #) McKeever
Pathogenesis, clinical features, diagnosis, and therapy of skin diseases of companion animals.

SACS 5255. DISEASES OF THE URINARY SYSTEM. (2 cr; prereq regis vet med, 3rd or 4th yr or grad or #) Osborne
Etiology, pathophysiology, clinical and laboratory findings, diagnosis, prognosis, and treatment of disorders of urinary system.

SACS 5256. DISEASES OF THE LIVER AND PANCREAS. (2 cr; prereq regis vet med, 3rd or 4th yr or grad or #) Osborne
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 veterinary curriculum)
Overview of proper interpretation of urinalysis findings in patients with variety of disorders of various body systems.

CVM 5260. ANIMAL BEHAVIOR. (2 cr; prereq #)
Principles of animal behavior and applied aspects related to management of clinical behavioral problems; companion and food animals emphasized.

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 vet med, 3rd or 4th yr or grad or #) Ogburn
Designed to help students develop skills in recognition, definition, and resolution of problems involving the cardiovascular system.

LACS 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.

LACS 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 vet med, 3rd or 4th yr or grad student or #)
Lectures. Management of small animal hospital. Zoning restrictions, employee supervision, drug purchases, facilities, fees, and other pertinent information.

LACS 5273. ECONOMICS OF VETERINARY MEDICINE. (1 cr; prereq vet med major) Olson
Designed for senior veterinary students to demonstrate important economic concepts through practical examples. Introduction to basic economic concepts, terminology, relationship of animal health to animal productivity, and financial return and analysis of cost and returns of actual beef cattle, dairy cattle, and hog farms. Economic issues facing veterinarians in practice management and the client in livestock production. Trends and outlooks in livestock production.

LACS 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 convenants. Law, tax, business and financial concepts, insurance, ownership vs. partnership.

LACS 5275. DISEASES OF ZOO ANIMALS AND EXOTIC PETS. (1 cr; prereq regis vet med, 3rd or 4th yr or grad or #) Farnsworth
Diseases of and management procedures for zoo animals and exotic pets, restraint procedures, medication and diagnosis.

LACS 5280. SEMINAR: WORLD FOOD SUPPLY PROBLEMS. (3 cr; prereq major in agriculture, veterinary medicine, nutritional sciences, social sciences or # or grad with #) Robinson, staff
(Same as AgEc 5790, FScN 5643, and Soc 5675) A 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 vet med, 3rd or 4th yr or grad or #) Hardy
Anatomic and physiologic bases for neurological examination of the dog. Stresses clinical approach to neurology.

LACS 5650. VETERINARY EPIDEMIOLOGY AND STATISTICS. (4 cr; prereq 10 cr biology, 12 cr chemistry or #) Diesch, Robinson
Principles of epidemiology, ecology, and veterinary public health. Biostatistics applied to the measurement of health and disease in populations.

LACS 5651. VETERINARY COMMUNITY MEDICINE. (3 cr; prereq VPB 5703, VPB 5503 or equiv or #) Diesch, Pullen, Robinson
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.

LACS 5660. EPIDEMIOLOGY OF ZOONOSES I. (1 cr; prereq regis vet med, 3rd or 4th yr or grad or #; offered when feasible) Diesch, Robinson
Zoonotic diseases of companion animals. Reservoirs, sources, transmission, and specific prevention and control programs emphasized.

LACS 5661. EPIDEMIOLOGY OF ZOONOSES II. (1 cr; prereq regis vet med, 3rd or 4th yr or grad or #; offered when feasible) Diesch, Robinson
Zoonotic diseases of food-producing animals. Reservoirs, sources, transmission, and specific prevention and control programs emphasized.

LACS 5663. INTERNATIONAL ANIMAL DISEASE PROBLEMS. (1 cr; prereq #) Diesch, Robinson
Diagnosis, transmission, and epidemiology of diseases not currently present in the U.S. International role of veterinarians in reducing disease and increasing world animal production.

LACS 5665. MONITORING AND SURVEILLANCE OF DISEASE. (Cr ar; prereq #) Diesch, Robinson
Seminars and discussions on techniques used to monitor disease in animal populations.

LACS 5670. COMPARATIVE MEDICINE AND PUBLIC HEALTH. (2 cr; prereq PubH 5002 and #) Diesch, Pullen, Robinson
Human relationship to the biologic environment. Interrelationships of animal and human health, occurrence of animal diseases, ecology of zoonoses, food production and hygiene, and laboratory animal medicine.

LACS 5671. BIOHAZARDS IN VETERINARY MEDICINE. (Cr ar; prereq #) Goyal, Robinson
Seminars and discussions on microbiological, toxicological, drug, and other hazards in veterinary medicine.

LACS 5672. PERSPECTIVES: ANIMAL-HUMAN RELATIONSHIPS AND COMMUNITY HEALTH. (2 or 3 cr; prereq #) Diesch, 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.

LACS 5673. PROBLEMS IN DISEASE CONTROL AND ERADICATION. (Cr ar; prereq PubH 5330 or #) Diesch, Robinson, Thawley
Past and present disease control and eradication programs, factors influencing success and failure. Development of models for disease control and eradication programs in the U.S. or a foreign country for group evaluation and analysis.

LACS 5680. PROBLEMS IN VETERINARY EPIDEMIOLOGY AND PUBLIC HEALTH. (Cr ar; prereq 5650 or equiv or #) Diesch, Robinson, Stein
Individual study arranged with faculty member.

LACS 5785. EXTERNSHIP SEMINAR. (1 cr; prereq regis vet med or 4th yr or grad student or #) Staff
Discussion of clinical problems that students experience during their externship with veterinarians in private practice. Emphasis on discussions of diseases of food-producing animals and horses.

CVM 5800. PROBLEMS IN VETERINARY RESEARCH. (5 cr; prereq #) Ames, Molitor, Osborne, Pijoan, Robinson
Development of approved research project by student in laboratory of faculty member who supervises conduct of research over ten-week summer period. Grade based on performance in lab and quality of written report.

CVM 5801. VETERINARY RESEARCH SURVEY SEMINAR. (1 cr; prereq #) Ames, Molitor, Osborne, Pijoan, Robinson
Fixed format seminars presented by University researchers to expose students to range of research problems and techniques. Grade based on critical essay discussing one or more of topics presented.

LACS 5951. DIRECTED STUDIES. (1-5 cr; prereq #, △)
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) 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 8191. ADVANCED COMPARATIVE ELECTROCARDIOLOGY. (3 cr; prereq grad and #)
Electrophysiology of the heart, with emphasis on arrhythmogenesis and vector analysis.

SACS 8192. SPECIAL CARDIOLOGY CLINICS. (Cr ar; prereq grad, #) Ogburn
Intensive clinical studies in investigative clinical cardiology. Diagnosis and management of cardiovascular disease in small animals.

LACS 8194.* PROBLEMS IN DIAGNOSTIC VIROLOGY, SEROLOGY, AND IMMUNOLOGY. (Cr ar; prereq grad or #) Ames, Joo, Molitor
Laboratory techniques of diagnostic virology, serology, and immunology. Research techniques of fluorescent antibody; determination of classes of immunoglobulins and immunostimulation of lymphocytes.

LACS 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, #) Osborne, Hardy, Klausner, Bistner, Ogburn, McKeever
Lectures, assigned readings, and discussions on internal medical problems of dogs and cats.

LACS 8197. METABOLIC AND NUTRITIONALLY INDUCED DISEASES OF CATTLE. (2 cr; prereq grad, #; offered alt yrs) Olson, Jorgenson
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, #) McKeever
In-depth clinical study of dermatologic disease states, diagnosis and therapy in animals.

SACS 8198.* PROBLEMS IN VETERINARY COMPARATIVE DERMATOLOGY. (Cr ar; prereq grad, #) McKeever
Individual study involving research on a selected dermatologic problem.

LACS 8199. PROBLEMS IN ECONOMICS OF ANIMAL HEALTH. (1-3 cr; prereq #) Marsh, Olson, Stein, 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, #) McKeever
Readings and literature review.

LACS and SACS 8290. ADVANCED VETERINARY MEDICINE. (Cr ar; prereq LACS 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.

LACS and SACS 8291. ADVANCED DIAGNOSIS AND THERAPEUTICS OF ANIMAL DISEASES. (Cr ar; prereq LACS 5162, SACS 5172, #) Ames, Joo, Larson, Osborne, McKeever, Ogburn, Olson, Pijoan
Detailed examination, discussions, and treatment of cases of animal diseases.

LACS and SACS 8292. SEMINAR: VETERINARY MEDICINE. (Cr ar; prereq grad, #) Larson, Osborne, staff

LACS and SACS 8293. MEDICAL CONFERENCE. (Cr ar; prereq LACS 5162, SACS 5172, #) Larson, Osborne, staff
Medical, surgical, or obstetrical cases supported by anatomic, bacteriologic, pathologic, physiologic, pharmacologic, and radiologic evaluations whenever applicable.

SACS 8295. COMPARATIVE VETERINARY MEDICAL OPHTHALMOLOGY. (3 cr; prereq grad or #) Bistner
Lectures, seminars, and laboratory exercises on diseases of the eye of domestic animals. Routine and experimental diagnostic procedures for the dog and horse emphasized. Research project in experimental or clinical medical ophthalmology with subsequent presentation to the faculty or publication.

SACS 8296. COMPARATIVE VETERINARY SURGICAL OPHTHALMOLOGY. (3 cr; prereq grad or #) Bistner
Lectures, seminars, and surgical exercises on diseases of the animal eye. Common and experimental surgical procedures for the dog and horse emphasized. A research project in experimental or clinical surgical ophthalmology with subsequent presentation to the faculty or publication.

SACS 8297. ADVANCED CLINICAL VETERINARY OPHTHALMOLOGY. (3 cr per qtr; prereq grad or #) Bistner
The graduate student assists in the medical and surgical treatment of patients in the University Veterinary Hospital.

SACS 8298.* RESEARCH IN VETERINARY OPHTHALMOLOGY. (3-5 cr per qtr; prereq grad or #) Bistner
Problems in experimental and/or clinical veterinary ophthalmology.

LACS 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.

LACS 8690. ZOONOSES AND COMPARATIVE MEDICINE. (Cr ar; prereq #) Diesch, Pullen, Robinson

LACS 8790. PROBLEMS IN VETERINARY CLINICAL PHARMACOLOGY AND THERAPEUTICS. (3 cr; prereq grad or #) Larson
Lecture, discussion, and clinical laboratory course examining clinical cases and experimental animals, and dealing with pharmacotherapeutics of various drugs used for food producing and companion animals.

LACS 8791. SEMINAR IN CLINICAL PHARMACOLOGY AND THERAPEUTICS. (2 cr; prereq grad or #; offered when feasible) Stowe
Examination of current literature and case material.

VDI 8792. SEMINAR IN VETERINARY TOXICOLOGY. (2 cr; prereq grad or #) Murphy
Livestock and small animal intoxication with insecticides, heavy metals, rodenticides, poisonous plants, mycotoxins, herbicides, and drugs and drug combinations

Veterinary Microbiology

Professor: Samuel K. Maheswaran, *director of graduate studies;* Donald M. Barnes; Stanley L. Diesch; Ashley T. Haase; David A. Halvorson; Russell C. Johnson; Han Soo Joo; Keith I. Loken; Glen H. Nelson; John A. Newman; Carlos B. J. Pijoan; Michael Pullen; Robert A. Robinson; S. R. Tatini; Gilbert E. Ward

Associate Professor: Russell F. Bey; Sagar Goyal; K. V. Nagaraja; Richard E. Shope, Jr.; V. Sivanandan

Assistant Professor: Thomas W. Molitor; Michael P. Murtaugh

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 general veterinary microbiology, avian diseases, veterinary public health, and comparative immunology.

Prerequisites for Admission—The D.V.M. degree or adequate background in the biological or physical sciences and demonstrated interest in veterinary microbiology are required.

Special Application Requirements—Students may begin in any quarter, but entry in fall quarter is preferred.

Degree Requirements—For the master's degree, students generally take a final oral examination.

Language Requirements—None.

For Further Information—Contact the director of graduate studies, Veterinary Microbiology, 346-C Veterinary Science, University of Minnesota, 1971 Commonwealth Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

LACS 5180. PREVENTIVE MEDICINE AND APPLIED IMMUNOLOGY. (2 cr; prereq regis vet med, 4th yr or grad or #) Shope
Principles and applications of preventive medical procedures for specialized practices. Review of the principles of immunology and the clinical application of these principles.

VDI 5621. LABORATORY DIAGNOSIS OF VIRAL DISEASES. (3 cr; prereq #) Goyal
Applications and limitations of methodology in laboratory diagnosis of human and animal viruses, including rapid diagnostic procedures utilizing cell cultures, laboratory animals, and chick embryos, and various serological, immunological, and molecular techniques.

VPB 5622. PROBLEMS IN DIAGNOSTIC VIROLOGY. (1-4 cr; prereq #) Goyal
Laboratory techniques in diagnostic virology and viral research.

LACS 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.

LACS 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.

LACS 5660. EPIDEMIOLOGY OF ZOONOSES I. (1 cr; prereq regis vet med, 3rd or 4th yr or grad or #) Diesch, Robinson
Zoonotic diseases of companion animals. Reservoirs, sources, transmission, and specific prevention and control programs emphasized.

LACS 5661. EPIDEMIOLOGY OF ZOONOSES II. (1 cr; prereq regis vet med, 3rd or 4th yr or grad or #) Diesch, Robinson
Zoonotic diseases of food-producing animals. Reservoirs, sources, transmission, and specific prevention and control programs emphasized.

LACS 5665. MONITORING AND SURVEILLANCE OF DISEASE. (Cr ar; prereq #) Diesch, Robinson
Seminars and discussions on techniques used to monitor disease in animal populations.

LACS 5671. BIOHAZARDS IN VETERINARY MEDICINE. (Cr ar; prereq #) Robinson, Vesley
Seminars and discussions on microbiological, toxicologic, drug, and other hazards in veterinary medicine.

LACS 5675. VETERINARY DIAGNOSTIC MICROBIOLOGY. (2 cr; prereq regis vet med, 4th yr or #) Ward
Lectures and laboratory on techniques of diagnostic microbiology utilizing clinical material from veterinary hospital and diagnostic laboratories.

LACS 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. ADVANCED VETERINARY MICROBIOLOGY AND IMMUNOLOGY. (3 cr; prereq 3103, 1st yr vet med, #) Bey, Loken, Shope
Lectures on humoral and cellular immune responses, hypersensitivity, bacterial genetics, antimicrobial agents and their actions.

VPB 5702. PATHOGENIC BACTERIA AND FUNGI. (5 cr; prereq 5701 or equiv or #) Loken, Maheswaran
Lectures and laboratory on animal pathogens, with emphasis on basic mechanisms of infection.

VPB 5703. VETERINARY VIROLOGY. (5 cr; prereq 5702 or equiv or #) 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 #) Halvorson, Newman
Lectures on diseases involving poultry, cage and aviary birds.

VPB 5707. POULTRY DISEASE CONTROL. (3 cr; not open to vet med students; prereq Biol 1002 and AnSc 1100, MicB 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 vet med, 4th yr or grad or #) Halvorson, Newman
Preventive avian disease programs and management practices. Visits to poultry and aviary establishments.

VPB 5748. PROBLEMS IN VETERINARY MICROBIOLOGY AND PUBLIC HEALTH. (Cr ar; prereq 5703 or equiv, #) Diesch, staff

LACS 8193.* ADVANCES IN CLINICAL IMMUNOBIOLOGY. (Cr ar; prereq grad 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.

LACS 8194.* PROBLEMS IN DIAGNOSTIC VIROLOGY, SEROLOGY, AND IMMUNOLOGY. (Cr ar; prereq grad 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 8416. COLLOQUIUM ON CURRENT TOPICS IN AVIAN IMMUNOLOGY. (2 cr; prereq MicB 5216, grad; offered alt yrs) Nagaraja, Sivanandan

VDI 8602. COLLOQUIUM IN VIROLOGY. (2 cr; prereq #) Goyal
For graduate students in microbiology, alternating with faculty as discussion leaders. Discussions on original papers in classical or newly developing areas of animal virology, with emphasis on critical evaluation of experimental procedures and conclusions.

LACS 8690. ZOONOSES AND COMPARATIVE MEDICINE. (Cr ar; prereq #) Diesch, Pullen, Robinson
Advanced study of selected zoonoses and comparative medicine.

VPB 8700. SEMINAR: VETERINARY MICROBIOLOGY. (1 cr; prereq #) Nagaraja

VPB 8720. ADVANCED VETERINARY MICROBIOLOGY. (Cr ar; prereq #) Staff

VPB 8721. IMMUNODIAGNOSTIC TECHNIQUES FOR AVIAN DISEASES. (2 cr; prereq MicB 5216, grad; offered alt yrs) Nagaraja, Sivanandan

VPB 8724. ADVANCED VETERINARY DIAGNOSTIC MICROBIOLOGY. (Cr ar; prereq #) Ward
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.

VPB 8726. COLLOQUIUM IN IMMUNOLOGY. (2 cr; prereq MicB 5216, grad; offered alt yrs) Maheswaran
Series of independent units, each led by staff member. Topics include immune system and infectious diseases, cellular immunobiology, immunochemical techniques, complement, tumor immunology, antibodies and cell-mediated immunity.

Veterinary Parasitology

Professor: William J. Bemrick, *director of graduate studies;* Roger D. Price; Donald E. Gilbertson; John C. Schlotthauer; Bert E. Stromberg

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 protozoology, entomology, and helminthology. The following areas of research are available: investigations in coccidiosis and coccidian immunity; investigations in immunity to and host-parasite relations of helminths, including ascarids, filarids and *Fascioloides;* evaluation of antiparasitic drugs.

Prerequisites for Admission—A bachelor's degree in biological science, or a D.V.M. degree or its equivalent, is required.

Degree Requirements—Required courses are VPB 5601 and 5602, EBB 5116, and Ent 5275 or their equivalents. Other courses are selected according to student interests. The final examination for the master's degree is oral.

Language Requirements—None.

Minor Requirements for Students Majoring in Other Fields—No minor is available in veterinary parasitology.

For Further Information—Contact the director of graduate studies, Veterinary Parasitology, College of Veterinary Medicine, 204 Veterinary Science, University of Minnesota, 1971 Commonwealth Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

VPB 5004. CLINICAL PARASITOLOGY. (1.4 cr; prereq #)
Laboratories. Application of principles and techniques of veterinary clinical and diagnostic parasitology.

VPB 5601. VETERINARY PARASITOLOGY. (5 cr; prereq ¶5501 or #) Bemrick, Stromberg, Schlotthauer
Systemic and biologic study of protozoan and arthropod parasites of animals. Emphasis on their relationships to disease and principles of parasite control.

VPB 5602. VETERINARY PARASITOLOGY. (4 cr; prereq ¶5502 or #) Bemrick, Schlotthauer, Stromberg
Helminth parasites and parasitic diseases of animals with emphasis on principles of control.

VPB 5603s. PARASITES OF WILDLIFE. (2 cr; prereq 5601, 5602, or #; offered odd yrs) Schlotthauer
In-depth examination of epidemiology and disease potential of some of the more significant helminth, arthropod, and protozoan parasites of regional wild mammals and birds. Term paper required.

VPB 8601. ADVANCED VETERINARY PARASITOLOGY. (Cr ar; prereq #; offered alt yrs) Bemrick
Parasites of domestic animals with emphasis on their identification. Protozoa and arthropods.

VPB 8602. ADVANCED VETERINARY PARASITOLOGY. (Cr ar; prereq #; offered alt yrs) Bemrick
Parasites of domestic animals with emphassis on their identification. Helminths.

VPB 8611w. IMMUNITY TO PARASITIC INFECTIONS: PROTOZOA AND ARTHROPODS. (3 cr; prereq parasitology, immunology, and #; offered even yrs) Stromberg
Basic concepts in immunology as they apply to parasitic protozoa and arthropods.

VPB 8612w. IMMUNITY TO PARASITIC INFECTIONS: HELMINTHS. (3 cr; prereq parasitology, immunology, and #; offered odd yrs) Stromberg
Basic concepts in immunology as they apply to parasitic helminths.

VPB 8648. PROBLEMS: VETERINARY PARASITOLOGY. (Cr ar; prereq #) Stromberg, staff

Veterinary Pathology

Professor: David W. Hayden, *director of graduate studies*; Donald M. Barnes; Kenneth H. Johnson; Harold J. Kurtz; Victor Perman; Ronald E. Werdin

Associate Professor: James E. Collins; Terrance P. O'Leary; George R. Ruth; Mary M. Walser; Douglas J. Weiss

Assistant Professor: Bruce D. Hultgren; Timothy D. O'Brien; Daniel P. Shaw

Other: Roland Gunther

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 anatomic and clinical pathology are available in both the master's and doctoral programs. Opportunities for research include hematologic, cytologic, metabolic, gastrointestinal, musculoskeletal, renal, and neoplastic disorders. Areas of specialization involve companion animals, food and fiber animals, and the avian species.

Prerequisites for Admission—Applicants must hold the D.V.M. degree or its equivalent, or must present credits equivalent to the first two years of coursework in the College of Veterinary Medicine, University of Minnesota.

Special Application Requirements—A curriculum vitae, a statement of career goals, and three letters of recommendation evaluating the applicant's potential for graduate study are required.

Master's Degree Requirements—Students must complete required advanced courses in anatomic or clinical pathology and demonstrate diagnostic proficiency in the area of their specialization. Detailed requirements for the degree are outlined in a program publication. Written and oral final examinations are required.

Doctoral Degree Requirements—Students must complete required advanced courses in anatomic or clinical pathology and demonstrate diagnostic proficiency in the area of specialization. Required components of the program include seminars, successful completion of a research project, statistics, biochemistry, and instruction in manuscript and thesis writing.

Language Requirements—None, except at the discretion of the adviser.

Minor Requirements for Students Majoring in Other Fields—For the Ph.D. degree, minor requirements are the same as requirements for the M.S. major in veterinary pathology.

For Further Information—Contact the director of graduate studies, Veterinary Pathology, Department of Veterinary Pathobiology, College of Veterinary Medicine, 1971 Commonwealth Avenue,

University of Minnesota, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

VDI 5503. DIAGNOSTIC PATHOLOGY. (3 cr; prereq VPB 5502 or #) Werdin
Gross and microscopic changes associated with specific infectious and noninfectious diseases of domestic animals.

VPB 5504. VETERINARY CLINICAL PATHOLOGY. (3 cr; prereq 5503 or #) Perman, Weiss
Technique, application, and interpretation of laboratory tests used in clinical diagnosis.

VDI 5511. SWINE DISEASE DIAGNOSIS. (1-2 cr; prereq regis vet med or grad and #) Kurtz
Illustrated lectures on the pathogenesis and pathology of porcine diseases with emphasis on the differential etiologic diagnosis of common clinical disease syndromes.

VPB 5513. PATHOLOGY OF WILDLIFE DISEASES. (3 cr; prereq 5501, 5502, 5503, #) O'Leary, Barnes
Principal disease conditions of selected, free-living North American mammals and birds, with concentration on diseases common in Minnesota.

VPB 5520. VETERINARY CLINICAL PATHOLOGY. (1-3 cr; prereq 5204, #) Perman, Weiss
Application of clinical laboratory methods.

VDI 5521. SURGICAL PATHOLOGY. (3 cr; prereq #) Barnes, staff
Preparation and interpretation of surgical and necropsy specimens.

VDI 5522. DIAGNOSTIC PATHOLOGY. (5 cr; prereq #) Barnes
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 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 8502f.* ADVANCED SYSTEMIC PATHOLOGY. (4-6 cr; prereq 8501 or Path 5101 and #) Walser, staff
Reaction of specific systems to injury with emphasis on basic response capabilities of tissue or organ, with materials illustrating gross and microscopic changes.

VDI 8503.* ADVANCED DIAGNOSTIC PATHOLOGY. (3-5 cr; prereq VPB 8501 or Path 5101 and #) Werdin
Emphasis on gross and microscopic changes associated with specific infectious and noninfectious diseases of domestic animals. Requires completion of a special project selected in conjunction with course instructor.

VPB 8504s. ADVANCED VETERINARY HISTOPATHOLOGY. (1 cr; prereq 5502, 5503 and #) Hayden
Discussion and study of selected case materials from the veterinary anatomic, diagnostic, and surgical pathology programs.

VPB 8530. ONCOLOGY. (4 cr; prereq #; offered alt yrs) Hayden, staff
Spontaneous and induced mammalian neoplasms with emphasis on diagnosis.

VPB 8531. HOSPITAL PATHOLOGY. (1-2 cr; prereq 5501, 5502, 5503, and #) O'Brien, O'Leary
Necropsy and surgical pathology techniques, examination of tissue for diagnosis, and preparation of reports and records.

VPB 8532. COMPARATIVE NEUROPATHOLOGY. (2 cr; prereq #) O'Leary
Gross and microscopic lesions of spontaneous neurologic diseases of animals.

VPB 8533. PROBLEMS: PATHOLOGY. (Cr ar; prereq #) Johnson, staff

VPB 8534. PROBLEMS: CLINICAL PATHOLOGY. (Cr ar; prereq #) Perman, Weiss

Veterinary Surgery, Radiology, and Anesthesiology

Professor: Carl R. Jessen; Donald W. Johnson; Francis A. Spurrell; Roby C. Thompson; Larry J. Wallace

Associate Professor: Daniel A. Feeney, *director of graduate studies;* Dennis D. Caywood; Gary R. Johnston, Alan J. Lipowitz; Marc R. Raffe; Elaine P. Robinson; Claude R. Swayze

Assistant Professor: Bradley J. Gordon; Ava M. Trent; Patricia A. Walter

Clinical Professor: Paul G. Gannon

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 clincial 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—Contact the director of graduate studies, Veterinary Surgery, Radiology, and Anesthesiology, Department of Small Animal Clinical Sciences, Veterinary Hospitals, University of Minnesota, 1352 Boyd Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

LACS 5002. CLINICAL LARGE ANIMAL SURGERY. (6 cr; prereq #)
Laboratories. Application and techniques of basic and clinical surgical sciences in diagnosis, treatment, and surgical management of disease in food-producing animals and the horse.

SACS 5002. CLINICAL SMALL ANIMAL SURGERY. (8 cr; prereq #)
Application of principles and techniques of basic and surgical sciences used in University Veterinary Teaching Hospital for diagnosis, prognosis, and surgical management of certain diseases of body systems in companion animals.

LACS 5003. CLINICAL LARGE ANIMAL SURGERY. (1-12 cr; prereq #)
See LACS 5002 for description.

SACS 5003. CLINICAL SMALL ANIMAL SURGERY. (1-12 cr; prereq #)
See SACS 5002 for description.

SACS 5006. CLINICAL ANESTHESIOLOGY. (4 cr; prereq #)
Laboratories. Application of principles and techniques of basic and clinical medical sciences in anesthesiology.

SACS 5007. CLINICAL ANESTHESIOLOGY. (1-12 cr; prereq #)
See SACS 5006 for description.

SACS 5008. CLINICAL RADIOLOGY. (4 cr; prereq #)
Laboratories. Application of principles and techniques of basic and clinical medical sciences in radiology.

SACS 5009. CLINICAL RADIOLOGY. (1-12 cr; prereq #)
See SACS 5008 for description.

CVM 5350. PRINCIPLES OF VETERINARY SURGERY. (4 cr; prereq 5150 or #) Caywood, Lipowitz, Wallace
Fundamentals of surgery applied to the various tissues and systems of the body; principles of anesthesia; preoperative evaluation; postoperative care. Includes laboratory application.

SACS 5351. VETERINARY SURGERY. (5 cr; prereq CVM 5350 or #) Caywood, Lipowitz, Wallace
Common surgical procedures applied to small animals.

LACS 5352. LARGE ANIMAL SURGERY. (5 cr; prereq #)
Common surgical procedures applied to large animals.

LACS 5353. EQUINE COLIC TEAM. (2 cr; prereq vet med, 3rd yr, CVM 5350 and #)
Instruction, emergency duty, and practical application of principles in evaluating and treating equine colic patients. Registration commits student to six quarters participating in clinical management of cases and periodic review of past cases, success rates, and topics in related fields.

LACS 5354. BOVINE SOFT TISSUE SURGERY. (2 cr; prereq 5352 or equiv, #)
Pathophysiology, surgical anatomy, and surgical principles and techniques for common surgical conditions in cattle. Emphasis on abdominal disorders. Dissection and surgical laboratories included.

LACS 5355. LARGE ANIMAL SURGERY LABORATORY. (1 cr; prereq 5352 or #)

SACS 5356. SMALL ANIMAL SURGERY LABORATORY. (1 cr; prereq 5352 or #) Caywood, Lipowitz

SACS 5360. SMALL ANIMAL ORTHOPEDICS. (2-3 cr; prereq regis vet med, 3rd yr, 4th yr, or grad or #) Wallace
Small animal orthopedic problems and surgical procedures to correct them.

LACS 5364. EQUINE LAMENESS. (2 cr; prereq regis vet med, 3rd or 4th yr, SACS 5352 or #)
Major musculoskeletal diseases affecting the horse that contribute to lameness.

LACS 5365. LARGE ANIMAL ORTHOPEDICS. (2-3 cr; prereq regis vet med, 4th yr or grad or #)
Equine gaits and specific types of lameness. Signs, causes, diagnostic principles, and treatments.

LACS 5367. SURGICAL DISEASES OF THE MAMMARY GLAND. (2 cr; prereq regis vet med, 4th yr or grad or #)
Etiology, diagnosis, and treatment of congenital and acquired surgical diseases of mammary gland, with emphasis on bovine species.

SACS 5380. ANESTHESIOLOGY AND CRITICAL CARE. (3 cr; prereq 5170 or #) Raffe
Principles and application of anesthesia. Management of severely injured patient.

SACS 5398. INDEPENDENT RESEARCH IN VETERINARY ANESTHESIOLOGY. (1-6 cr; prereq registered in Vet Med or grad student or #) Raffe, 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 vet med, 3rd or 4th yr or grad or #) Feeney, Johnston
Contrast agents and procedures used to examine various body systems or anatomical areas.

SACS 5454. ROENTGENOLOGY BONE—LARGE ANIMALS. (1 cr; prereq regis vet med, 3rd or 4th yr or grad 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 vet med, 3rd or 4th yr or grad or #) Feeney, Johnston, Walter
Roentgen signs of common bone diseases of small animals.

LACS 8390. SEMINAR: VETERINARY SURGERY. (Cr ar; prereq DVM or equiv) Gordon, Kobluk, Trent

SACS 8390. SEMINAR: VETERINARY SURGERY. (Cr ar; prereq 5360, 5365 or equiv and #)

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.

LACS 8392. ADVANCED LARGE ANIMAL SURGERY. (Cr ar; prereq DVM or equiv, #) Gordon, Kobluk, Trent
Surgery of various systems in large animals with preoperative and postoperative evaluation and treatment.

LACS 8393. PROBLEMS IN LARGE ANIMAL ORTHOPEDICS. (3 cr; prereq 5365 or equiv, #)

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) Raffe
Principles of anesthesia; administration of local, regional, and general anesthesia in large or small animals.

LACS 8397. LARGE ANIMAL ANESTHESIA. (Cr ar; prereq 5380 or equiv, #) Raffe
Special problems associated with anesthesia of large animals.

SACS 8398.* RESEARCH IN VETERINARY ANESTHESIA. (2-4 cr; prereq grad of professional vet curriculum, 8397, SACS 8396, or equiv, #) Raffe
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, #) Raffe
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 and #) 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 and #) Feeney, Jessen, Johnston, Walter
Current reviews, reports, and discussion of problems.

SACS 8483. ABDOMINAL ROENTGENOLOGY. (Cr ar [max 3 cr]; prereq 5452 or equiv and #; 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 8484. UROLOGIC AND GYNECOLOGIC ROENTGENOLOGY. (Cr ar; prereq 5452 or equiv and #; offered alt yrs) Feeney, Johnston, Walter
Soft tissue roentgenology with emphasis on urologic roentgenology. One credit equals approximately 10 lecture hours, 30 laboratory hours, or 40 hours of paper preparation.

SACS 8485. THORACIC ROENTGENOLOGY. (Cr ar [max 3 cr]; prereq 5452 or equiv and #; offered alt yrs) Feeney, Johnston, Walter
Soft tissue roentgenology of strucutures 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 and #) Feeney, Jessen, Johnston, Walter
Problems associated with diagnostic procedures and their interpretation.

SACS 8491. FUNDAMENTALS OF NUCLEAR MEDICINE. (Cr ar; prereq grad, #; offered when feasible) Feeney, Jessen, Johnston, Walter
(See Rad 5511) Lecture and laboratory exercises to orient the graduate student in medical sciences to principles and applications of radioisotopes in medicine.

SACS 8492. RADIATION BIOLOGY. (Cr ar [max 3 cr]; prereq grad, #; offered when feasible) Feeney, Jessen, Johnston, Walter
Lectures on effects of irradiation on living systems, especially diseases of animal kingdom.

Vocational and Technical Education

VOCATIONAL EDUCATION

Professor: George Copa[1], *chair;* W. Forrest Bear[1]; David Bjorkquist[1]; Charles Hopkins[1]; Judith Lambrecht[1]; Gary McLean[1]; Jerome Moss[1]; Edgar Persons[1]; Roland Peterson[1]; David Pucel[1]; Gordon I. Swanson; Richard Swanson[1]; W. Wesley Tennyson[1]

Associate Professor: Jerry McClelland[1], *director of graduate studies;* James M. Brown[1]; Gary Leske[1]; Jane Plihal[1]; Marilyn A. M. Rossmann[1]; James R. Stone III[1]; Ruth Thomas[1]

Assistant Professor: Stephen Miletich[1]; Mary A. Smith[1]; George W. Wardlow[1]; Karen F. Zuga[1]

AGRICULTURAL EDUCATION

Professor: W. Forrest Bear[1]; Patrick Borich; George Copa[1]; Richard A. Krueger[1]; Curtis D. Norenberg[1]; Edgar Persons[1]; Roland Peterson[1]; Gordon I. Swanson[1]

Associate Professor: Gary W. Leske[1], *director of graduate studies*

Assistant Professor: George W. Wardlow[1]

BUSINESS EDUCATION

Professor: Charles Hopkins[1], *director of graduate studies;* Judith Lambrecht[1]; Gary McLean[1]

HOME ECONOMICS EDUCATION

Professor: Richard A. Krueger[1]

Associate Professor: Jerry McClelland[1], *director of graduate studies*; Shirley L. Baugher; Jane Plihal[1]; Marilyn A. M. Rossmann[1]; Ruth Thomas[1]

Assistant Professor: Mary A. Smith[1]

INDUSTRIAL EDUCATION

Professor: David Bjorkquist[1], *director of graduate studies;* Jerome Moss[1]; David Pucel[1]; Richard Swanson[1]

Associate Professor: James M. Brown[1]

Assistant Professor: Stephen Miletich[1]; Karen F. Zuga[1]

MARKETING EDUCATION

Associate Professor: James R. Stone III[1], *director of graduate studies*

[1]*Also holds graduate faculty appointment in Education*

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 education, home economics education, industrial education, marketing education. Ph.D. in education (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 education* (emphasis on school and non-school instruction in the processes, technology, and material employed in modern office and business operations and management); *home economics education* (emphasis on school and non-school instruction, family life, home economics extension, planning, evaluation, and youth activities); and *industrial education* (emphasis on school and non-school instruction in the processes, technology, and material employed in preparing individuals and groups for industry-related occupations and work roles); *marketing education* (emphasis on school and non-school instruction in the processes, technology, and material employed in distributing and marketing goods and services).

Two doctoral degrees are offered with specializations in agricultural education, business education, extension education, home economics education, industrial education, international vocational education and training, marketing education, training and development, 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 area of vocational education.

Special Application Requirements—Scores from the Miller Analogies Test are required. Master's degree applicants should designate the specific degree program to which they seek admission.

Master's Degree Requirements—Specific degree requirements are flexible. Students should consult the director of graduate studies in the major field 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 90 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 90 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 or technical specialization as a related field for the master's degree, a minimum of 8 credits in the chosen specialization is required.

For Further Information—Contact the appropriate director of graduate studies identified in the faculty listing. Address inquiries to the Department of Vocational and Technical Education, 210 VoTech Building, University of Minnesota, 1954 Buford Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

Agricultural Education (AgEd)

5010. RURAL EDUCATION AND COMMUNITY LEADERSHIP. (3 cr, §1010; prereq #)
Role of school in rural community, coordination of school with nonschool educational agencies; responsibility for community leadership.

5021. EDUCATION THROUGH EXTENSION METHODS. (3 cr, §HEEd 5021; prereq grad or #)
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)
Extension methods to promote the rapid adoption of improved agricultural practices.

5024. EXTENSION HISTORY AND PHILOSOPHY. (3 cr, §HEEd 5024)
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)
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.

5028. TEACHING METHODS IN AGRICULTURAL EDUCATION. (5 cr; prereq SeEd 3155 or ¶SeEd 3155)
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.

5032. HIGH SCHOOL CURRICULUM IN AGRICULTURE. (3 cr; prereq 10 cr in education)
Philosophy, organization, and administration of instruction in agriculture departments in secondary schools.

5034. PROCEDURES IN TEACHING AGRICULTURE. (3 cr; prereq #)
New developments in methodology; assessment of innovations and procedures; consideration of various levels of instruction.

5035. METHODS AND PRACTICES IN TEACHING POST-HIGH SCHOOL AGRICULTURE. (3 cr)
Problems unique to area school and junior college teaching; improving the ability to organize and present subject matter.

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. AG MECHANICS. (1-3 cr [max 12 cr])
Technical and managerial information, techniques, and materials. Designed to facilitate participant's instructional planning, resource development, and instruction.

5043. FARM MANAGEMENT. (1-3 cr [max 12 cr])
Application of agricultural economics theory and principles, techniqes, and materials. Designed to facilitate participant's instructional planning, resource development, and instruction.

5049. AGRICULTURAL EDUCATION FOR ADULTS. (4 cr)
Methods, 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; developing a continuing program, observation.

5051. ENTERPRISE ANALYSIS. (3 cr; prereq #)
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 #)
Administration, organization, and operation of farm business management education programs for adults; development and utilization of curriculum materials based on farm business record data.

5055. INTRODUCTION TO FARMING SYSTEMS RESEARCH AND EXTENSION. (3 cr)
Theory and practice; interdisciplinary approach to holistic view of farm family agricultural enterprise.

5056. APPLICATION OF FARMING SYSTEMS RESEARCH AND EXTENSION. (3 cr; prereq 5055 or HEEd 5055)
Seminar and fieldwork; sondeos and on-farm trials.

5061. PROGRAM PLANNING AND EVALUATION. (3 cr)
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)
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 #)
Observation, study, and experience in agricultural business and industry; application to educational problems in agriculture.

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 #)
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 #)
Emphasizes study and clarification of current issues, strategies of response, implications of response actions, and related leadership roles.

5084. CURRICULA FOR CAREER EXPLORATION IN AGRICULTURAL OCCUPATIONS. (3 cr)
Analysis and evaluation of material; criteria for selection of material; content, organization, resource activities, and teaching techniques.

5085. CAREER DEVELOPMENT IN AGRICULTURAL EMPLOYMENT. (3 cr)
Methods and materials in teaching career development for agricultural industries.

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 #)
Methods of teaching agriculture or related subjects; developing competencies in planning, organizing, implementing, and evaluating instruction, with practice in instructional techniques.

5129. CURRICULUM PLANNING. (3 cr; prereq 5128 or ¶5128, non-agricultural education major and/or #)
Methods and procedures in planning a curriculum to teach within a specific subject matter area; curriculum construction for use in native country setting.

5130. EFFECTIVE TEACHING IN A COLLEGE OF AGRICULTURE. (3 cr; prereq 1 yr grad study in agriculture or #)
Approaches to effective teaching; development of a personal philosophy; practice in employing types of instructional improvement activities. Intended primarily for graduate students planning to teach in a college of agriculture.

5200. SEMINAR: WORKING WITH YOUTH THROUGH ADULTS. (1-3 cr [max 9 cr including HEEd 5200 and YoSt 5200]; prereq △)
Interdisciplinary seminar focusing on definition of the youth work profession; essential skills for youth workers; youth needs, roles, relationships with adults; development and management of a system of support for youth work.

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.

8001. RESEARCH IN AGRICULTURAL EDUCATION. (Cr ar; prereq 15 cr in education)
Selecting problems, preparing bibliographies, analyzing and interpreting data, and preparing manuscripts.

8020. SEMINAR: AGRICULTURAL EDUCATION. (Cr ar)

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 Marketing Education (BME)

5150. RESEARCH AND METHODS IN TEACHING ACCOUNTING. (4 cr, §BDE 5150)
Application of current research findings to teaching methodology.

5151. RESEARCH AND METHODS IN TEACHING TYPEWRITING/KEYBOARDING. (3 cr, §BDE 5151)
Application of research findings to classroom methodology and materials development.

5152. RESEARCH AND METHODS IN TEACHING THE BASIC BUSINESS SUBJECTS. (4 cr, §BDE 5152)
Application of research findings to classroom methodology in general business, economics, introduction to business, business law, and consumer education.

5153. CONSUMER EDUCATION: CURRICULUM, METHODS, AND MATERIALS. (3-4 cr, §BDE 5153, §HEEd 5153)
Objectives, content, curriculum organization, teaching methods, materials, and evaluation methods for elementary, secondary, postsecondary, and adult levels.

5154. MATERIALS AND METHODS FOR MODEL OFFICE COURSES. (4 cr, §BDE 5154)
Course organization, methods, development, and evaluation of objectives and materials; practicum in simulation.

5156. TEACHING SHORTHAND AND TRANSCRIPTION. (3 cr, §BDE 5156)
Classroom methodology and materials development in shorthand and shorthand transcription.

5157. MATERIALS AND METHODS IN OFFICE EDUCATION. (4 cr, §BDE 5157)
Recent research and developments in teaching office procedures, the preparatory and related classes for cooperative office education, and advising of vocational office education student organizations.

5158. OFFICE MANAGEMENT TECHNIQUES AND TECHNOLOGY. (4 cr, §BDE 5158)
Present and future management principles, financial management, personnel, communications, systems, and environment.

5159. WORD/INFORMATION PROCESSING CONCEPTS AND MANAGEMENT. (4 cr, §BDE 5159)
Personnel and organization in industry; input and output hardware; implementation of word processing systems.

5160. WORD PROCESSING PRACTICUM. (3 cr)
Introduction to software for personal and business applications; projects using basic through advanced editing and printing capabilities.

5161. RECORDS MANAGEMENT. (4 cr)
Management of records in business; records creation, maintenance, protection, and disposition.

5252. TEACHING MERCHANDISE DISPLAY. (3 cr, §BDE 5252; prereq #)
Materials and methods; practice in using equipment.

5253. SUPERVISORY TRAINING. (3 cr, §BDE 5253)
Problems, practices, programs, issues, and methodologies related to preparing trainers of supervisors in business, office, and marketing occupations.

5255. MATERIALS LABORATORY: MARKETING EDUCATION. (3 cr, §BDE 5255; prereq 5305 or BDE 3305 or BDE 5251)
Development of specific related vocational materials for marketing occupations, cooperative vocational education classes.

5260. PROFESSIONAL SALES EDUCATION. (3 cr)
Acquiring and demonstrating higher order selling competencies reflecting client-centered and problem-solving abilities.

5304. METHODS: MARKETING EDUCATION. (4 cr, §BDE 3304)
Determining and organizing course content based on competency lists and objectives; constructing units and lesson plans; locating and selecting resources; demonstrating specific teaching methods pertinent to marketing topics.

5305. APPLIED METHODS: MARKETING EDUCATION. (4 cr, §BDE 3305; prereq 5304, #)
Applying, practicing specific methods pertinent to marketing content categories; constructing complete unit and teaching five 1-hour sessions in school or laboratory setting.

5310. INTRODUCTION TO MICROCOMPUTER APPLICATIONS IN BUSINESS AND MARKETING EDUCATION. (3 cr, §BDE 5310)
Instructional uses of microcomputers, representative business and marketing education applications, and BASIC programming.

5320. BUSINESS PROGRAMMING APPLICATIONS USING MICROCOMPUTERS. (3 cr; prereq 5310 or equiv)
Using microcomputers to program business and marketing applications in the BASIC language.

5330. SPREADSHEET ANALYSIS USING MICROCOMPUTERS IN BUSINESS AND MARKETING EDUCATION. (3 cr; prereq 5310 or equiv)
Introduction to use of spreadsheet software; instructional applications in business areas.

5335. TEACHING MICROCOMPUTER BUSINESS GRAPHICS. (3 cr; prereq 5310 or equiv)
Representative microcomputer-based graphics software packages; instructional presentations; simulated projects for teaching applications in business and marketing classrooms.

5340. TRENDS AND ISSUES IN BUSINESS AND MARKETING EDUCATION. (3 cr [max 6 cr], §BDE 5155, §BDE 5250)
Identification, analysis, and discussion of recent issues and trends.

5345. DATA BASE MICROCOMPUTER APPLICATIONS. (3 cr; prereq 5310 or equiv)
Introduction to data base software; instructional applications in business areas.

5350. BUSINESS DATA PROCESSING: CONTENT AND TEACHING METHODS. (4 cr, §BDE 5350)
Business applications of electronic data processing; current curriculum developments and teaching methodology in high school and postsecondary business and marketing education.

5351. ORGANIZATION AND ADMINISTRATION OF BUSINESS AND MARKETING EDUCATION. (4 cr, §BDE 5351)
Organization and administrative structure in the United States; objectives, programs, practices, teacher selection and supervision, evaluative criteria for business and marketing education departments.

5352. COORDINATION TECHNIQUES IN BUSINESS AND MARKETING EDUCATION. (4 cr, §BDE 5352)
The cooperative program in marketing and office education; program establishment; guidance, selection, and placement of students; work adjustment, student objectives, evaluation; labor laws; public relations.

5353. CURRICULUM CONSTRUCTION IN BUSINESS AND MARKETING EDUCATION. (4 cr, §BDE 5353)
Content identification, program organization, preparation of instructional objectives, guidelines for selection and development of instructional materials.

5354. POSTSECONDARY BUSINESS AND MARKETING EDUCATION. (3 cr, §BDE 5354)
Determining needs, curriculum facilities, admission practices, placement and follow-up of students, teacher qualifications, interorganizational relations in junior college and area technical school programs.

5355. ADULT BUSINESS AND MARKETING EDUCATION PROGRAMS. (3 cr, §BDE 5355)
Selection and training of evening school instructors; planning and promoting evening school business and marketing education classes; teaching adults; course and program evaluation.

5357. RESEARCH PROCEDURES IN BUSINESS AND MARKETING EDUCATION. (4 cr, §BDE 5357)
Research design and techniques, computer orientation, preparation of reports; criteria for appraisal and critical analysis of research completed in business and marketing education.

5358. BUSINESS AND MARKETING EDUCATION STUDENT ORGANIZATIONS. (3 cr, §BDE 5358)
Organization, administration, and operation of local, state, and national business and marketing education vocational student organizations.

5359. OCCUPATIONAL EXPERIENCE. (1-18 cr; S-N optional; prereq #)
Observation and employment experiences in business offices or marketing businesses; weekly seminars on application to teaching and guidance of high school and post-high school students.

5360. PROGRAM DEVELOPMENTS IN BUSINESS AND MARKETING EDUCATION. (1-6 cr)
Developments emerging from research and local, state, and national programs and projects. Content varies with each offering.

5361. BUSINESS OBSERVATION AND SEMINAR. (3-9 cr, §BDE 5361)
Current operating practices and career opportunities in business and industry combining planned experience in work environments and related seminars.

5370. SPECIAL TOPICS IN INSTRUCTION. (1-6 cr)
Planning and providing content, evaluating instruction. Topics vary with each offering.

5380. SPECIAL TOPICS IN CURRICULUM. (1-6 cr)
Content development and evaluation of curriculum and curriculum materials. Topics vary with each offering.

5390. SPECIAL TOPICS IN TECHNICAL UPDATING. (1-6 cr)
Technological and procedural changes in business content. Topics vary with each offering.

5600. FIELD-BASED PROJECTS IN BUSINESS AND MARKETING EDUCATION. (1-12 cr [max 12 cr]; prereq #)
Individual or group work on curricular, instructional, developmental, or evaluative problems and projects applicable to local school or business situations.

5900. DIRECTED STUDY IN BUSINESS AND MARKETING EDUCATION. (1-6 cr [max 6 cr]; S-N optional; prereq △)
Opportunity for individual learning experiences not covered by regular courses.

8300. SEMINAR: RESEARCH IN BUSINESS, MARKETING, AND ECONOMIC EDUCATION. (1 cr per qtr; prereq #)
Primarily for doctoral level students; planning and evaluation of research and individual projects.

8600. INTERNSHIP: BUSINESS AND MARKETING EDUCATION. (1-12 cr; prereq #)
Practical experience in a business or marketing education specialist role; supervised experience in communication, planning, decision making, materials and curriculum development, and supervising and working with people.

8900. PROBLEMS: BUSINESS AND MARKETING EDUCATION. (1-9 cr [max 9 cr]; prereq #)
Individual research.

Home Economics Education (HEEd)

5001. SPECIAL TOPICS. (1-6 cr; S-N optional)
Topics not covered by available courses.

5003. INTERNSHIP: COMMUNITY/WORK SETTINGS. (3-12 cr [max 12 cr], max 3 cr for MEd and MA programs; prereq #; S-N only; offered when feasible)
Planned work experience focusing on educational competencies in these settings. Students assume defined responsibilities of position.

5021. EDUCATION THROUGH EXTENSION METHODS. (3 cr, §AgEd 5021; prereq grad or #)
Methods and techniques of formal and nonformal education used by Extension Service and other organizations.

5023. EXTENSION METHODS FOR DEVELOPING COUNTRIES. (3 cr, §AgEd 5023)
Extension methods to promote the rapid adoption of improved practices.

5024. EXTENSION HISTORY AND PHILOSOPHY. (3 cr, §AgEd 5024)
Origin, philosophy, historical development, objectives, and organizational structure of Extension Service.

5025. EXTENSION PROGRAM DEVELOPMENT. (3 cr, §AgEd 5025)
Planning, implementing, and evaluating the program development process.

5026. EXTENSION ADMINISTRATION. (3 cr, §AgEd 5026; prereq #)
Administration of Cooperative Extension Service organization at county, area, and state levels.

5027. PRACTICUM: PLACEMENT FOR EXTENSION EXPERIENCES. (2-9 cr [max 9 cr], §AgEd 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.

5055. INTRODUCTION TO FARMING SYSTEMS RESEARCH AND EXTENSION. (3 cr)
Theory and practice; interdisciplinary approach to holistic view of farm family agricultural enterprise.

5056. APPLICATION OF FARMING SYSTEMS RESEARCH AND EXTENSION. (3 cr; prereq 5055 or AgEd 5055)
Seminar and fieldwork; sondeos and on-farm trials.

5100. SERVICE OCCUPATIONS EDUCATION. (3 cr [max 12 cr], §5331)
Development of occupational programs; exploration of career opportunities; identification of competencies for career clusters; development of objectives, learning experiences and appraisal procedures; preparation of teaching materials; licensure course for instructors.

5102. SERVICE OCCUPATIONS WORK EXPERIENCE. (3-6 cr [max 12 cr], §5336; S-N optional; prereq #; max 3 cr may be applied to grad degree; offered when feasible)
Observation and directed experience in selected occupational cluster with application to teaching. Each credit requires 85 hours of paid occupational experience; work experience course for licensure requirements.

5104. CURRICULA, METHODS, AND MATERIALS FOR SERVICE OCCUPATIONS. (3 cr, §5301; offered when feasible)
Examination of curricula, including methods and materials, for occupational clusters related to cooperative secondary and postsecondary programs; licensure course for instructor coordinators.

5106. COORDINATION TECHNIQUES FOR SERVICE OCCUPATIONS. (3 cr; offered when feasible)
Responsibilities of instructor-coordinators in cooperative secondary and postsecondary programs: guidance, selection, and placement of students in training agencies; articulation, supervision, and evaluation of training; licensure course for instructor-coordinators.

5108. SEMINAR IN SERVICE OCCUPATIONS. (3-9 cr [max 9], §5337; prereq #; max 3 cr may be applied to degree program; offered when feasible)
Exploration of current practices and career opportunities in business and industry, including planned experiences in work environments.

5109. SPECIAL TOPICS IN SERVICE OCCUPATIONS EDUCATION. (1-6 cr; S-N optional; offered when feasible)
Relevant emerging issues, current literature, technological development, and technical updating.

5153. CONSUMER EDUCATION: CURRICULUM, METHODS, AND MATERIALS. (3 or 4 cr, §BDE 5153; offered when feasible)
Objectives, content, curriculum organization, teaching methods, materials, and evaluation methods for the elementary, secondary, postsecondary, and adult levels.

5200. SEMINAR: WORKING WITH YOUTH THROUGH ADULTS. (1-3 cr [max 9 cr including AgEd 5200 and YoSt 5200]; prereq △; S-N optional; offered when feasible)
Interdisciplinary seminar focusing on definition of the youth work profession; essential skills for youth workers; youth needs, roles, relationships with adults; development and management of a system of support for youth work.

5244. TOPICS IN PROGRAM PLANNING FOR EXTENSION EDUCATION. (1-6 cr [max 9 cr], §AgEd 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], §AgEd 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], §AgEd 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], §AgEd 5247)
Overall evaluation design; choosing quantitative vs. qualitative evaluation methods; developing skills and conceptual frameworks to apply theory to Extension settings.

5300. HOME ECONOMICS CURRICULUM. (3 cr)
Examination of research and literature; development of units of study and programs at elementary and secondary levels; production and evaluation of materials.

5305. HOME ECONOMICS CURRICULUM: COLLEGE LEVEL. (3 cr; prereq #; offered when feasible)
Examination of research and literature; course and program development in higher education; analysis of current college programs; production and evaluation of curriculum materials.

5310. METHODS IN TEACHING HOME ECONOMICS: ATTITUDES, VALUES, AND KNOWLEDGE. (3 cr)
Derivation of theory for educational method from relevant research; application to educational objectives, strategies, and student motivation.

5315. EVALUATION: THEORETICAL AND TECHNICAL ASPECTS. (3 cr)
Collecting and interpreting evidence related to achievement of objectives, emphasizing higher levels of cognition and affective behaviors.

5320. ADULT EDUCATION IN HOME ECONOMICS. (3 cr)
Planning a community program; teaching procedures; special problems.

5321. INTERNATIONAL PERSPECTIVES IN HOME ECONOMICS EDUCATION. (3 cr; offered alt yrs)
Examination of field (formal and nonformal) around world; commonalities and differences in purpose, problems, history, methods of delivery, and context.

5325. TRENDS IN HOME ECONOMICS EDUCATION. (1-4 cr [max 12 cr]; offered alt yrs)
Current status; purposes, programs, content emphasis, research, problems, and issues in the field.

5400. HOUSING EDUCATION. (1-4 cr [max 12 cr]; offered when feasible)
Objectives, content, curriculum organization, teaching methods, materials, and evaluation approaches for teaching youth and adults about concepts, issues, and current trends related to housing and home furnishing problems.

5403. TEXTILES AND CLOTHING EDUCATION. (1-4 cr [max 12 cr]; offered when feasible)
Curricula, methods, and materials for teaching consumer, social, cultural, psychological, and technical aspects; analysis of family clothing and textile-related problems; decisions at middle, secondary, and adult levels; evaluation and critique of instructional design.

5404. INTRODUCTION TO EARLY CHILDHOOD FAMILY EDUCATION PROGRAM. (1 cr)
Concept and philosophy of such programs as basis for implementation.

5405. CHILD DEVELOPMENT AND PARENT EDUCATION. (1-4 cr [max 12 cr])
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; S-N optional)
Issues and current literature.

5407. FAMILY LIFE EDUCATION. (1-4 cr [max 12 cr])
Objectives, content, curriculum development, teaching methods, materials, and evaluation approaches for teaching diverse groups of youth and adults family life concepts including current research in communication, relationships, sexuality, self-esteem, and decision-making.

5408. EDUCATION FOR WORK-FAMILY RELATIONSHIPS. (3 cr)
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)
Development of skills for leading parent and family education groups.

5410. FOOD AND NUTRITION EDUCATION. (1-4 cr [max 12 cr]; offered when feasible)
Objectives, content, curriculum organization, teaching methods, materials, and evaluation approaches for teaching youth and adults about nutrition principles; psychological, social, cultural, political, economic, and technical aspects of food and nutrition-related problems, decisions, and issues.

5412. NUTRITION FOR EXERCISE AND PHYSICAL PERFORMANCE. (3 cr, §PE 5141; prereq PE 3115 or FScN 3600 or equiv; offered when feasible)
Application of basic nutritional principles to active populations, current issues related to dietary modifications for possible improvement of physical performance, and educational strategies relating to nutrition and physical performance.

5415. WORKSHOP: MATERIALS FOR INSTRUCTION. (1-4 cr [max 12 cr]; offered when feasible)
Problems in selection and use of new materials for instruction in home economics.

5420. WORKSHOP: ADULT EDUCATION. (1-4 cr [max 12 cr]; offered when feasible)
Procedures in teaching adults; planning the program; use of new materials and techniques; group and individual problems.

5430. WORKSHOP: CONTEMPORARY PROBLEMS IN HOME ECONOMICS EDUCATION. (1-6 cr [max 12 cr])
Topic of current concern.

5440. COMPUTER APPLICATIONS IN HOME ECONOMICS. (3 cr; offered when feasible)
Uses of computers in instruction and management of home economics programs; review of software.

5500. PROSEMINAR: HOME ECONOMICS EDUCATION. (2 cr; required of all new grad students)
Relation of processes and standards of rational thought to professional competence and goals of a graduate program of study.

5505. SEMINAR: SUPERVISION OF STUDENT TEACHING. (2 cr; offered when feasible)
Examination of research pertinent to purposes, procedures, evaluation, and interpersonal relations.

5520. PHILOSOPHY OF HOME ECONOMICS. (4 cr; prereq #; offered alt yrs)
Application of philosophic thought to conceptions of home economics upheld in literature and practice.

5600. PRACTICUM: ADULT EDUCATION. (1-9 cr; prereq #)
Individual field assignments under supervision.

5900. READINGS IN HOME ECONOMICS EDUCATION. (1-3 cr [max 12 cr]; prereq #)
Independent study under tutorial guidance.

5920. DIRECTED STUDIES. (1-6 cr; prereq #; S-N optional)
Opportunity for individualized learning experience in areas not covered by regular courses.

8300. RESEARCH METHODS. (3 cr; prereq 5315, #; offered when feasible)
Methods of inquiry; descriptive and causal-comparative methods, with attention to experimentation.

8305. RESEARCH METHODS. (3 cr; prereq 8300, 9 cr in history and philosophy of education, or history, or philosophy, #)
Historical and philosophical methods applied to problems of meaning, validity, value, and conceptual structure.

8500. SEMINAR: CURRICULUM DEVELOPMENT. (2 cr; prereq 5300 or 5305, 8300; offered when feasible)
Examination of philosophical, descriptive, and experimental research pertinent to the development of a theory of curriculum.

8510. SEMINAR: IMPROVEMENT OF INSTRUCTION IN ADULT EDUCATION. (2 cr; prereq 5320 or #; offered when feasible)
Examination of research and literature.

8515. SEMINAR: TEACHER EDUCATION. (2 cr; prereq 5300, 8300, Educ 8285; offered when feasible)
Research related to problems of selection and education of teachers of home economics and family life education; development of a theoretical framework.

8520. SEMINAR: HISTORY AND PHILOSOPHY OF HOME ECONOMICS EDUCATION. (2 cr; prereq 5325, 8305; offered when feasible)
Examination of sources of data to trace the meaning of home economics as a field of study; relation of developments in the field to intellectual forces in society; examination of conceptual foundations. Emphasis during any quarter on any one of these three areas.

8525. SEMINAR: ADMINISTRATION AND SUPERVISION OF HOME ECONOMICS PROGRAMS. (2 cr; prereq 5320, 8520 or #; EdAd 8201 or EdAd 8253 recommended; offered when feasible)
Application of research and theory of educational administration to clarify the role of leadership in home economics.

8530. SEMINAR: HOME ECONOMICS EDUCATION. (1 cr [max 3 cr])
Discussion and reports of inquiry into selected topics of concern to home economics educators.

8631. PRACTICUM: HOME ECONOMICS TEACHER EDUCATION. (3 cr [max 6 cr]; prereq #; offered when feasible)
Individually planned and supervised practice in a selected area of home economics teacher education.

8900. PROBLEMS: HOME ECONOMICS EDUCATION. (1-9 cr; prereq 8300, #)
Independent study of current educational problems.

Industrial Education (Ind)

5100. COMMUNICATIONS OCCUPATIONAL EXPERIENCE. (1-5 cr [max 15 cr]; prereq #)
Structured/supervised employment in the communications industry. Credits derive from the ratio of 100 clock hours of supervised work experience per credit. Total credits earned in 5100, 5101, 5102, 5103 may not exceed 15.

5101. PRODUCTION/MANUFACTURING OCCUPATIONAL EXPERIENCE. (1-5 cr [max 15 cr]; prereq #)
Structured/supervised employment in the production/manufacturing industry. Credits derive from the ratio of 100 clock hours of supervised work experience per credit. Total credits earned in 5100, 5101, 5102, 5103 may not exceed 15.

5102. POWER/ENERGY OCCUPATIONAL EXPERIENCE. (1-5 cr [max 15 cr]; prereq #)
Structured/supervised employment in the power/energy industry. Credits derive from the ratio of 100 clock hours of supervised work experience per credit. Total credits earned in 5100, 5101, 5102, 5103 may not exceed 15.

5103. CONSTRUCTION OCCUPATIONAL EXPERIENCE. (1-5 cr [max 15 cr]; prereq #)
Structured/supervised employment in the construction industry. Credits derive from the ratio of 100 clock hours of supervised work experience per credit. Total credits earned in 5100, 5101, 5102, 5103 may not exceed 15.

5112. CONSTRUCTION: SPECIALIZATION. (1-9 cr; prereq △)
Integration of specialized technical instruction in advanced or emerging areas into courses in industrial education.

5113. SPECIAL TOPICS IN CONSTRUCTION. (1-6 cr)
Topic not covered by available courses.

5122. GRAPHIC COMMUNICATIONS: SPECIALIZATION. (1-9 cr; prereq △)
Integration of specialized technical instruction in advanced or emerging areas into courses in industrial education.

5123. SPECIAL TOPICS IN COMMUNICATIONS. (1-6 cr)
Topic not covered by available courses.

5132. MANUFACTURING: SPECIALIZATION. (1-9 cr; prereq △)
Integration of specialized technical instruction in advanced or emerging areas into courses in industrial education.

5133. SPECIAL TOPICS IN MANUFACTURING. (1-6 cr)
Topic not covered by available courses.

5142. POWER AND ENERGY: SPECIALIZATION. (1-9 cr; prereq △)
Integration of specialized technical instruction in advanced or emerging areas into courses in industrial education.

5143. SPECIAL TOPICS IN POWER AND ENERGY. (1-6 cr)
Topic not covered by available courses.

5152. TRANSPORTATION: SPECIALIZATION. (1-9 cr; prereq △)
Integration of specialized technical instruction in advanced or emerging areas into courses in industrial education.

5153. SPECIAL TOPICS IN TRANSPORTATION. (1-6 cr)
Topic not covered by available courses.

5300. INDUSTRIAL SURVEYS. (3 cr)
Practices and techniques for studying instructional needs to establish or improve industrial courses in schools and industry.

5301. TESTS IN INDUSTRIAL SUBJECTS. (3 cr)
Development, performance evaluations, work attitude evaluations, student progress reporting systems.

5302. INSTRUCTIONAL MANAGEMENT. (3 cr)
Theory and application of classroom and laboratory management practices for industrial educators.

5303. INSTRUCTIONAL AIDS. (3 cr; prereq educ major or grad)
Planning, construction, use.

5305. CRITICAL ISSUES IN INDUSTRIAL EDUCATION. (3 cr; prereq educ major or grad)
Identification, analysis, and discussion of major current problems in the field.

5306. INDUSTRIAL EDUCATION WORKSHOP. (1-6 cr; prereq tchg exper, #)
Areas of concentration vary with each offering.

5309. CONFERENCE LEADING FOR INDUSTRY. (3 cr; prereq #)
Purposes, advantages, and limitations of method; techniques of procedure; experience in planning, leading, and evaluating conferences and in writing summaries.

5310. COORDINATION. (3 cr)
Duties and responsibilities of coordinators in trade schools, part-time programs, and comprehensive high schools.

5312. SUPERVISION OF INDUSTRIAL EDUCATION. (3 cr)
Functions of communications, group dynamics, management by objectives, motivation, problem solving, delegation and evaluation.

5314. ADMINISTRATION OF INDUSTRIAL EDUCATION. (3 cr)
General and vocational phases; objectives, programs, and practices; laws, rulings, and standards for aid; significant literature.

5320. VOCATIONAL GUIDANCE. (3 cr)
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)
History, objectives, development, and current practices of the field.

5330. INDUSTRIAL COURSE CONSTRUCTION. (3 cr; prereq educ major or grad)
Principles and techniques; experience in planning, organizing, and building a teaching guide.

5344. FACILITIES AND MANAGEMENT. (3 cr; prereq 1300 or 5330 or #)
Planning, evaluation, and management of industrial education shop and laboratory facilities.

5360. INDUSTRIAL INSTRUCTION. (3 cr)
Concepts and techniques of instruction in the industrial arts, trade and industrial schools and classes, and training- within-industry programs.

5400. INSTRUCTIONAL MATERIALS LABORATORY FOR NONMAJORS. (3 cr; prereq tchg exper or #)
For students needing manipulative skills and craftwork activities in their teaching; individual and group projects.

5401. WORKSHOP: OCCUPATIONAL EDUCATION PROGRAMS FOR HANDICAPPED. (1-6 cr; prereq #)
Examination of exemplary programs in occupational education; workshop sessions involving directors of model programs and other personnel.

5600. INSTRUCTIONAL MATERIALS LABORATORY. (3-6-9 cr; prereq major, tchg exper or #)
Laboratory and shop experiences with new materials, processes, and equipment; development of complementary instructional materials.

5901. INDEPENDENT STUDY. (1-6 cr; prereq △)
In-depth study of areas in education, or supplementation of areas not covered in regular course structure.

8300. LITERATURE OF INDUSTRIAL EDUCATION. (3 cr; prereq #)
Professional literature, organizations, leaders, and movements in the field.

8310. RESEARCH. (3 cr; prereq #)
Analysis of existing research; selection of problems; organization and presentation of projects.

8700. SEMINAR: INDUSTRIAL EDUCATION. (No cr)
Required of all candidates for advanced degrees.

8900, 8901, 8902. RESEARCH PROBLEMS. (3-6-9 cr per qtr; prereq approval of candidacy)
Individual conferences.

Vocational Education (VoEd)

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)
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, §Educ 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, §EdAd 5274 or 8274)
Present status, development, functions, organization, curriculum, trends in postsecondary but nonbaccalaureate institutions.

5280. STRESS MANAGEMENT FOR THE VOCATIONAL EDUCATOR. (1 cr)
Managing stressful situations in vocational classrooms and laboratories.

5281. TORT LIABILITY AND THE VOCATIONAL EDUCATOR. (1 cr)
Complying with local requirements of managing vocational education programs.

5282. COUNSELING ADULTS IN TRANSITION. (3 cr, §EPsy 5434)
Theoretical and empirical knowledge as base for analyzing adaptation to transitions; applications of counseling interventions; training in coping skills.

5283. TIME MANAGEMENT FOR THE VOCATIONAL EDUCATOR. (1 cr)
Concepts, strategies, and skills; managing and organizing personal and professional life to support educational process and environment.

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.

5285. VOCATIONAL PLACEMENT. (3 cr)
Methods and techniques for designing effective school-based vocational placement program. Principles of school-based placement, placement process, and planning placement program.

5286. MARKETING OF EDUCATION AND TRAINING PROGRAMS. (3 cr)
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.

5300. PHILOSOPHY AND PRACTICE OF VOCATIONAL EDUCATION. (3 cr)
Interpretation of purposes of vocational education in varying socioeconomic contexts; analysis of vocational fields in regard to recipients, practices, legislation, and funding.

5330. COORDINATION TECHNIQUES IN COOPERATIVE EDUCATION. (3-4 cr; §BME 5352, §HEEd 5106, §Ind 5310, §AgEd 5071)
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)
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 #)
Examination of contextual bases underlying education for work; implications for practice.

5451. MICROCOMPUTER INSTRUCTIONAL UTILITY SOFTWARE. (2 cr; prereq microcomputer coursework or experience)
Examination of software to aid in preparation of tests, worksheets, learner reports and records, instructional inventory records, and classroom group presentations for vocational educators.

5452. AUTHORING INSTRUCTION USING MICROCOMPUTERS. (3 cr; prereq 5450 or equiv or #)
Design and preparation of instructional materials using an authoring language.

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)
Context, definition, methods, and information needs in planning at national, state, and local education agency levels.

5700. TEACHING ENTREPRENEURSHIP: SMALL BUSINESS MANAGEMENT. (4 cr)
Methods, organization, curriculum modification, and implementation of education programs.

5750. TRAINING IN INDUSTRY AND BUSINESS. (3 or 4 cr)
Appraisal of the training function in industry and business; advancement of competencies in areas of analysis, design, development, delivery, and evaluation of training.

5760. ORGANIZATION DEVELOPMENT IN INDUSTRY AND BUSINESS. (3 or 4 cr)
Introduction to major concepts, skills, and techniques.

5762. MANAGEMENT OF CONFLICT. (2 cr)
Types, sources, and diagnosis of conflict styles; skills and strategies for managing interpersonal, intergroup, and intragroup conflict.

5770. TRAINING AND DEVELOPMENT. (1-4 cr)
Developments relating to problems, practices, programs, and methodologies in training and development; content varies with each offering.

5780. INTERNSHIP: TRAINING AND DEVELOPMENT. (Cr ar [max 15 cr]; prereq 5750)
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.

5790. STRATEGIC PLANNING: TRAINING AND DEVELOPMENT. (3-4 cr; prereq 5750 or 5760)
Human capital as component of industry and business strategic planning; analysis and articulation of practices.

5800. WORKING WITH SPECIAL NEEDS STUDENTS. (3 cr)
Designed to help 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.

5802. EDUCATING DISADVANTAGED VOCATIONAL STUDENTS. (1 cr)
Overview of nature of such students; instructional strategies for meeting their educational needs.

5803. MICROCOMPUTER MANAGEMENT OF SPECIAL NEEDS STUDENT INFORMATION AND SERVICES. (2 cr)
Application of microcomputer to student-oriented information and related services; identification, analysis, manipulation of types of relevant information.

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.

5900. USING VOCATIONAL EDUCATION RESEARCH. (3 cr; prereq grad program admission or #)
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.

8100. VOCATIONAL EDUCATION TUTORIAL. (3-18 cr; prereq #)
Selected fundamental vocational education propositions.

8110. COMPARATIVE SYSTEMS IN VOCATIONAL EDUCATION. (3 cr; prereq VoEd grad student)
Comparison of vocational education and training systems within U.S. and between U.S. and other countries.

8130. CRITICAL ISSUES IN VOCATIONAL EDUCATON. (3 cr; prereq admission to doctoral program in educ, 5300 or 8110 or #)
Perennial issues in context of contemporary vocational education and training settings.

8500. SEMINAR: GENERAL EDUCATION ASPECTS OF THE VOCATIONAL FIELDS. (3 cr; prereq #)
Integrating conceptual content from various foundational areas of education for application to particular educational concerns.

8810. INTERNSHIP IN VOCATIONAL EDUCATION. (1-15 cr [max 15 cr]; prereq △)
Student applies for position in professional practice of vocational education; individual arrangements describe specific responsibilities during period of internship.

Water Resources

Regents' Professor: Margaret B. Davis (ecology and behavioral biology); Eville Gorham (ecology and behavioral biology); Herbert E. Wright (geology and geophysics)

Professor: Ira R. Adelman (fisheries and wildlife); E. Calvin Alexander, Jr. (geology and geophysics); Roger E. A. Arndt (St. Anthony Falls Hydraulic Lab); Donald G. Baker (soil science); Paul R. Bloom (soil science); Patrick L. Brezonik (Water Resources Research Center); Kenneth N. Brooks (forest resources); Dwight A. Brown (geography); Robert M. Carlson (chemistry[1]); Hollie L. Collins (biology[1]); David G. Darby (geology[1]); K. William Easter (agricultural and applied economics); Robert C. Einsweiler (Humphrey Institute of Public Affairs, planning); Steven J. Eisenreich (civil and mineral engineering); Cesar Farell (civil and mineral engineering); George R. Foster (agricultural engineering); Luther P. Gerlach (an-

[1]*University of Minnesota, Duluth*

thropology); Philip J. Gersmehl (geography); Hans M. Gregersen (forest resources); David F. Grigal (soil science); Satish C. Gupta (soil science); Richard S. Hanson (microbiology); William E. Larson (soil science); Richard W. Lichty (economics[1]); Walter J. Maier (civil and mineral engineering); Donald C. McNaught (ecology and behavioral biology); Robert O. Megard (ecology and behavioral biology); Robert J. Naiman (fisheries and wildlife); Gary N. Parker (civil and mineral engineering); Hans-Olaf Pfannkuch (geology and geophysics); William E. Seyfried (geology and geophysics); 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 Tilman (ecology and behavioral biology); James C. Underhill (ecology and behavioral biology); John J. Waelti (agricultural and applied economics); Thomas F. Waters (fisheries and wildlife); Melbourne C. Whiteside (biology[1]); John M. Wood (Gray Freshwater Biological Institute)

Associate Professor: Donald N. Alstad (ecology and behavioral biology); James L. Anderson (soil science); Yosef Cohen (fisheries and wildlife); Florence K. Gleason (Gray Freshwater Biological Institute); Sagar M. Goyal (veterinary diagnostic investigation); John S. Gulliver (civil and mineral engineering); Andrew R. Klemer (biology[1]); John L. Nieber (agricultural engineering); Charles A. Onstad (agricultural engineering); James A. Perry (forest resources); C. Ford Runge (agricultural and applied economics); Michael J. Semmens (civil and mineral engineering); Rexford D. Singer (environmental and occupational health); Robert A. Young (agricultural engineering)

Assistant Professor: Charles J. Clanton (agricultural engineering); Dianne Dorland (materials processing engineering[1]); Anne E. Hershey (biology[1]); Randall E. Hicks (biology[1]); Ralph W. Holzenthal (entomology); Anne R. Kapuscinski (fisheries and wildlife); Ian D. Moore (agricultural engineering); Christopher Paola (geology and geophysics); Deborah L. Swackhamer (environmental and occupational health)

Research Associate: Carol A. Johnston (Natural Resources Research Institute[1])

Course of Study—Minor in water resources, applicable to either master's or doctoral programs.

Curriculum—A structured interdisciplinary graduate curriculum is offered. The minor program focuses on four categories: biological sciences, earth and climate sciences, engineering, and social sciences. Students are required to select courses in one of these areas for the master's or in two areas for the doctoral degree. The student's major and minor cannot be in the same category.

Prerequisites for Admission—Admission to the water resources minor program is contingent upon prior admission to the Graduate School and to a master's or doctoral program in a degree-granting department.

Minor Requirements—An introductory seminar on water resources management (2 credits), two core courses (6-9 credits), and elective courses 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 four categories listed under Curriculum above, for both the master's and doctoral degrees. 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 and a List of Courses—Contact the director of graduate studies, Water Resources Minor, c/o The Graduate School, 302a Johnston Hall, University of Minnesota, 101 Pleasant Street S.E., Minneapolis, MN 55455.

Wildlife (FW)

Professor: Gary E. Duke; Gordon W. Gullion; Donald B. Siniff; Anthony M. Starfield; John R. Tester

Adjunct Professor: Alfred H. Berner; David L. Garshellis; L. David Mech; Ulysses S. Seal

Associate Professor: Yosef Cohen, *director of graduate studies;* James A. Cooper; Peter A. Jordan; James R. Kitts; Michael C. Zicus

Adjunct Associate Professor: Ronald L. Tilson

Assistant Professor: Francesca Cuthbert; J. L. David Smith

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—This program is administered within the Department of Fisheries and Wildlife. The wildlife graduate program, unlike the ecology program, is an applied program stressing resource-management applications. For the M.S. degree, emphasis is on wildlife biology and related areas in ecology, animal behavior, and physiology, as well as on management and problem-solving approaches. 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.

Prerequisites for Admission—For the M.S. program, a bachelor's degree and a biological sciences background, preferably with emphasis on terrestrial or wetland vertebrates, and a natural resource management orientation are prerequisites. 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, since the faculty reviews most applications in early February for admission the following fall, it is recommended that complete applications be received by February 1.

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 specialize in 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. Work on the thesis, which is usually field-oriented, may extend over two but not more than three years. In addition to the final oral examination, students must give an oral presentation describing the dissertation results.

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 reasonable exposure to wildlife ecology and management.

For Further Information—Contact the director of graduate studies (wildlife), Department of Fisheries and Wildlife, 200 Hodson Hall, University of Minnesota, 1980 Folwell Avenue, St. Paul, MN 55108.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

5129. MAMMALOGY. (5 cr, §EBB 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)
Lectures and/or laboratories in special fields of wildlife biology given by a visiting scholar or regular staff member.

5398. SPECIAL PROBLEMS IN WILDLIFE BIOLOGY. (Cr ar; prereq #)
Individual field, library, and laboratory research in various areas of wildlife biology.

5601. ASSESSMENT AND MANAGEMENT OF VERTEBRATE POPULATIONS. (5 cr; prereq 1101, 3052, FR 1201)
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.

5602. FISHERIES AND WILDLIFE PLANNING AND POLICY. (4 cr; prereq 3052)
Quantitative management methods such as linear programming; other decision-making methods. Extensive use of computer exercises. Policy and structure of management agencies.

5603 WILDLIFE HABITAT RELATIONSHIPS AND MANAGEMENT. (3 cr; prereq 5601 or #)
Management of habitats for birds and mammals based on their environmental interactions and requirements. Emphasis on regional settings and practices. Lab includes team projects and demonstrations.

5701f, 5702w, 5703s. SENIOR PROBLEM. (1 cr per qtr; prereq FW sr or grad student, or #)
Problem-solving training. Management problem identification and analysis design (fall), information and data gathering and analysis (winter), and oral and written problem reporting (spring). Problem selection influenced by guest speakers, resource agency contacts, and group discussions; topic is contemporary fisheries and wildlife management issue.

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.

8377.* RESEARCH IN WILDLIFE BIOLOGY. (Cr ar; prereq wildlife grad) Cohen, Cooper, Cuthbert, Duke, Gullion, Jordan, Kitts, Mech, Seal, Siniff, Smith, Tester

8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES. (3 cr; prereq intro genetics course or #)
Seminar on current conservation biology issues; genetic, demographic, and environmental analysis and management of populations; ecosystem conservation; case studies of species conservation strategies.

8574.* WILDLIFE MANAGEMENT: UPLAND GAME. (3 cr; prereq 5603 or #; offered alt yrs) Gullion
Survey of life histories, ecology and management of North American upland and small game, with emphasis on forest wildlife species.

8575.* WILDLIFE MANAGEMENT: WATERFOWL. (3 cr; prereq 5603 or #; offered alt yrs) Cooper
Life histories, ecology, and management of North American waterfowl.

8576. WILDLIFE MANAGEMENT: LARGE MAMMALS. (4 cr; prereq #; 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 wildlife management. Presentation of data in time and frequency domains, interpretation of results.

Zoology (Zool)

Professor: Elmer C. Birney, *director of graduate studies;* Franklin Barnwell; Kendall Corbin; Agustin P. Dalmasso; Robert Elde; Stanley Erlandsen; Donald E. Gilbertson; William S. Herman; Robert G. McKinnell; Frank McKinney; David Parmelee; Philip Regal; William Schmid; Akhouri Sinha; Harrison Tordoff; James C. Underhill
Associate Professor: Peter Abrams; Robert C. Bright; Stuart F. Goldstein; Bert Stromberg

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—Contact the director of graduate studies, Zoology Graduate Program, 109 Zoology, University of Minnesota, 318 Church Street S.E., Minneapolis, MN 55455.

Grad 8777. THESIS CREDITS: MASTER'S. (1-16 cr per qtr; Plan A only)

Grad 8888. THESIS CREDITS: DOCTORAL. (1-36 cr per qtr)

For course descriptions, see Ecology, Genetics, and Cell and Developmental Biology.

Related Courses

Related Courses

Degree programs do not exist in the following fields. However, students may earn graduate credit in courses related to their program in these fields.

Afro-American and African Studies (Afro)

Professor: Allen Isaacman; Philip W. Porter; Geneva H. Southall

Associate Professor: Reginald T. Buckner; August H. Nimtz, Jr.; Earl P. Scott; John M. Taborn

Assistant Professor: Victoria B. Coifman; Charles A. Pike; Brenda Plummer

5072. RACISM: SOCIAL/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 milieus of student interest.

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. CONTEMPORARY BLACK THEATRE, 1960-PRESENT. (4 cr, §Th 5181)
Essays, plays, playwrights, and theatres that have contributed significantly to contemporary black theatre, from beginning of Black Arts Movement to present.

5182. BLACKS IN AMERICAN THEATRE, 1820-1960s. (4 cr, §Th 5182)
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.

5201. THE BLACK COMPOSER: CONTRIBUTIONS TO WESTERN MUSIC AND CULTURE. (4 cr, §Mus 5708; prereq grad student or #) Southall
Achievements of black Americans in classical music.

5301. AFRICAN LITERATURE: THE NOVEL. (4 cr) Pike
The novel in continental Africa in English, French, and African languages. Non-English materials in translation.

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)
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.

5701, 5702. PROSEMINAR: AFRO-AMERICAN STUDIES. (4 cr per qtr, §3701, 3702; prereq #)
5701: Multidisciplinary exploration of classic works in Afro-American Studies. 5702: Comparatist frameworks for Afro-American Studies 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.

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 from quarter to quarter. Topics specified in *Class Schedule*.

5970. DIRECTED STUDIES. (1-6 cr; prereq #, △, CLA approval; qualified sr and grad students may register with # for work on tutorial basis) Staff

American Indian Studies (AmIn)

Language and Culture

5048. INDIANS OF THE GREAT LAKES. (4 cr; prereq 3111, 3002 or #; offered when feasible) Staff
The history, social structure, and intertribal relations of American Indian tribes in the Great Lakes region.

Contemporary Issues

5251. AMERICAN INDIANS AND THE CINEMA. (4 cr, §AmSt 5251)
Stereotypes and visage of tribal people in selected motion pictures from silent documentaries to the new Westerns.

5322. CONTEMPORARY INDIAN EDUCATION. (4 cr; offered when feasible)
Critical issues in the education of American Indian youth.

5332. CONTEMPORARY ISSUES IN INDIAN LAW. (4 cr; prereq 3121 or #; offered when feasible)
Specific questions in Indian law currently the subject of court litigation, legislative inquiry, administrative hearings, or Indian activism.

5341. CONTEMPORARY INDIAN MOVEMENTS. (4 cr)
Indian organizations and social movements during the 20th century.

Tribal Development

5411. URBAN INDIAN COMMUNITIES. (4 cr)
Social science and historical analysis of the rapid cityward Indian migration since World War II.

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.

5423. TRIBAL POLICY AND PROGRAM ANALYSIS. (4 cr; prereq 3112 or #; offered when feasible)
Tribal policy, formulation processes, selected policy issues; related programs and services.

Special Topics

5920. SEMINAR IN AMERICAN INDIAN STUDIES. (Cr ar; prereq stated 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

5990. DIRECTED RESEARCH. (4-15 cr; prereq by petition only, #, △, CLA approval) Staff
Independent research under the guidance of a faculty member.

Biology (Biol)

5001f,w,s,su. BIOCHEMISTRY. (4 cr, §3021; prereq 1011 or 1009, 12 cr organic chemistry or #)
Biochemistry and biophysics of cells; emphasis on enzyme catalysis, cellular energetics, biosynthesis of cellular constituents, and cellular regulatory mechanisms.

5003f,w,s. GENETICS. (4 cr, §GCB 3022, §GCB 5022; prereq 5001)
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)
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)
Taxonomy, anatomy, physiology, biochemistry, and ecology of microbes. Emphasis on molecular structure in relation to bacterial function.

5041. ECOLOGY. (4 cr; 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; prereq #) 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, △; 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.

5870. ITASCA SEMINAR. (Cr ar; prereq #, △) Staff
Weekly seminar by faculty and visiting lecturers.

5890su. RESEARCH PROBLEMS AT ITASCA. (Cr ar; prereq #; △) 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

5970. DIRECTED STUDIES. (Cr ar; prereq #, △, CLA approval)

Humanities (Hum)[1]

Professor: Jackson P. Hershbell; Richard D. Leppert; Bruce K. Lincoln; Robert B. Tapp

Associate Professor: W. John Archer, *chair;* George Lipsitz

Assistant Professor: George Kliger; John W. Mowitt; Gianna Pomata; Gary C. Thomas

5301. SOCIETY, IDEOLOGY, AND THE PRODUCTION OF ART. (4 cr, §CSDS 5301; prereq jr or sr or grad; offered alt yrs) 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; prereq jr or sr or grad; offered alt yrs) 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.

5711. INTERPRETATION OF MYTH. (4 cr, §CSDS 5711, §RelS 5111; prereq jr or sr or grad; offered alt yrs) Lincoln
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.

5751. BASIC CONCEPTS OF CINEMA. (4 cr, §CLit 5221) Bensmaia, Mowitt
Film, as a mass cultural phenomenon, in historical context; current film theory; fundamentals of film analysis. Comparative perspective on mass culture.

5756. ART AND IDEOLOGY: LIVING CINEMA. (4 cr, §CLit 5243) Bensmaia
Principal aesthetic and ideological characteristics of *Direct-Cinema,* its impact on contemporary development of cinema of fiction, role in evolution of different forms of documentary and political cinema.

5831 (formerly 5231). INDO-EUROPEAN CIVILIZATIONS. (4 cr; prereq jr or sr or #) Lincoln
Common origins of Celtic, Germanic, Greek, Roman, and Indo-Iranian cultures. Myth, religion, poetry, philosophy in context of social, political, economic life. Epic literature, priestly ideology, and comparative method in linguistics, archaeology, and study of myth.

5832. PRE-CHRISTIAN EUROPE: GERMANS AND CELTS. (4 cr; prereq jr or sr or #) Lincoln
Overview of two major European civilizations in antiquity. Literary forms (epic, saga, poetry), art, and religion, along with social, political, and economic background.

5833. INDIA'S GODS AND GODDESSES. (4 cr, §SoAS 5833; prereq Hum 1211 or RelS 1031 or SoAS 1504 or equiv, jr or sr or #) Tapp
Societies create gods/goddesses and are in turn shaped by their mythological creations. Understanding Indian history by examining development of Krishna, Shiva, and Kali. Interactions of region, gender, and class as manifested in art, drama, literature, and ideology.

5835 (formerly 5035). RICHARD WAGNER'S *DER RING DES NIBELUNGEN:* MUSIC, MYTH, AND POLITICS. (4 cr; prereq jr or sr, #) Thomas
Literary and musical analysis of the four works composing Wagner's Ring cycle: *Das Rheingold, Die Walkure, Siegfried, Gotterdammerung.* Critical assessment of Wagner's achievement and influence.

5910. TOPICS IN HUMANITIES. (4 cr per qtr [max 15]; prereq jr, sr or grad student)
Topics specified in *Class Schedule.*

5910H. TOPICS IN HUMANITIES: HONORS. (4 cr; prereq jr or sr or grad, #)

5970. DIRECTED STUDIES. (Cr ar; prereq jr, sr or grad student and #, △, CLA approval)
Guided individual reading or study.

5970H. DIRECTED STUDIES: HONORS. (Cr ar; prereq jr or sr or grad, #, △, CLA approval)

Jewish Studies (JwSt)

Professor: Tzvee Zahavy, *director;* Bernard Bachrach; Hyman Berman; David Cooperman

Associate Professor: Jonathan Paradise; Riv-Ellen Prell; Daniel Reisman

[1]*See Comparative Studies in Discourse and Society in the Fields of Instruction section for other graduate-level courses offered by the Humanities Department.*

The following JwSt courses may be used to satisfy requirements for the M.A. (Plan B) degree in Arabic, along with courses under the following designators: Arabic (Arab)—see Arabic; Akkadian (Akka); Ancient Near Eastern (ANE); Aramaic (Arm); Hebrew (Hebr); Sumerian (Sum)—see Near Eastern Studies under Related Courses; Persian (Per); South Asian Studies (SoAS)—see South and Southwest Asian Studies. These courses may also be used as part of a minor program or a related field. Students who wish to present a Ph.D. minor composed of these courses should plan their program in consultation with an adviser.

5621. COMPARATIVE SOCIOLOGY OF JEWISH COMMUNITIES. (4 cr; prereq Soc 1001 or 1002 or #)
Comparative historical, cross-societal analysis of Jewish communities. Social organization and structure of Diaspora communities. Sephardic, Ashkenazic, Asian communities. Jews in American society: demography, social ecology, social psychology, stratification patterns.

5900. TOPICS IN JEWISH STUDIES. (4 cr, §RelS 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 #, △, CLA approval)
Guided individual reading or study.

Latin American Studies (LAS)

5101. METHODS AND SOURCES FOR LATIN AMERICAN STUDIES. (4 cr; prereq jr or sr or grad student, reading knowledge of Spanish or Portuguese or #)
Research sources, particularly bibliographic; reference materials and principal works within each discipline. Designed to prepare students for research in Latin American studies utilizing a discipline centered approach.

5120s. SEMINAR: TOPICS. (4 cr)
Integrating course for students majoring in Latin American studies.

5530. TOPICS IN LATIN AMERICAN STUDIES. (4 cr)
Topics in various social science and humanities disciplines focusing on Latin America.

5970f,w,s. DIRECTED STUDIES. (Cr ar; prereq #, △, CLA approval)

Near Eastern Studies

Professor: Tzvee Zahavy

Associate Professor: Jonathan Paradise; Daniel D. Reisman

Akkadian (Akka)

5011-5012-5013. ELEMENTARY AKKADIAN. (4 cr per qtr; for advanced undergrad students by permission only and for grad students)
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: BACKGROUND OF THE BIBLE. (4 cr, §3505; prereq grad student or #)
Students attend lectures of 3505 but follow special syllabus. Knowledge of Hebrew not required.

5701. INTRODUCTION TO COMPARATIVE STUDY OF SEMITIC LANGUAGES. (4 cr; prereq grad student or #, 1 yr of two Semitic languages)
Historical survey of linguistic development in Semitic languages. Selected problems in phonology and morphology.

5711. NORTHWEST SEMITIC INSCRIPTIONS. (4 cr; prereq Hebr 3013 or #)
Introduction to Paleo-Hebrew script. Morphology, phonology, syntax, and linguistic changes in early Hebrew, Moabite, Phoenician, and Punic inscriptions.

5970. DIRECTED STUDIES. (1-4 cr; prereq #, △, CLA approval)
Special problems for advanced students.

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; recomended for students of Talmud; prereq 1 yr Hebrew or Arabic or #)
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.

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 #)
Selected issues in modern biblical studies. Scientific methodology and use of research tools.

5970. DIRECTED READINGS. (Cr ar; prereq 3013, #, △, CLA approval)
Special problems for advanced students.

5990. HONORS COURSE: RESEARCH. (Cr ar; prereq 5970 or #)
Independent research under guidance of a faculty member on a topic of interest to the student.

8321. JUDEO-ARABIC LITERATURE. (3 cr; prereq knowledge of Arabic and Hebrew or #)
Techniques and methodologies of research. Important works. Selected readings from Saadia, Haleri, Maimonides, and some medieval Jewish chronicles (all written in Judeo-Arabic).

Sumerian (Sum)

5011-5012. ELEMENTARY SUMERIAN. (4 cr per qtr; prereq advanced undergrad student with 2 yrs other foreign language or grad student)
Introduction to Sumerian writing and grammar. Readings from classical Sumerian literary and historical texts.

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, communication disorders, education, education (emphasis music education), educational psychology (counseling), and English. 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 and master of social work degrees are offered. The 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 Office of the Assistant Dean of the Graduate School, 431 Darland Administration Building, Duluth.

International students are eligible to apply for international student tuition scholarships. A special form is required for this purpose. These awards are usually made during spring quarter. International students should submit their completed application to the Graduate School as early as possible. For information, write to the international student adviser, 184 Darland Administration Building, University of Minnesota, Duluth, MN 55812.

Assistantships are normally granted through the individual departments. Information about them can be obtained by writing to the department director of graduate studies.

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 General Bulletin*.

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 master's programs exist in biochemistry, microbiology, pharmacology, and physiology; cooperative doctoral programs exist in biochemistry, chemistry, and microbiology. Students interested in these programs should see the listing for each program in the Fields of Instruction section of this bulletin.

General information concerning graduate work on the Duluth campus may be obtained from the Office of the Assistant Dean, 431 Darland Administration Building, University of Minnesota, Duluth, MN 55812.

Applied and Computational Mathematics

Director of Graduate Studies—Associate Professor Harlan W. Stech.

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. Scores from the General (Aptitude) and Mathematics Subject (Advanced) Tests of the Graduate Record Examination are recommended; they are required if the undergraduate degree is not from the United States or Canada. 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, 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 and statistics. 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—Associate Professor Dean R. Lettenstrom.

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 (20 to 30) 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, distributed in most cases as follows: 30 credits in studio art and 14 credits in art history (related field).

Biology

Director of Graduate Studies—Associate Professor David J. Schimpf.

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 General Test (verbal, quantitative, and analytical sections) and from the Subject (Advanced) Test in biology as part of their application materials.

Prior coursework and Graduate Record Examination 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—Associate Professor Kjell R. Knudsen.

Degree Offered—M.B.A. (Plan B only).

Language Requirement—None.

Credit Requirements—A minimum of 45 credits.

Major Field Requirements—A total of 27 credits in 8xxx courses in the M.B.A. core is required. In addition, 9 credits in an M.B.A. research project are required, including 3 credits of coursework in research methodology.

Related Field Requirements—A total of 9 credits in supporting fields.

Chemistry

Director of Graduate Studies—Professor James C. Nichol.

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 prior to 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—Assistant Professor Cindy S. Spillers.

Degree Offered—M.A. (Plan B only).

Prerequisites for Admission—Bachelor's degree in communication disorders or 49 quarter credits in speech/language pathology, audiology, speech/language/hearing science, or related areas. Although no specific amount of clinical experience is required for admission, candidates with fewer than 100 supervised hours of clinical practice may need additional time to complete the degree.

Language Requirement—None.

Major Requirements—50 credits in communication disorders are required, including CD 5060, 5076, 5276, 5375, 5472 or 5476, 5505, 5500, 5550, 5575, 5600, 5621, 5956, 8100, 8176, 8205, and 8305.

Other Requirements—8 credits of coursework outside of communication disorders. Final written and oral examinations. Plan B projects may be completed in conjunction with any course or in 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 Keith Pierce.

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 concurrent with graduate work. The Graduate Record Examination (GRE) General Test is required. Students applying for financial aid should also take the GRE Subject Test in computer science.

Language Requirement—None.

Major Requirements—At least 49 credits of graduate coursework are required, which must include CS 8001, 8002, 8003, 8010, 8011, and 1 credit of the CS 8900 seminar.

Other Requirements—Students must demonstrate proficiency in the use of computers by writing and executing a significant and adequately documented computer program, which can be carried out in conjunction with the thesis, Plan B project, graduate seminar, or independent study. All students must pass a comprehensive written examination. Each student must present the thesis or a project at a department colloquium. For Plan A, students must pass an oral examination in defense of the thesis. For Plan B, students are required to take at least 12 additional credits in graduate computer science courses.

Education

Director of Graduate Studies—Professor William C. Gemeinhardt.

Degree Offered—M.A. (Plan B only).

Prerequisites for Admission—A minimum of 15 quarter credits in education.

Language Requirement—None.

Credit Requirements—The 4 to 9 credits for the Plan B project(s) are to be included in the major. A minimum of 8 credits must be completed in one or more related fields outside the major. The stu-

dent's program will include the following components: handicapping conditions, learning theory, multicultural education, research methods, and the purposes and goals of human service professions.

For information about the master of education degree program, contact the dean of the College of Education at Duluth.

Education With Emphasis in Music Education

Director of Graduate Studies—Professor Phillip Coffman.

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.

Major Requirements—A minimum of 27 credits in music education is required. The Plan B research project for 9 credits is included as part of the 27 credits. Five additional credits in music education, music, or other areas must be completed.

Related Field(s) Requirements—A minimum of 12 credits is required in the related field of music. Areas outside of music education and music may be included to complete the 44 credits required for the degree.

Educational Psychology

Director of Graduate Studies—Professor Moy F. Gum.

Degrees Offered—M.A. (Plan B) with emphasis on counseling.

Prerequisites for Admission—A minimum of 6 quarter credits in psychology, GRE General test (which is preferred, although satisfactory performance on the Miller Analogies Test will be accepted), evidence of social service activities and experience related to guidance interests, and recommendation of the previous employer. Successful teaching or social service work is helpful (most states require public school counselors to have teacher licensure).

Language Requirement—None.

Major Requirements—50 to 65 graduate credits in psychological foundations (PsyF) and psychological applications (PsyA), of which 6 to 9 credits will count toward the research project requirement (see below).

Related Field Requirements—A minimum of 8 credits must be taken outside the major.

Other Requirements—Completion of 6 to 9 credits of Plan B projects (PsyF 8050), a final written comprehensive examination, and when required, an oral examination.

English

Director of Graduate Studies—Professor Joseph E. Duncan.

Degrees Offered—M.A. (Plan B); M.A. (Plan B) with emphasis on English studies.

M.A. (Plan B)

Prerequisites for Admission—A minimum of 27 quarter credits in English, 12 of which must be in the upper division. Students who have not had satisfactory courses in Chaucer, Shakespeare, Milton, and linguistics must take the necessary courses as part of their regular graduate program.

Language Requirement—Reading knowledge of French, German, Latin, Greek, Italian, Spanish, or Russian.

Major Requirements—36 credits in English courses in literature, linguistics, writing.

Related Field Requirements—A minimum of 8 credits in a field(s) related to the major. Linguistics can be taken as a related field or as a designated minor.

Other Requirements—Completion of a two-day, five-hour written examination containing the following sections: (1) analysis of a text selected prior to the examination; (2) discussion of questions on a reading list prepared by the candidate and approved by the graduate committee; and (3) discussion of questions on a related field.

Before taking the examination, the student must submit two or three projects (normally papers) totaling 120 hours of effort. The projects will normally be completed in connection with graduate courses in English or in a related field. Completed projects must be approved by a member of the graduate faculty.

M.A. (Plan B) with Emphasis on English Studies

Prerequisites for Admission—32 credits in English (appropriate courses in literature and/or language and/or advanced composition), including 16 in the upper division.

Major Requirements—A minimum of 36 credits in the following categories: literature and literary analysis, linguistics, rhetoric and composition theory, and electives.

Related Field Requirements—Same as for M.A. (Plan B) program above.

Other Requirements—A foreign language, as required for the M.A. program, or 8 credits of graduate coursework in addition to the minimum 44 credits.

Candidates will take a comprehensive examination, which will include both written and oral sections. The examination will be individually designed to test the student's knowledge in the program of studies completed.

The Plan B project requirement is the same as for the M.A. (Plan B) program.

Geology

Director of Graduate Studies—Professor James A. Grant.

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 and one year each of college mathematics including two terms of calculus, college chemistry, and college physics. Candidates with degrees in chemistry, physics, biology, engineering, or other disciplines may be admitted on an individual basis.

Language Requirement—None.

Other Requirements—Advisory examination at the beginning of the first quarter of residency, a subject examination during the second quarter, and an oral final examination.

Physics

Director of Graduate Studies—Associate Professor Bo R. Casserberg.

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 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 an interdisciplinary study in environmental problems. A student who wants to complete a minor must complete 9 credits in a single department outside physics.

Social Work

Director of Graduate Studies—Assistant 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: economics, political science, psychology, statistics, sociology, and anthropology (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);
- a minimum GPA of 2.80 on a 4 point scale is required;
- 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) are 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.

Campus Maps

BUILDING ABBREVIATIONS AND BUILDING ACCESSIBILITY INFORMATION

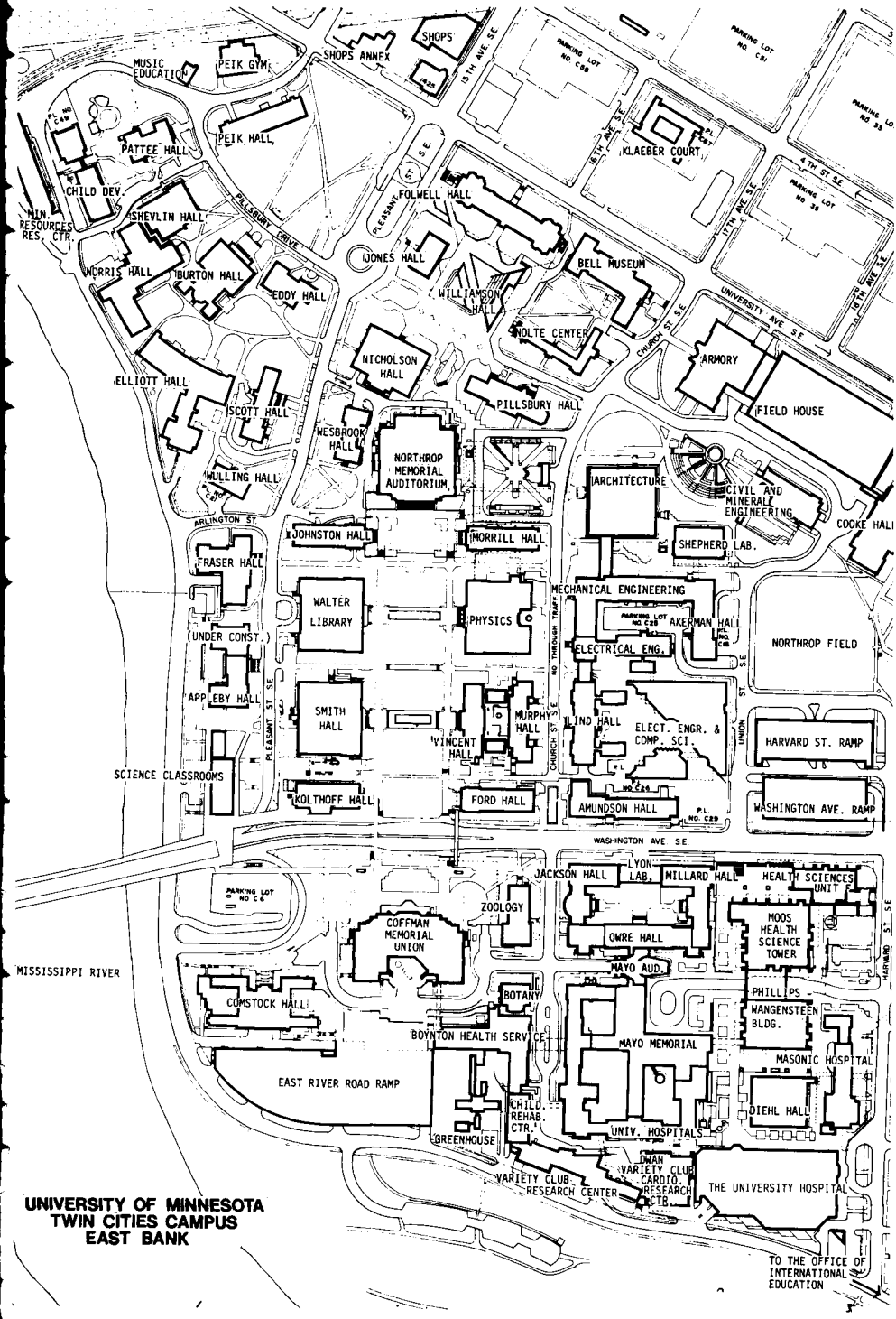
MINNEAPOLIS

East Bank

AkerH, Akerman Hall ⊡
AmundH, Amundson Hall ♿ * L
ApH, Appleby Hall ■ *
Arch, Architecture ♿ * L
Armory ⊡
BellMus, Museum of Natural History ♿ * L
BFAB, Bierman Field Athletic Building ⊡ * L
Botany ⊡
BoynHS, Boynton Health Service ♿ * L
BuH, Burton Hall ♿ * L
CenH, Centennial Hall
ChDev, Child Development ♿ *
ChRC, Children's Rehabilitation Center ♿ * L
CivMinE, Civil and Mineral Engineering ♿ * L
CMU, Coffman Memorial Union ♿ * L
CookeH, Cooke Hall ■
DiehlH, Diehl Hall ♿ *
DVCCRC, Dwan Variety Club Cardiovascular Research Center ♿ * L
EddyH, Eddy Hall ■
EdHAn, Eddy Hall Annex
ElectE, Electrical Engineering ⊡
EltH, Elliott Hall ♿ * L
FieldHse, University Field House
FolH, Folwell Hall ♿ * L
FordH, Ford Hall ♿ * L
FraserH, Fraser Hall ⊡
FronH, Frontier Hall ♿ *
HL, St. Anthony Falls Hydraulic Laboratory (Hennepin Island)
HSUnitF, Health Sciences Unit F ♿ * L
JacH, Jackson Hall ♿ *
JOAd, Jackson-Owre Addition ♿ *
JohH, Johnston Hall ♿ * L
JonesH, Jones Hall ■
KlaCt, Klaeber Court ⊡
KoltH, Kolthoff Hall ♿ * L
LindH, Lind Hall ♿ * L
LyonL, Lyon Laboratories
Mayo, Mayo Memorial ♿ * L
MechE, Mechanical Engineering ♿ * L
MinMet, Mines and Metallurgy ♿ *
MirdH, Millard Hall ♿ *
MMA, Mayo Memorial Auditorium ⊡
MoosT, Moos Health Sciences Tower ♿ * L
MorH, Morrill Hall ♿ * L
MRRC, Mineral Resources Research Center ■
MurH, Murphy Hall ■
MusEd, Music Education ■
NichH, Nicholson Hall ♿ * L
NMA, Northrop Memorial Auditorium ♿ * L
NorrisH, Norris Hall ⊡ L
OwreH, Owre Hall ♿ * L
PeikG, Peik Gym ⊡
PeikH, Peik Hall ⊡ *
Phys, Tate Laboratory of Physics ⊡ *
PiH, Pioneer Hall ⊡
PillsH, Pillsbury Hall "
PtH, Pattee ♿ *
PWB, Phillips Wangensteen Building ♿ * L
SaH, Sanford Hall ■
SciCB, Science Classroom Building ⊡ *
ScottH, Scott Hall ■
ShepLab, Shepherd Laboratories ♿ *
ShevH, Shevlin Hall ♿
SmithH, Smith Hall ♿ *
Stad, Stadium ⊡ L
TerH, Territorial Hall ■
TNA, Temporary, North of Appleby ■
VFWCRC, VFW Cancer Research Center
VinH, Vincent Hall ♿ *
WaLib, Walter Library ♿ * L
WesH, Wesbrook Hall ■
WmsA, Williams Arena ⊡ L
WmsonH, Williamson Hall ♿ * L
WullH, Wulling Hall ⊡ *
Zoology ♿ * L

CODES:

♿ = accessible building
⊡ = partially accessible
■ = inaccessible building
* = elevator
L = adapted restroom



UNIVERSITY OF MINNESOTA
TWIN CITIES CAMPUS
EAST BANK

BUILDING ABBREVIATIONS AND BUILDING ACCESSIBILITY INFORMATION

MINNEAPOLIS

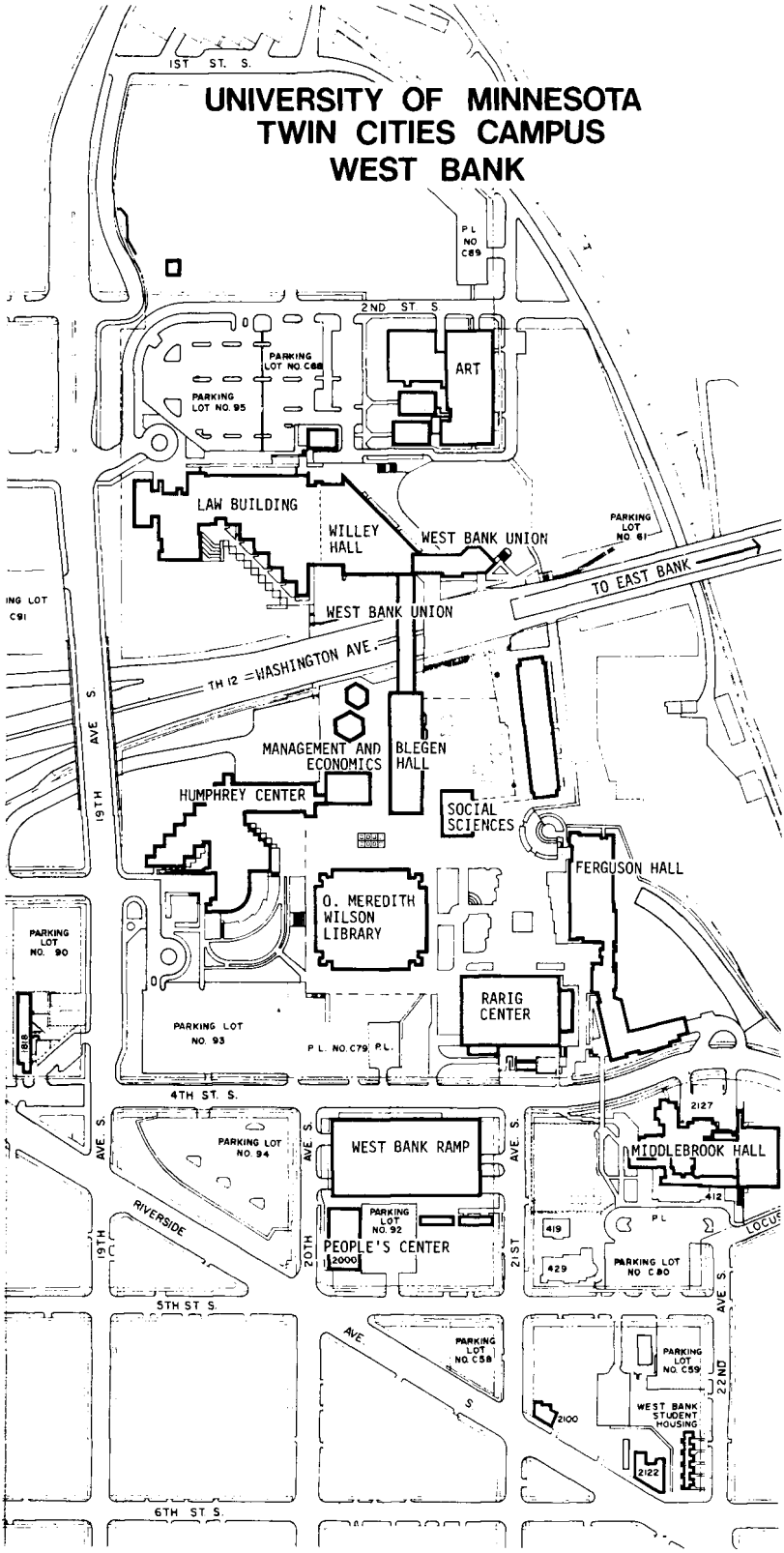
West Bank

AndH, Anderson Hall ♿*
ArtB, Art Building (2020 Washington Ave S) ⊡
BlegH, Blegen Hall ♿* L
FergH, Ferguson Hall ♿* L
HHH Ctr, Humphrey Center ♿ * L
Law, Law Building ♿* L
MdbH, Middlebrook Hall ♿* L
Mgmt/Econ, Management/Economics Building ♿*
OMWL, O Meredith Wilson Library ♿* L
PeoCtr, People's Center (2000 5th Street)
RarigC, Rarig Center ♿* L
SocSci, Social Sciences Building ♿*
WBU, West Bank Union ♿L
WilleyH, Willey Hall ♿* L

CODES:

♿ = accessible building
⊡ = partially accessible
■ = inaccessible building
* = elevator
L = adapted restroom

UNIVERSITY OF MINNESOTA
TWIN CITIES CAMPUS
WEST BANK



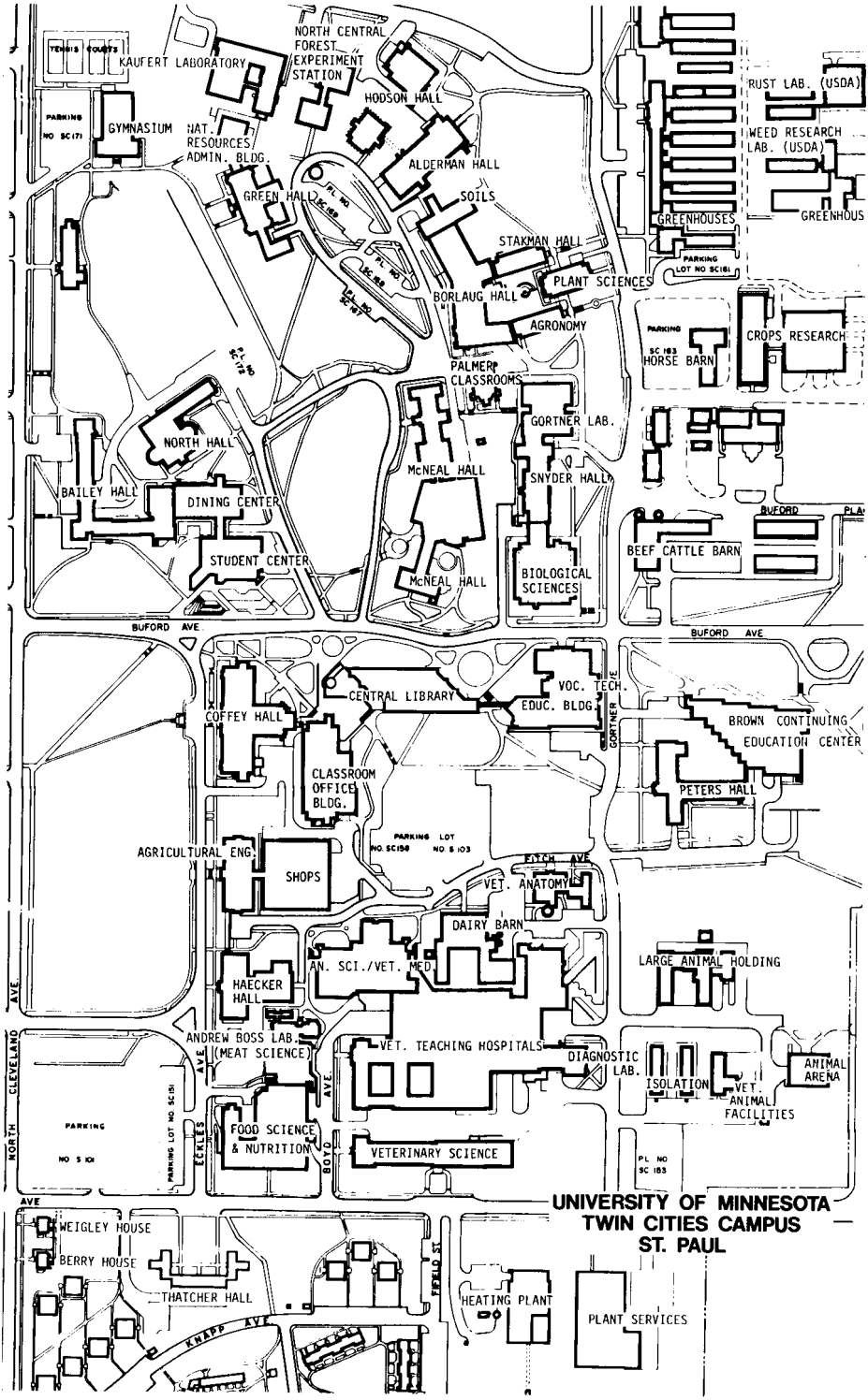
BUILDING ABBREVIATIONS AND BUILDING ACCESSIBILITY INFORMATION

ST PAUL

ABLMS, Andrew Boss Laboratory-Meat Science ♿*
AgEng, Agricultural Engineering ⊡*
AgEngShop, Agriculture Engineering Shop ♿
Agr, Agronomy ■
AgrGhClr, Agronomy Greenhouse Classroom ♿
AgrPGGh, Agronomy/Plant Genetics Greenhouse
AlderH, Alderman Hall ♿*
AnAren, Animal Arena
AnScVM, Animal Science, Veterinary Medicine ⊡*
BCB, Beef Cattle Barn ♿
Berry, Berry House (1304 Cleveland Ave N) ⊡
BioSci, Biological Sciences Center ⊡*
BorH, Borlaug Hall ♿* **L**
CentLib, St. Paul Campus Central Library ♿*
ClaOff, Classroom Office Bldg ♿*
CofH, Coffey Hall ♿*
DinC, Dining Center ♿*
EBCEC, Earle Brown Continuing Education Center ♿* **L**
FScN, Food Science and Nutrition ♿*
GorL, Gortner Laboratory of Biochemistry ♿*
GrnH, Green Hall ♿* **L**
Gym, Gymnasium ■
HckrH, Haecker Hall ⊡
HodsonH, Hodson Hall ♿*
KaufL, Kaufert Laboratory ♿*
McNH, McNeal Hall ♿* **L**
NorH, North Hall ■
PalmC, Palmer Classroom Building ⊡
PetH, Peters Hall ⊡
PlSci, Plant Sciences ■
SnH, Snyder Hall
Soils ♿*
StakH, Stakman Hall of Plant Pathology ■
StCen, Student Center ♿* **L**
VetA, Veterinary Anatomy ⊡
VetDL, Veterinary Diagnostic Laboratories ■
VetS, Veterinary Science ■
VetTchHos, Veterinary Teaching Hospitals ⊡
VoTech, Vocational-Technical Education ♿* **L**
Weigley, Weigley House (1316 Cleveland Ave N)

CODES:

♿ = accessible building
⊡ = partially accessible
■ = inaccessible building
* = elevator
L = adapted restroom


TENNIS COURTS
KAUFERT LABORATORY
NORTH CENTRAL FOREST EXPERIMENT STATION
HODSON HALL
PARKING NO SC 171
GYMNASIUM
NAT. RESOURCES ADMIN. BLDG.
ALDERMAN HALL
GREEN HALL
SOILS
STAKMAN HALL
PLANT SCIENCES
BORLAUG HALL
AGRONOMY
PALMER CLASSROOMS
GORTNER LAB.
NORTH HALL
McNEAL HALL
SNYDER HALL
BAILEY HALL
DINING CENTER
STUDENT CENTER
McNEAL HALL
BIOLOGICAL SCIENCES
RUST LAB. (USDA)
WEED RESEARCH LAB. (USDA)
GREENHOUSES
GREENHOUS
PARKING LOT NO SC161
PARKING SC 183
HORSE BARN
CROPS RESEARCH
BUFORD
BEEF CATTLE BARN
BUFORD AVE
BUFORD AVE
CENTRAL LIBRARY
VOC. TECH. EDUC. BLDG.
COFFEY HALL
GORTNER AVE
BROWN CONTINUING EDUCATION CENTER
CLASSROOM OFFICE BLDG.
PETERS HALL
PARKING LOT NO. SC158
PARKING LOT NO S 103
AGRICULTURAL ENG.
SHOPS
FITCH AVE
VET. ANATOMY
DAIRY BARN
LARGE ANIMAL HOLDING
AN. SCI./VET. MED.
HAECKER HALL
ANDREW BOSS LAB. (MEAT SCIENCE)
VET. TEACHING HOSPITALS
DIAGNOSTIC LAB.
ISOLATION
VET. ANIMAL FACILITIES
ANIMAL ARENA
NORTH CLEVELAND AVE
PARKING NO S 101
PARKING LOT NO SC151
ECKLES AVE
FOOD SCIENCE & NUTRITION
BOYD AVE
VETERINARY SCIENCE
PL NO SC 183
AVE
UNIVERSITY OF MINNESOTA
TWIN CITIES CAMPUS
ST. PAUL
WEIGLEY HOUSE
BERRY HOUSE
THATCHER HALL
FIFIELD ST
HEATING PLANT
PLANT SERVICES
KNAPP AVE

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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 Prefixes—In conjunction with course numbers, departments are designated by a 2-, 3-, or 4-letter prefix (e.g., CE for Civil Engineering, Pol for Political Science, WoSt for Women's Studies). When no department prefix 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.
†	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 the equivalent course listed after this symbol has been taken for credit.
¶	Concurrent registration is allowed, or required, in the course listed after this symbol.
#	Registration Override Permit, completed and signed by the instructor, is required for registration.
△	Registration Override Permit, completed and signed by the department offering the course, is required for registration.
□	Registration Overide Permit, completed and signed by the college, 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.

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.

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