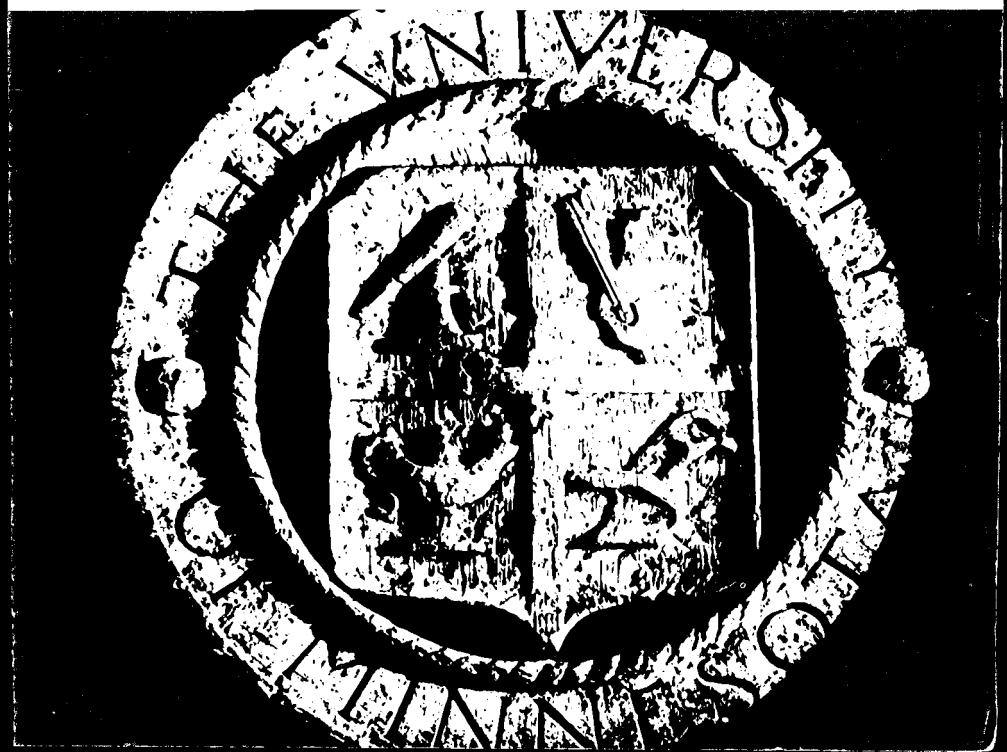
University of Minnesota 72/74 Bulletin

JULY 31, 1972

graduate school



UNIVERSITY OF MINNESOTA

Volume LXXV | Number 15 | July 31, 1972

UNIVERSITY OF MINNESOTA BULLETIN

Published by the University of Minnesota, Office of Admissions and Records, 105 Morrill Hall, Minneapolis, Minnesota 55455, January through September inclusive. One issue in January, none in February, two issues in March, four issues in April, three issues in May, two issues in June, three issues in July, four issues in August, and one issue in September. Second class postage paid at Minneapolis, Minnesota. Send change of address notices and other communications to Office of Admissions and Records, Minneapolis, Minnesota 55455.

Graduate School

UNIVERSITY OF MINNESOTA

HOW TO USE THIS BULLETIN

The "General Information" section of this bulletin is your official source of information about the policies of the Graduate School and about procedures in earning graduate degrees.

The section entitled "Fields of Instruction" contains statements of the policies and requirements of the various departments and listings of the course offerings in those departments.

Do Not Fail to Read

(1) The complete description of conditions and requirements for the degree you expect to earn (for the Master's degree, page 8; for the Ph.D. degree, page 12)

(2) The paragraphs headed "Time Limit for Earning the Doctor's Degree and Continuous Registration Requirement," page 13.

(3) The section entitled "Symbols and Explanations," inside back cover. This is your guide to the understanding of terms and symbols used in course descriptions.

Graduate School

GENERAL INFORMATION

Purpose and Organization—A central purpose of the Graduate School is the advanced training of men and women in a wide variety of fields and the promotion of research resulting in contributions to knowledge in an atmosphere of freedom of inquiry.

The Graduate School is organized into six Policy and Review Committees, made up of faculty and students, in the areas of education and psychology, health sciences, language, literature and arts, physical sciences, plant and animal sciences, and social sciences. These committees, together with the Executive Committee, are responsible for general Graduate School policy making. The Executive Committee is made up of the chairmen of the Policy and Review Committees, representatives from the Duluth Campus and the Mayo Graduate School, the Graduate School deans, and student representatives from the Council of Graduate Students.

There are additionally 24 Unit Committees, made up of faculty in clusters of related major fields, and covering the total range of graduate programs, whose responsibility it is to review individual student degree program proposals for their fields and to make recommendations to the dean on the approval of programs and the assignment of student degree examining committees.

Human Rights—The Board of Regents has committed itself and the University of Minnesota to the policy that there shall be no discrimination in the treatment of persons because of race, creed, color, sex, or national origin. This is a guiding policy in the admission of students in all colleges and in their academic pursuits. It is also to be a governing principle in the University-owned and University-approved housing, in food services, student unions, extracurricular activities, and all other student and staff services. This policy must also be adhered to in the employment of students either by the University or by outsiders through the University and in the employment of faculty and civil service staff.

ADMISSION

Any student with a Bachelor's degree or its equivalent from a recognized college or university may apply to the dean of the Graduate School for admission. University of Minnesota undergraduates who lack not more than 9 quarter credits or two courses toward the Bachelor's degree (*counting required and sequence courses*), if they meet admission requirements, may register in the Graduate School to begin a graduate program while simultaneously completing work for the Bachelor's degree. Applicants with the necessary background for their chosen major field, an excellent scholastic record from an approved college or university, and satisfactory character and 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.

Credentials Examination Fee

A credentials examination fee of $15 is required for each applicant. Persons who were previously officially admitted to and registered in a college of the University of Minnesota are exempt from this requirement. (This exemption *does not* extend to students previously registered only in Continuing Education and Ex-

tension or as "summer-only" students.) Residents of the United States must submit the fee by personal check or money order; foreign applicants must submit the fee by certified bank check. All checks should be made payable to the University of Minnesota. The fee will not be refunded.

Test Data

Miller Analogies Test—A graduate level form of the Miller Analogies Test is required of applicants for the following major fields or programs:

American Studies
Anthropology
Child Psychology
Education (*ALL* majors and emphases in this field, e.g., educational administration, industrial education, music education, educational psychology, etc.)
Family Social Science
Hospital and Health Care Administration
Industrial Relations
Library Science
Mass Communication (formerly journalism)
Psychology
Public Health (when emphasis is public health nursing)
Social Work
Sociology
Speech-Communication
Zoology

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, 304 E. 45th Street, New York, New York 10017, for a list of Miller Analogies testing centers.

Admission Test for Graduate Study in Business—All applicants in business administration are required to present an official report of their performance on the Admission Test for Graduate Study in Business as part of the application for admission to graduate work in that field. Since this test is given at limited times and places during the year, applicants would be well advised to make early arrangements for registration for this test. For information concerning registration for the examination, students should write to the Educational Testing Service, P. O. Box 592, Princeton, New Jersey 07110.

Graduate Record Examination—Although the Graduate Record Examination is not a general requirement for admission, it may be requested by the department in which students are applying and in individual cases to determine admissibility. 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. For further information on this examination and places where it may be taken, applicants should write to the Educational Testing Service, P.O. Box 592, Princeton, New Jersey 07110, or to the Student Counseling Bureau, 101 Eddy Hall, University of Minnesota, Minneapolis, Minnesota 55455.

The Graduate School reserves the right to request data in any case where it is believed necessary.

Test of English as a Foreign Language (TOEFL)—This test is required of all foreign applicants whose native language is not English except in those cases in which applicants will have completed an academic year in residence as full-time students in another recognized institution of higher learning in the United States prior to entering the University of Minnesota. The University of Minnesota reserves the right to require additional testing upon arrival.

Applications will be considered prior to the time that TOEFL results are available, but the Certificate of Eligibility necessary to obtain the visa will not be issued until the University has evidence of satisfactory performance on the test.

Application Procedure

Requests for application materials must be sent to the Graduate School, 322 Johnston Hall, Minneapolis, Minnesota 55455, and should specify the applicant's proposed major field.

Applications for admission must be received in the Graduate School, complete in every detail (one official transcript from each college attended, the credentials examination fee, and test results, if required) at least 4 weeks prior to the opening of the quarter or summer term in which the applicant expects to register. Applicants would be wise to apply as early as possible, but not more than 1 year prior to the opening of the term in which they propose to begin their studies.

Transient Graduate Student

Students currently engaged in a graduate degree program in another recognized graduate school who wish to enroll for a summer session or a single quarter in the Graduate School of the University of Minnesota, and who intend thereafter to return to the graduate school in which they are carrying forward their program of studies for a graduate degree, may be admitted as transient graduate students. They will not be required to submit a full transcript of credits but may ask the dean of their graduate school to complete Form 57 and return it to the Graduate School, 322 Johnston Hall, University of Minnesota, Minneapolis, Minnesota 55455.

Under no circumstances will students be permitted to register for more than 1 quarter or summer session as a transient student. Persons originally registering in this status who wish to apply for regular admission must follow the directions outlined above.

Readmission, Change of Major, or Change of Degree Objective

Persons who have withdrawn from the Graduate School for 2 consecutive years or more and who wish to request readmission, or persons currently enrolled who intend to change their major field or degree objective from that originally approved by the Graduate School, should request a copy of the Change of Status form (GS #72) from the Graduate School, 322 Johnston Hall. Processing of these requests requires a minimum of 4 weeks.

ACADEMIC RANK AND CANDIDACY FOR A GRADUATE DEGREE

Members of the University of Minnesota staff of instruction above the rank of instructor or research fellow are not permitted to take a graduate degree at the University of Minnesota. They may register for graduate work, however, and credit thus obtained may be presented elsewhere.

TRANSFER OF CREDITS

From an Undergraduate College of the University of Minnesota—Credits for advanced courses earned while students were registered as undergraduates at the University may be transferred to the Graduate School record once students have been admitted and have registered as graduate students, but under the following conditions:

If not more than 9 quarter credits of undergraduate work are lacking for the degree (including both distribution and total credit requirements), a limited amount of graduate

work in approved courses numbered 5-000 or above may be carried for graduate course credit, such courses not to be applied toward an undergraduate degree. The conditions stated must exist at the beginning of the quarter in which the courses for graduate credit are taken. Transfer of credit to the Graduate School must be arranged by petition and may not exceed the credits earned in a single academic quarter or summer term. *P-N credits cannot be transferred.*

From Adult Special or Summer Special Status—Students admitted to, and registered in, the Graduate School may transfer to their graduate record the credits earned *in their first academic quarter or summer term* as adult special or summer special students. Such work must be graduate level and taught by a member of the graduate faculty, and students must complete the work required of graduate students in the courses. The courses should be included on the graduate program form when it is submitted for approval.

The adult special and summer special statuses are not intended as trials for graduate study.

From Continuing Education and Extension—No more than 12 credits of graduate-level work taken in Continuing Education and Extension may be transferred to the graduate record and included on the degree program. Courses so taken must bear the special CEE transcript entry showing they were completed for graduate credit. Transfer is achieved by including them on the official degree program when it is submitted for approval.

From Independent (Correspondence) Study—Graduate credit is *not* allowed for credits earned through independent (correspondence) study.

From Other Graduate Institutions to Apply Toward a Master's Degree—In the usual Master's program (Plan A—27 credits or Plan B—45 credits) a maximum of 9 quarter credits is allowed from other graduate schools. The transfer allowance will often be higher for Master's programs of greater length (e.g. master of social work, master of fine arts) and referral should be made to the departmental section of the bulletin. The work is included on the official program form when it is submitted for approval.

From Other Graduate Institutions to Apply Toward the Doctoral Degrees (Ph.D. and Ed.D.)—Graduate credit may be applied from other institutions. The appropriate work is included on the doctoral program when it is submitted for approval.

GRADUATE SCHOOL NEWSLETTER

The Graduate School publishes quarterly and once each Summer Session a newsletter entitled *G.S. Form 7000,* which is used to inform students and graduate faculty of changes in regulations and procedures. The newsletter also contains information on fellowship opportunities, quarterly graduation deadlines, the Council of Graduate Students' activities, and includes a directory of offices in the Graduate School from which information on various matters can be requested. The newsletter is distributed to all graduate students and faculty each term with registration materials.

QUARTERLY PROGRESS REPORT

The Graduate School issues a Quarterly Progress Report to the major department for each active student which indicates progress made toward degree attainment. The report includes grades received, grade point average, the content of the official degree program and the courses on it which have been completed, examining committees, and degree requirements yet to be completed.

The computer registration system depends upon the Quarterly Progress Report as a basis on which to determine whether a student is clear to register. These decisions are based on the individual department's criteria as to G.P.A., acceptable number of incompletes, and deadlines for the submission of degree program and thesis title forms.

REGISTRATION

The Graduate School operates on a quarter system and registration ordinarily begins about 6 weeks before the opening of the term and closes at the end of the first week of classes. Work is also offered in a variety of fields in 2 summer terms of 5 weeks each. For the University calendar and tuition and fee rates please see the University's current *General Information Bulletin.*

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

Registration Requirements—See the sections on degree requirements.

Varieties of Registration—The four kinds of registration are listed as follows:

1. Registration for course work.
2. "Thesis-only" Registration: This type of registration, for which any students with their adviser's approval are eligible, is for the convenience of the student. It is a means of registering when students must or wish to do so but are not taking course work. They need not actually be working on a thesis. For tuition purposes it is treated as half-time.
3. "Examination-only" Registration: This is open only to doctoral students who have completed language requirements and all course work on their *officially approved* doctoral programs but who have not yet passed their preliminary oral examinations. The status can be utilized only twice. It is not a requirement; it is for the convenience of the student, and bears a special tuition rate. *Late registration for "examination only" is not allowed.*
4. Doctoral Candidate Registration: Available only to doctoral students who have passed their preliminary oral examinations. It bears a special tuition rate and *is required.* See the section on degree requirements.

Changes in Registration—Changes in the original registration are made by use of a Cancel-Add Form. Through the first 6 weeks of the academic year quarter or the first 3 weeks of the summer term the Cancel-Add Form requires only the adviser's approval. Changes after that (but before final examinations begin) also require approval of the individual instructors. No changes in a registration after final examinations begin or the term closes can be made without the additional special approval of the dean of the Graduate School.

TUITION AND FEES

For current tuition and fees see the *General Information Bulletin.*

For Summer Session tuition and fees see the *Summer Session Bulletin.*

All college teachers new to the state of Minnesota, including new full-time University faculty members with the rank of instructor or above, may pay tuition at the resident rate from the time they begin their teaching in this state.

Exemptions from the Student Services Fee—Exemptions from the Student Services Fee are granted on request to:

1. Teachers currently employed full time in elementary and secondary schools (public, private, parochial) in the Twin Cities and surrounding areas and whose quarterly credit load does not exceed 5 credits, or who are registering for "thesis only."
2. Graduate students who are living beyond commuting distance of the campus and whose registration is for "thesis only," research or topics courses, or Plan B papers.
3. Doctoral candidates (students who have passed the preliminary oral examination for the doctorate) who do not wish to pay the fee.

Minimum tuition payments for graduate degrees are described under the sections on degree requirements (residence), pages 8 and 12.

GRADING SYSTEM

The Graduate School uses two grading systems (A, B, C, D, N, and S, N). These systems were approved for use by the entire University during the 1971-72 academic year and the specific manner in which they were to be utilized at the graduate level was still in the process of definition in the summer of 1972.

For information on required G.P.A. standards for degree programs see the sections on degree requirements.

Incompletes—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. Courses may be retaken only after approval of a petition to the Graduate School. Permission of the course instructor and the major adviser is required before submission of the petition.

ATTENDANCE AT COMMENCEMENT

Attendance at commencement is voluntary. However, Ph.D. candidates, since they are individually recognized and hooded at the ceremony, should inform the Graduate School as to whether or not they will attend.

THE MASTER'S DEGREE

The 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 course work and 9 credits of special papers for the thesis.

Residence Requirement for the Master's Degree—A Master's program ordinarily takes from 4 to 6 quarters in residence to complete. The minimum residence *requirement* for the degree, however, is 3 academic quarters or its equivalent in summer terms at full tuition (2 summer terms—that is, a full summer session—are equivalent to 1 quarter for this purpose). State residents may petition to complete the program in 5 summer terms, but nonresidents must pay full tuition for the 3 academic quarters or summer equivalent. Some programs, such as the master of fine arts and the master of social work, require a minimum of 2 years. The clinical medical areas and dentistry sometimes require longer (see special bulletin, *Graduate Programs in the Health Sciences*).

The Official Program for the Degree—After taking 15 credits, and ordinarily not later than the third quarter of registration (the second year for the longer programs), students should file with the Graduate School the official proposed program for the degree (Plan A or Plan B). The program form is obtained in the Graduate School Office. On it students list all course work, completed and proposed, which will be offered in fulfillment of degree requirements. If a language is required the one to be offered is specified, and if the degree is being taken under Plan A, students also include their thesis proposal on the program form. *On the basis of this program the student's final examining committee, and for Plan A the thesis readers, are appointed.* The minimum credit requirements for the program are specified below under the two plans for the degree.

Changes in the Program—Once approved, the program must be fulfilled in each detail to meet graduation requirements. Alterations in the program which

are found necessary or desirable by students and their adviser should be requested in advance by General Petition form.

The minimum grade point average established by the Graduate School for courses included on the program is 2.80 (on a 4.00 scale). No graduate credit is allowed for work below C level. Higher standards may be set by the individual major fields.

In cases in which students take course work beyond the minimum requirements, both the adviser and the Unit Committee may demand comparable standards of performance for all work taken in evaluating and approving the program submitted, and may both reject the degree program if the total record falls below a 2.80 G.P.A. and terminate candidacy.

Time Requirement for the Master's Degree—All requirements for the Master's degree must be completed within 7 years. The 7-year period begins with the oldest work included on the official degree program, including any transfer work applied.

Language Requirement for the Master's Degree—There is no Graduate School requirement for a foreign language. See the departmental section to determine the language requirement, if any, for a specific major field.

Plan A: Master's Degree With Thesis

Course Requirements—A minimum of 18 quarter credits in the major and 9 in the minor must be included in the official degree program.

Master's Thesis—The thesis proposal is submitted for approval in advance as a part of the student's official degree program (see above). The thesis must be written in acceptable English, and the student must show ability to work independently as a research scholar. Citation of authorities and a bibliography are included in the thesis.

Instructions for the Preparation of the Thesis—Instructions should be obtained from the Graduate School Office before preparation of the thesis begins. The instructions contain information as to the number of copies required and general regulations governing the preparation. Questions not resolved by the instructions should be settled in consultation with the adviser and by reference to a standard style manual.

Registration of the Thesis with the Graduate School—A complete clean draft of the thesis with title page, table of contents, and bibliography must be presented for registration in the Graduate School Office at least 9 weeks before the commencement at which candidates expect to receive the degree. The copy will be returned to the candidate immediately, together with the report form on which the readers will signify their approval of the thesis and other forms necessary for graduation. When the thesis report form is returned properly signed, a final examination report form will be issued to the student. Please note that the Unit Committee or the student's examining committee may, at their discretion, require a 30-day interval between the registration of the thesis and the date of the final examination.

Thesis Readers—The thesis will be read by a committee of not less than three, as appointed by the dean of the Graduate School on recommendation of the appropriate Unit Committee at the time of approval of the student's official degree program. The examining committee will ordinarily include at least two representatives from the major field and one from the minor. *This committee must be unanimous* in certifying that the thesis is ready for defense, and the

report form certifying this must be filed with the Graduate School Office before students will be admitted to the final examination.

Inclusion of Published Work in the Thesis—Candidates may include, as a part of the thesis, material published while University of Minnesota graduate students, provided the research was supervised by graduate faculty and its use approved by the adviser.

Thesis Binding—Two copies of the thesis (including the ribbon copy) are to be bound and deposited with the Graduate School Office. For the deadline for a particular commencement, consult the Graduate School Office, or the current newsletter.

Examinations—Candidates for the Master's degree, Plan A, must pass a final written examination, a final oral examination, or both, at the discretion of the examining committee.

A final written examination covers the major and minor fields and may include any work fundamental thereto. This examination is arranged by the chairman of the thesis committee, and questions are prepared by the graduate faculty in the major and minor fields. *A majority vote* of the committee is required to pass candidates on the written examination. The results are reported to the Graduate School on a final examination report form which will be issued to students when the form, certifying that the thesis is ready for defense, is submitted.

A final oral examination is conducted by the committee appointed to examine the thesis, with the adviser normally serving as its chairman, and covers both the major and minor fields. *A majority vote* is required for a pass. Results must be reported to the Graduate School on the report form obtained by the student when the signed thesis approval form is submitted to the Graduate School Office.

If both a written and oral examination are specified, the written examination must precede the oral examination.

Clearing for Graduation—To qualify for graduation in a particular quarter students must complete the examination and all other requirements (including the submission of required forms and fees) by a specified date *approximately* 5 weeks before the commencement day. The deadlines for a particular term are published in the newsletter for that term, and are available from the Graduate School Office.

Substitution of the Doctoral Preliminary Oral for the Master's Final—Students eligible for the preliminary oral examination for the Doctor's degree may, at the discretion of the preliminary oral examination committee, substitute that examination for the final oral for the Master's degree, if all other requirements for the preliminary oral examination have been met and there is no conflict in majors or minors.

Plan B: Master's Degree Without Thesis

Course Requirements—A total of 45 quarter credits is required, at least 21 of which should be in the major field. Not less than 18 of the total should be offered in at least two related fields of a minimum of 6 credits each.

Plan B Papers—Papers representing the quality but not the range of the Master's thesis shall be prepared in three advanced courses or seminars or in problems courses or courses which permit independent work under faculty supervision and involve the equivalent of 9 quarter credits.

Examinations—Candidates will be examined by a committee of at least three members, normally two from the major and one from a related field, appointed

by the dean on recommendation of the appropriate Unit Committee at the time of the approval of the official degree program. This examination may be written or oral or both, at the discretion of the examining committee. Students will make available to the examining committee for its review the Plan B papers prepared to fulfill the requirement for 9 hours of independent work. *A majority vote* is required to pass the student, and should be reported to the Graduate School on the form students obtain from that office before the examination.

MASTER OF ARCHITECTURE

See departmental section for requirements.

MASTER OF ENGINEERING

A number of engineering departments offer a 1-year program, with emphasis on design methods, leading to a professional master of engineering degree in a specific field. The design emphasis of the program focuses on engineering application rather than on engineering method or material behavior, and it applies the knowledge and methods of engineering with those of the physical and social sciences. The program is designed primarily for students who have already received a Bachelor's degree in a related engineering field and have appropriate professional experience. Students normally are expected to be recent B.S. in engineering graduates from ECPD-accredited programs. Full-time students should be able to complete the program in 1 calendar year with no less than 3 quarters of registration.

Application procedure should be followed as described under the "Admission" section of this bulletin. Applicants should be careful to designate the master of engineering as their degree objective to distinguish it from the master of science program also available in these fields. All applicants are expected to complete an interview with the departmental professional engineering committee before completing the application processing.

Course Requirements—The degree program should include work in a major field and in a minor or supporting area. The minimum requirements are 27 quarter credits in graduate-level courses in which a minimum of a 2.80 G.P.A. must be maintained. A special form available in the Graduate School is used for requesting approval of the official program for the degree.

Design Project—Approximately 20 weeks are spent on a design project.

Examination—Students must pass a project examination given by a committee appointed by the dean on recommendation of the Professional Master's Committee at the time of approval of the official program.

Fields in Which the Program is Offered—Please see the appropriate departmental engineering sections for information as to the fields in which the master of engineering is awarded.

MASTER OF FINE ARTS

Prerequisites—For the master of fine arts, admission to candidacy is limited to a select group of students with the Bachelor's degree from accredited universities or colleges, or its equivalent, and who provide evidence of exceptional promise as creative artists in one or more of the subfields in the department. For a

list of the subfields see the departmental sections for music, studio art, and theater arts.

Course Requirements—Candidates for the master of fine arts must complete a program of approximately 2 full years of graduate course work, 45 credits of which must be earned at the University of Minnesota. A minimum of 9 credits is required in the history or literature of art, theater, or music; and the departments will require a minimum of 9 credits in areas of study outside the major department.

Creative Project—Students must execute and leave a record of a creative project (production, recital, or exhibition) which will be accompanied by a supporting paper which deals with the planning and/or execution of the creative work.

Examinations—Candidates will be subject to a final oral examination, a final written examination, or both, at the discretion of the committee appointed by the dean on recommendation of the appropriate Unit Committee at the time of approval of the official degree program. A *majority vote* of the examining committee is required for a pass and the results should be reported to the Graduate School on a form students obtain from that office before taking the examination.

MASTER OF FORESTRY

See departmental section for requirements.

MASTER OF SCIENCE (DESIGNATED) IN CLINICAL MEDICINE AND DENTISTRY

See the special bulletin, *Graduate Programs in the Health Sciences.*

MASTER OF SOCIAL WORK

See departmental section for requirements.

SPECIALIST IN EDUCATION

See departmental section for requirements.

THE DOCTOR OF PHILOSOPHY DEGREE

The degree of doctor of philosophy is granted not on the basis of successful completion of a definite amount of prescribed work but chiefly in recognition of candidates' high attainments and ability in their special field as demonstrated, first, by passing the required examinations covering both the general and special fields of candidates' subjects, and second, by the preparation of a thesis.

Residence Requirement for the Doctor's Degree—Candidates for the Doctor's degree must register in the Graduate School for at least 9 quarters of graduate study in approved subjects, and thesis research and writing. Students who transfer work from other graduate schools for the degree must spend the first 2 years or the last year in residence at the University of Minnesota. There is also a continuous registration requirement. See below.

The Official Program for the Degree—Students are expected to file the official program for the degree in the second year of the program, the specific quarter depending upon individual departmental requirements. The program form is obtained from the Graduate School Office. The program should contain course work completed and proposed in fulfillment of degree requirements, in the major field and in the minor or supporting program fields. Transfer work from other graduate schools may be included as appropriate. On the program students should also specify the foreign languages, if any, that will be offered in fulfillment of the departmental requirement. *On the basis of the program students' preliminary oral examining committee will be appointed.*

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

Minor or Supporting Program Work—It is expected that from 18 to 24 quarter credits will 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 students are offering a supporting program, it will comprise a coherent pattern of courses possibly embracing several disciplines. Students electing the supporting program option may be expected to take written preliminary examinations in the fields included but will not be expected to have competency in each of the fields in their supporting program comparable to that of a person with a traditional minor in the field concerned.

Changes in the Approved Program or Students' Preliminary Oral Examining Committee—Once approved, the program must be fulfilled in each detail to meet graduation requirements. Changes which are found necessary or desirable by students and their advisers should be requested in advance by General Petition form.

Substitutions on the examining committee, which may be necessitated, for example, by the departure of a faculty member or absence on leave at the point that students wish to take their examination, should be requested *well in advance* through the Graduate School Office.

Official Candidacy—Candidacy is established when students have passed the preliminary oral examination. The Graduate School issues to all students passing the preliminary oral examination without reservation a Candidate in Philosophy certificate.

Time Limit for Earning the Doctor's Degree and Continuous Registration Requirement—Effective with the quarter immediately following admission to candidacy for the doctorate students must:

1. Complete all requirements and receive the degree within 5 calendar years. Petitions for extension of this time limit must be submitted before expiration of the 5 years. Failure to receive the Ph.D. before the close of the 5-year period may necessitate retaking the preliminary oral examination.
2. Register continuously and pay candidacy fees during the academic year (fall, winter, spring) until the doctorate is awarded. Failure to register continuously automatically terminates candidacy for the doctorate. To reinstate candidacy students may be required to retake the preliminary oral examination and must pay fees past due. Course registration for the first or second summer term (or both) may be made in lieu of registration for the academic quarter or quarters immediately following.

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 should file the thesis proposal with the Graduate School. The thesis title form is obtained from that office. The form must be accompanied by a typewritten statement, some 250 words in length, describing the research to be undertaken and the methods to be used in carrying it out.

On the basis of the thesis proposal the thesis readers, and other members of the final oral examining committee, will be appointed by the dean on recommendation of the appropriate Unit Committee.

Changes in the Thesis Title or Final Oral Examining Committee—Changes in the wording of the thesis title may be made without special approval. If the substance of the proposal should change markedly in the course of the research a revised proposal should be submitted.

Substitutions on the Final Oral Examining Committee—Please see the section above on changes in the preliminary committee.

Language Requirement—Please see the departmental section to determine the requirement. If there is a requirement, the Graduate School will accept, for graduation purposes, certification from the major department that students are proficient. However, if students wish proficiency recorded on the official transcript, the appropriate language department's proficiency test must be satisfied. For the forms necessary for obtaining proficiency certification consult the Graduate School.

Written and Preliminary Oral Examinations

Written Examination—A written examination in the major subject shall be given by the graduate faculty in the major field prior either to the preliminary or to the final examination, as the graduate faculty in the field may decide. This examination shall cover all work done in the major and may include any work fundamental thereto. *The passing or failing of this written examination shall be reported to the Graduate School* over the signatures of the adviser and the major department's director of graduate study on a form students obtain from the Graduate School. In case of failure candidates will normally be allowed only one opportunity to retake the failed examination; this reexamination will be permitted not earlier than the following academic quarter.

Preliminary Oral Examination—At least 1 full academic quarter before the degree is conferred, a preliminary oral examination of the student shall be given by the committee appointed by the dean and the appropriate Unit Committee on the basis of the official doctoral program.

Scheduling the Preliminary Examination—It is the students' responsibility to schedule the examination with the examiners *and with the Graduate School Office* not less than 1 week in advance. *In certain of the health science areas, however, 1 month's notice must be given* (for information consult the Graduate School). At the point that the examination is scheduled the Graduate School must have on file a report on the preliminary written examinations certifying that students have passed them and are ready for the oral.

The Graduate School issues the report form for the preliminary oral examination to the students' adviser, and informs both students and their adviser if the language requirement has not been met or there are courses on the official program which have not yet been completed. The preliminary oral will be authorized in spite of such deficiencies but these matters must be taken care of before the final oral is scheduled, either by completion or by petition for removal.

Preliminary oral examinations will not be scheduled during the period of final oral examinations for the June commencement (normally from about April 8 to May 6), or from the beginning of the second term of summer session to the opening of the fall quarter, when many faculty are away.

The Preliminary Examining Committee—The Unit Committee may recommend the appointment of different examiners for the preliminary oral and final oral examinations if in their judgment this seems appropriate. The Unit Committee may also recommend the inclusion on the preliminary oral examining committee of a member of the graduate faculty outside the major and minor fields of the student. Ordinarily the examining committee shall include a minimum of five members, three from the field of the major and two from the field of the minor or supporting program; the Unit Committee may recommend additional members if it seems in their judgment desirable in given cases.

The Preliminary Oral Examination—The preliminary oral examination shall cover both the major and minor fields or supporting program and may include any work fundamental thereto, including possible plans for thesis research as determined by the major field.

The outcome of the examination will be recorded in one of three possible ways: passed, failed, passed with reservations. *The voting proportions necessary for these decisions are as follows*: in the case of a five-member examining committee, a favorable verdict for passing candidates will consist of either a unanimous vote or a vote of 4-1; if the committee consists of six members, a unanimous vote or a vote of 5-1 or 4-2 will pass candidates; and if the committee consists of seven members, a unanimous vote or a vote of 6-1 or 5-2 will pass candidates. Unless candidates obtain favorable committee votes in these proportions the outcome is failure, except that, on the basis of the same proportions in the voting, the verdict may be passed with reservations.

Pass with Reservations—In the case of an examination reported as passed with reservations, these reservations may involve: additional preparation and study followed by reexamination; the preparation of a special paper or written examination in a stated field; or other special conditions deemed appropriate by the examining committee.

Reporting the Results—The chairman and the examining committee will report the results of the preliminary oral examination to the Graduate School Office, stating clearly, in the case of a pass with reservations, what additional requirements must be met by candidates to remove the reservations. The removal of the reservations must also be subsequently reported in writing to the Graduate School.

Failure of the Examination—Students failing the preliminary oral examination (a) may, upon recommendation of the examining committee, be allowed to retake the preliminary oral examination, or (b) may be excluded from candidacy for the degree. In no case may the reexamination take place until at least 1 full academic quarter has passed. No more than two preliminary examinations are allowed.

Doctor's Thesis

The thesis must show originality and power of independent investigation and embody results of research that form a real contribution to knowledge as well as exhibit mastery of the literature of the subject and familiarity with the sources. The matter must be presented with a fair degree of literary skill.

Language of the Thesis—The normal expectation is that theses will be written in English, the language of instruction. However, in some fields of study, particu-

larly foreign languages, a language other than English may be used provided there is a scholarly reason for its use. If a non-English thesis is proposed, the title must be translated into English. At the time of the thesis proposal, a statement from the adviser or director of graduate study must accompany the thesis plan declaring the necessity for the foreign language and attesting that the recommended thesis readers (including the outside reader) are thoroughly competent 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. Questions which are not resolved by the instructions should be settled at the discretion of students and their advisers and by referral to a standard style manual.

Registration of the Thesis with the Graduate School—A complete clean draft of the thesis with title page, table of contents, and bibliography must be registered in the Graduate School Office and copies distributed to the thesis committee not later than 9 weeks before the commencement at which candidates expect to receive the degree. This copy will be returned to students immediately, together with the report form on which the readers certify that the thesis is ready for defense, and a number of other forms required for graduation (for which see below). One copy of the thesis should be delivered to the Graduate School for each member of the examining committee from the Mayo Graduate School of Medicine.

A 30-day period must elapse between the registration of the thesis and the date of the final oral examination.

Thesis Readers—The thesis must be read by a committee of not less than three members (see Thesis Proposal, page 14). As a rule, the student's major adviser will be the chairman of the committee, and the field of the minor or the supporting program will be represented by at least one committee member. *The committee must be unanimous* in certifying that the thesis is ready for defense before the final oral examination will be authorized by the Graduate School (see Registration of the Thesis above).

Inclusion of Published Work in the Thesis—The thesis may include material that students have published while University of Minnesota graduate students, provided it 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.

The Final Oral Examination

For admission to the final oral, students must have completed all work on the official doctoral program including the language requirement if any, both the written and oral preliminary examinations must have been passed, and final written if required, and the thesis must have been certified by the readers as ready for defense. The examination will ordinarily be conducted by a committee appointed at the time of approval of the thesis proposal, and consisting minimally of the adviser, two additional readers, and two other members of the graduate faculty. The examination covers the thesis and the field of the candidate's special study and shall not exceed 3 hours.

Scheduling the Final Oral—*The examination must be scheduled by students 1 week in advance* (see below for graduation deadlines) with the committee and

with the Graduate School. The interval between registration of the thesis (see above) and the date of the oral must ordinarily be at least 30 days. *In certain of the health science fields the faculty require 30 days' notice of the scheduling of the final oral.* Please consult the Graduate School for information.

When the examination is scheduled the file will be checked to determine that students are 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.

The date of the examination will be publicly announced and any member of the graduate faculty may attend.

The final oral cannot be scheduled for the same quarter in which students took the preliminary oral examination.

Reporting the Results of the Final Oral—Upon completion of the examination a formal vote of the committee shall be taken. To be recommended for the award of the doctoral degree *candidates must receive either a unanimous vote or a vote showing not more than one dissenting member* of the total examining committee. The results should be reported to the Graduate School on the report form sent to the adviser when the examination was scheduled.

Clearing for Graduation—In addition to the forms mentioned in the above paragraphs students must submit the following forms which were issued when the thesis was registered. *If students wish to graduate at a particular commencement the forms, including the report of the results of the final oral,* must be submitted by the deadline date for that commencement. For the proper dates for a particular commencement students should consult the form issued for this purpose at the time the thesis was registered, or current issue of the newsletter, or the Graduate School Office.

1. *Microfilming Agreement*—Candidates sign, in duplicate, the *Memorandum of Agreement* with University Microfilms, Ann Arbor, Michigan, under which the ribbon copy of the thesis will be microfilmed before being permanently filed in the University of Minnesota Library. The microfilm fee to be paid at that time is $25. If students wish the thesis copyrighted an additional $15 will be required for the Copyright Office and to pay the cost of depositing two microfilm copies with the Library of Congress.
2. *Thesis Abstract*—Candidates must submit *three copies* of an abstract of 600 words or less, approved by their adviser, embodying the principal findings of their research. Such abstracts will be published in *Dissertation Abstracts,* which announces the availability of the thesis for distribution.
3. *Thesis Binding*—Two copies (including the ribbon copy) of the thesis are to be bound and deposited in the Graduate School Office.
4. *Release Card*—Students should sign the Release Card permitting immediate circulation of their thesis. For valid reasons and with their adviser's endorsement they may request, on the same form, that the thesis be withheld from circulation for 6 months to a year.
5. *Office of Scientific Personnel Survey Form*—Before students' names can be included on the degree list they must complete a survey form for the Office of Scientific Personnel of the National Research Council.
6. *Application for Degree*—This form must be filed with the Office of Admissions and Records, and the diploma fee paid.
7. *Commencement Attendance*—A card must be filed indicating whether or not candidates will attend the commencement ceremonies.

THE DOCTOR OF EDUCATION DEGREE

The University of Minnesota awards the doctor of education (Ed.D.), its highest professional degree in the field of education, in recognition of completion of academic preparation and demonstrated competence for professional activity in that field. For fields in which the Ed.D. is given, see the departmental section of the bulletin.

Standards and procedures for admission and expectations for performance are, in general, comparable to those held for the Ph.D. A major part of the program must be conducted in full-time residence including at least 1 continuous academic year at advanced stages of the program. *Rules and procedures governing examinations, candidacy, time limits, appointment of committees, and the thesis (essay) 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. No foreign language is required. A significant proportion of the graduate course work, usually not less than one-fifth of the total program, should be in fields other than education.

A supervised internship or clinical experiences are 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 which demonstrates the ability to carry out an independent and meaningful study of a problem relevant to the field.

Examinations—Satisfactory performances on both a written comprehensive examination conducted by the major department and on a preliminary oral examination conducted by a committee of graduate faculty are required to establish candidacy for the degree. These examinations should 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 appointed by the Graduate School shall consist of three "readers" and two others who are qualified to assess students' professional competency. In the final examination students are expected to defend the essay and their general qualifications for the highest professional degree in their field.

For detailed requirements, please see the section on the doctor of philosophy degree.

THE DOCTOR OF PHILOSOPHY (DESIGNATED) IN CLINICAL MEDICINE

See the special bulletin, *Graduate Programs in the Health Sciences.*

MAJOR FIELDS FOR THE MASTER'S AND DOCTOR'S DEGREES

Fields listed as majors may be used as minors, but all combinations are not acceptable.

MASTER'S DEGREE	DOCTOR'S DEGREE
Aerospace Engineering	Aerospace Engineering
Agricultural Economics	Agricultural Economics
Agricultural Education	
Agricultural Engineering	Agricultural Engineering

MASTER'S DEGREE	DOCTOR'S DEGREE
Agronomy	Agronomy
American Legal Institutions	
American Studies	American Studies
Anatomy	Anatomy
Anesthesiology	
Animal Physiology	Animal Physiology
Animal Science	Animal Science
Anthropology	Anthropology
Arabic	
Architecture	
Art Education	
Art History	Art History
Astronomy	
	Astrophysics
Biochemistry	Biochemistry
Biology	Biology
	Biomedical Engineering
Biometry	Biometry
Biophysics	Biophysics
Botany	Botany
Business Administration	Business Administration
Business Education	
Chemical Engineering	Chemical Engineering
	Chemical Physics
Chemistry	Chemistry
Child Psychology	Child Psychology
Chinese	Chinese
Civil Engineering	Civil Engineering
Classical Area Studies	Classical Area Studies
Classics	Classics
Comparative Literature	Comparative Literature
Computer and Information Sciences	Computer and Information Sciences
	Control Sciences
Dentistry	
Dermatology	Dermatology
Distributive Education	
Ecology	Ecology
Economics	Economics
Education	Education
Educational Administration	Educational Administration
Educational Psychology	Educational Psychology
Electrical Engineering	Electrical Engineering
Elementary Education	
English	English
English as a Second Language	
Entomology	Entomology
Environmental Health	Environmental Health
Epidemiology	Epidemiology
Experimental Surgery	
Family Practice and Community Health	
Fisheries	Fisheries
Fluid Mechanics	Fluid Mechanics
Food Science and Industries	Food Science and Industries
Forestry	Forestry
French	French
French and Italian	
Genetics	Genetics
Geo-Engineering	Geo-Engineering
Geography	Geography
Geology	Geology
Geophysics	Geophysics
German	German
Germanic Philology	Germanic Philology
Greek	Greek
History	History
History and Philosophy of Education	
	History of Medicine and Biological Sciences
Home Economics	Home Economics

MASTER'S DEGREE	DOCTOR'S DEGREE
Home Economics Education	
Horticulture	Horticulture
	Hospital and Health Care Administration
Hospital Pharmacy	
Hydrogeology	Hydrogeology
Industrial Education	Industrial Education (Ed.D. only)
Industrial Engineering	Industrial Engineering
Industrial Relations	Industrial Relations
Italian	Italian
Japanese	Japanese
Laboratory Medicine	
Latin	Latin
Library Science	Library Science
Linguistics	Linguistics
Mass Communication	Mass Communication
Mathematics	Mathematics
Mathematics Education	
Mechanical Engineering	Mechanical Engineering
Mechanics	Mechanics
Medical Microbiology	
Medical Technology	
Medicinal Chemistry	Medicinal Chemistry
Medicine	Medicine
Metallurgy and Materials Science	Metallurgy and Materials Science
Microbiology	Microbiology
Mineral Engineering	Mineral Engineering
Mineralogy and Petrology	Mineralogy and Petrology
Museology	
Music	Music
Music Education	
Neurology	Neurology
Neurosurgery	Neurosurgery
Nursing	
Nutrition	Nutrition
Obstetrics and Gynecology	Obstetrics and Gynecology
Operations Research	Operations Research
Ophthalmology	
Oral Biology	Oral Biology
Orthopedic Surgery	Orthopedic Surgery
Otolaryngology	Otolaryngology
Pathology	Pathology
Pediatrics	Pediatrics
Pharmaceutics	Pharmaceutics
Pharmacognosy	Pharmacognosy
Pharmacology	Pharmacology
Pharmacy Administration	Pharmacy Administration
Philosophy	Philosophy
Physical Education	Physical Education
Physical Medicine and Rehabilitation	Physical Medicine and Rehabilitation
Physical Therapy	
Physics	Physics
Physiological Chemistry	Physiological Chemistry
Physiological Hygiene	Physiological Hygiene
Physiology	Physiology
Plant Breeding	Plant Breeding
Plant Pathology	Plant Pathology
Plant Physiology	Plant Physiology
Plastic Surgery	
Political Science	Political Science
Proctology	
Psychiatry	Psychiatry
Psychology	Psychology
Public Affairs	
Public Health	
Radiology	Radiology
Recreation and Park Administration	
Scandinavian	Scandinavian
Secondary Education	

MASTER'S DEGREE

Social Work
Sociology
Soil Science
South Asian Languages
Spanish
Speech-Communication
Speech Science, Pathology, and Audiology
Statistics
Studio Arts
Surgery
Theatre Arts
Urology
Veterinary Anatomy
Veterinary Microbiology
Veterinary Medicine
Veterinary Obstetrics and Gynecology
Veterinary Parasitology
Veterinary Pathology
Veterinary Physiology and Pharmacology
Veterinary Surgery and Radiology

Wildlife
Zoology

DOCTOR'S DEGREE

Social Work
Sociology
Soil Science
South Asian Languages
Spanish
Speech-Commmunication
Speech Science, Pathology, and Audiology
Statistics

Surgery
Theatre Arts
Urology
Veterinary Anatomy
Veterinary Microbiology
Veterinary Medicine
Veterinary Obstetrics and Gynecology
Veterinary Parasitology
Veterinary Pathology
Veterinary Physiology and Pharmacology
Veterinary Surgery and Radiology
Vocational Education
Wildlife
Zoology

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.

This program enables graduate students to travel to another of the member institutions for 1 or 2 quarters (1 semester) of study to take advantage of special resources available on another campus but not available on their own, including course offerings, research opportunities, unique laboratories and library collections, etc.

Graduate students who desire graduate course offerings not available on the University of Minnesota campus should confer first with the major department and their major advisers concerning which of the 10 other cooperating institutions to select for program enrichment and diversification. Information regarding the procedure to be followed in seeking admission to another CIC institution is available at the Graduate School Fellowship Office.

ASSISTANTSHIPS, FELLOWSHIPS, AND SCHOLARSHIPS

The awards described in this section are listed under three headings. Those that require service to the University appear first. In most departments they are called assistantships or associateships. At the time a student applies for one of these appointments, he must also file an application for admission to the Graduate School. Each department selects its own awardees.

The second heading describes those fellowships, scholarships, and traineeships that are not restricted to one field of study. In some cases applications for these awards are submitted through the student's department; in others, applications should go directly to the Graduate Fellowship Office, or to the awarding agency.

Third, many individual departments have awards restricted to students in that department. Applications for these awards, and questions regarding the application procedures, should be addressed to the department concerned.

It should be noted that in accordance with the resolution adopted by the Council of Graduate Schools in the United States, acceptance of an offer of a graduate scholarship, fellowship, traineeship, or graduate assistantship for the next academic year by an actual or prospective graduate student completes an agreement which both student and the Graduate School expect to honor. In those instances in which the student indicates his acceptance prior to April 15 and subsequently desires to change his plans, he may submit in writing a resignation of his appointment at any time through April 15 in order to accept another scholarship, fellowship, traineeship, or graduate assistantship. However, an acceptance given or left in force after April 15 commits him not to accept another appointment without first obtaining formal release for the purpose.

This list of fellowships is, of course, not exhaustive. There are other subventions offered by national or regional agencies in competitions that do not involve the University of Minnesota. The National Institutes of Health and the National Science Foundation, for instance, offer fellowships in a national competition (these fellowships should not be confused with the traineeships offered through the University of Minnesota). Students who are interested in these national competitions submit their applications directly to the awarding agency. In most cases, students must write to the awarding agency for application forms.

Questions about fellowships—those here listed or others—may be addressed to the Graduate Fellowship Office, 309 Johnston Hall.

Appointments Requiring Service to the University

NOTE—To be eligible to hold one of these appointments, a student must have been admitted to the Graduate School and be registered in the Graduate School each quarter that he holds the appointment during the academic year. Registration during the summer sessions is not required.

Assistants, Medical Fellows, and Teaching Associates—Approximately 3,173 such appointments are offered to graduate students through the various colleges, divisions, and departments of the University of Minnesota. A student may be appointed for any percentage of full-time service below 75 percent, but the schedule shown below is based on a 50 percent time academic year appointment.

Research Assistants
One-half of full-time service for the academic year $3,222
Some research assistantships also involve full-time service during the summer months with additional compensation for that period.

Teaching Assistants and Administrative Fellows I
One-half of full-time service for the academic year $3,375

Teaching Associates I and Administrative Fellows II
One-half of full-time service for the academic year $3,780

Teaching Associates II
One-half of full-time service for the academic year $4,167

These figures are based on salary rates in effect for 1971-72.

All of these appointments serve the double purpose of financial aid to students and of providing faculty with qualified persons to perform needed services. Medical fellowships at Minneapolis are full-time appointments at rates determined by individual departments with fees and tuition paid.

Graduate students holding appointments as teaching assistants, research assistants, teaching associates, and administrative fellows at 25 percent time or more

pay "in-state" tuition rates. This same privilege applies to members of their immediate families in the schools and colleges of registration in the University.

Effective June 16, 1970, these same privileges have been extended beyond the term of qualifying appointment, subject to the following rules:

The qualifying appointee must have held one of the above appointments for a minimum of 3 academic quarters, at 25 percent time or more, after September 15, 1969, in one of the specific positions listed above. Two summer sessions will count as one academic-year quarter.

The use of the privileges is extended, after completion of the qualifying 3 quarters of appointment, on a quarter-for-quarter basis up to a maximum of 6 quarters of use. Appointment for 3 quarters entitle extension of the privilege for 3 additional quarters; more than 3 quarters entitle extension (on a quarter-for-quarter basis) for not more than 6 quarters.

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

Civil service appointees working 75 percent time or more and who are registered in the Graduate School may pay fees at the resident rate. This privilege does *not* extend to members of the immediate families of such appointees.

Residence counselors with Bachelors' degrees are privileged to pay tuition at the resident rate of the college in which they are enrolled.

Application Deadline—Each department sets its own deadline. Unless otherwise noted, applications must be received by each February 15 for appointments covering the ensuing academic year, but applications received at other times will be considered for any available vacancies. Application blanks and further information may be obtained either from the head of the department in question or from the Graduate School Fellowship Office, 309 Johnston Hall, University of Minnesota, Minneapolis, Minnesota 55455, **but all application blanks for staff appointments should be returned to the appropriate department head—not to the Graduate School.**

Resident Adviserships—There are 120 resident adviserships (which require a minimum of 20 hours of work per week) available to men and women in the University residence halls and fraternities. Resident advisers are responsible for making residence living an educational experience for their students. They become personally acquainted with each student in their residence units and stimulate group activities and student participation in intellectual, cultural, social, and athletic activities and programs. *Remuneration* for a minimum of 20 hours of work a week in the fraternities is room and board. *In the residence halls,* resident adviserships which require 20 hours of work a week provide room and board and a stipend of $110 a quarter for new staff and $120 a quarter for those who are reappointed. Advisers who are out-of-state students pay tuition fees at the resident rate. Resident advisers are required to participate in regularly scheduled training programs. Application blanks may be obtained from the Housing Office, University of Minnesota, Minneapolis, Minnesota 55455.

Fellowships Not Restricted to One Field

APPLICATION DEADLINE—Unless otherwise noted, applications for most of these awards must be received by February 15. Interested students should allow ample time to assemble their application materials.

Caleb Dorr Research Fellowships (3) at $500 each in Agriculture, Forestry, and Home Economics. Apply to the Office of the Dean, Institute of Agriculture.

Class of 1890 Fellowship. Whenever sufficient funds have accumulated this fellowship of approximately $250 is available to a graduate student in the arts and science fields or the engineering fields. Apply through department. Each eligible department nominates one candidate to the Graduate School Selection Committee.

Walter B. Cline Memorial Fellowship (1-2) at $250-$500, for graduate study of languages and/or cultural history of Asia or the Moslem world. Apply to the Graduate Fellowship Office.

Committee on Institutional Cooperation Traveling Scholar Program. The University of Minnesota is 1 of 11 institutions (the Universities of Chicago, Illinois, Indiana, Iowa, Michigan, Michigan State, Minnesota, Northwestern, Ohio State, Purdue, Wisconsin) participating in the program. A graduate student at the University of Minnesota may make use of special resources not available at Minnesota but present at one of the other 10 participating institutions. If a graduate student is granted CIC Traveling Scholar privileges, he registers, pays fees, and has his grades recorded at the University of Minnesota while attending another university. Such visits are limited to 2 quarters or 1 semester, and all arrangements must be completed at least 1 quarter before a student's departure for another campus. For details on this program write or call the Graduate School, 309 Johnston Hall, University of Minnesota, Minneapolis, Minnesota 55455.

Corporate Associates Fellowships at up to $4,000 with tuition paid for students in business, physical science, mathematics, architecture, and engineering. Offered simultaneously with one-fourth time teaching associateship. Total award to student is about $5,000 plus tuition. Approximately 20 fellowships will be available in 1972-73. Intended for new or presently registered graduate students who have high qualifications, are interested in participating in the teaching activities of the department, and are working toward the Ph.D. Application may be made through the appropriate department.

Norman Johnston DeWitt Award in Humanities in varying amounts for graduate students in the area of humanities, especially those interested in the broad spectrum of the humanistic studies and the interrelationships of these studies. Apply through the Graduate Fellowship Office.

Foreign Student Tuition Scholarships (90) open in any department or college are offered to qualified foreign graduate and undergraduate students who indicate their intention to return home upon completion of their studies. Because of the large number of applications received each year compared with the few financial aids available, students are unlikely to receive these grants during their first year of study and should plan for alternative methods of financing their education. Applications for the academic year should be sent by March 15 to the Office of the Foreign Student Adviser, 717 E. River Road, Minneapolis, Minnesota 55455.

Graduate School Doctoral Fellowships (1-2) available *when funds permit* at $3,000 for students well advanced in their graduate studies, preferably in their doctoral thesis writing year. Graduate School pays tuition. Application must be made through departments.

Graduate School Special Grants. As funds are available the dean of the Graduate School may make awards up to $500 for expenses directly connected with the Ph.D. thesis (travel, microfilming, recording tapes, questionnaire printing and mailing, etc.). Final typing and binding costs cannot be covered. Funds from the Lucetta O. Bissell Memorial Fellowship provide for an additional one or two awards. Apply to the Graduate Fellowship Office. Applications are reviewed four times per year.

Graduate School Tuition Scholarships and *Graduate School Summer Tuition Scholarships.* A separate competition each quarter. Applications are due approximately 4 weeks before the beginning of the quarter. U.S. citizenship or permanent residence required and 1 academic year's residence in Graduate School must have been completed. Apply to the Graduate Fellowship Office. Financial need is a factor in this competition.

Arle and Billi Haeberle Fellowship in Speech, Journalism, and Theatre Arts, in amount depending on availability of funds for a woman student of speech, journalism, or theatre arts. Recipients should be preparing for a career in broadcasting. Apply to the Graduate Fellowship Office.

Albert Howard Fellowship at $240. Offered when funds permit. Open only to graduates of the University of Minnesota. Apply through department. Each eligible department nominates one candidate to the Graduate School Selection Committee.

IBM Fellowship at $3,000 with dependency allowance up to a maximum stipend of $4,800. Doctoral candidates should apply through their departments. In 1971-72, eligible fields were chemistry, computer science, electrical engineering, mathematics, physics, and materials science. Agency pays fees.

Torske Klubben Fellowships (2) usually at $2,000 for 9 months or $2,400 for 12 months. Offered to Norwegian nationals for study in the United States. Apply to the Graduate Fellowship Office.

Putnam D. McMillan Fellowships to graduate students at the University of Minnesota in any area of liberal arts for necessary transportation expenses connected with Ph.D. dissertation research in this country or abroad. Apply through the dean of the College of Liberal Arts.

Minneapolis Foundation—Frances E. Andrews Fund, up to $1,000 to graduate students for the purpose of carrying on research abroad. U.S. citizenship required. Apply through department. Each eligible department nominates one candidate to the Graduate School Selection Committee.

National Defense Foreign Language Fellowships (NDEA VI) at $2,000 to $2,400 for the academic year; tuition and fees paid; $500 per dependent. Applicants must be either U.S. citizens or permanent residents studying non-Western foreign languages or related areas. Awarded through approved area study programs. Interest in college teaching or in a career with the United States government is necessary. Apply through department.

National Science Foundation Graduate Traineeships at $3,000 for 12-month tenure; tuition and fees paid. Nine-month tenure is available with proportionately reduced stipends and benefits. Offered to students in participating departments of the sciences. U.S. citizenship is required. Summer traineeships at $85 per week are also available for persons who have held a teaching assistantship for at least 1 academic year. Apply through department.

National Science Foundation Program for Improving Doctoral Dissertation Research in Social Sciences. Open to a student majoring in one of the social sciences who is at the doctoral dissertation stage. Funds awarded through this grant may be used for such items as travel to specialized libraries, museums, or field research locations; sample survey costs; costs of specialized equipment; purchase of computer time where an appropriate machine is not available in the institution; purchase of microfilms and other forms of data; and payments for subjects or for field research expenses. These funds may *not* be used as a stipend for the doctoral candidate. Student should apply to his department, who in turn will submit a proposal to the National Science Foundation. Applications may be submitted at any time. Four months should be allowed for processing. Awards will be made to the institution with the chairman or adviser designated as "project supervisor."

Walter G. Seeger Fellowship at $2,000 in Chemical, Electrical, and Mechanical Engineering. Apply through department.

Shevlin Fellowship at $3,000, offered to a student in the following colleges and schools: Agriculture, Biological Sciences, Chemistry, Forestry, Geology, Home Economics, Liberal Arts, Mathematics, Medical School, and Physics and Astronomy. The Graduate School will provide a tuition scholarship. Application must be made through the department concerned.

William W. Stout Memorial Graduate Fellowship at $3,000 to a student in the intermediate years of his Ph.D. program. The Graduate School will provide a tuition scholarship. Apply through department. Each eligible department nominates one candidate to the Graduate School Selection Committee.

U.S. Army Corps of Engineers Graduate Fellowship Program. This award designed for students at the Master's degree or Doctoral level who have completed their graduate course requirements except for the thesis, to be employed for a period of time by all Army Corps of Engineers offices and laboratories, except Mediterranean Division and Far East, Saudi Arabia, and Okinawa Districts. During the employment period, the student will accomplish research, analysis, or other practical work that will supply the basic material for his graduate degree thesis on a subject area preselected by mutual agreement between the student, the University, and Army Corps of Engineers officials. The thesis topic must concentrate on a subject of current analytical or informational need related to the mission of the Army Corps of Engineers. U.S. citizenship is required. Stipend—$8,582 per calendar year for Master's candidate; $10,470 per calendar year for Doctoral candidate. Students majoring in engineering science, social science, and administrative work should apply through their departments.

U.S. Department of Transportation—Program in Urban Transportation. As funds are available, this award is given to graduate students who intend to pursue careers in urban transportation planning, design, and operation. The amount of the stipend varies with the experience and background of the applicant and includes payment of tuition and fees. Special consideration is given to professional practitioners returning for further study. Applications must be made to Program in Urban Transportation, 150 Experimental Engineering Building, University of Minnesota, Minneapolis, Minnesota 55455.

University Alumni Graduate Fellowships (3) at $500 for students at the Ph.D. thesis stage in any area of graduate study. Application must be made through the Graduate Fellowship Office.

Thomas F. Wallace Graduate Fellowship at $3,000 in the humanities or social sciences for a student in the intermediate year of preparation for the Ph.D. degree. The Graduate School will provide a tuition scholarship. Apply through department. Each eligible department nominates one candidate to the Graduate School Selection Committee.

Woman's Club of Minneapolis Biennial Fellowship at $1,800 available in alternate years to a woman student meeting scholarship and leadership qualifications.

Woodrow Wilson Dissertation Fellowships at $225 per month plus dependency allowance for not more than 15 months; a supplementary allowance, not to exceed $1,000, may be granted on request to meet special research needs. Tuition and fees paid. All graduate students are eligible who expect to complete all requirements for the Ph.D. degree, including the dissertation within 4 calendar years after beginning postbaccalaureate study. Candidates must be nominated to the national foundation by the Graduate School. The application deadline is about January 15 of each year.

Fellowships Restricted as to Field

APPLICATION DEADLINE—Applications are due in the office of the department concerned by February 15 unless otherwise stipulated.

AEROSPACE ENGINEERING AND MECHANICS

Corporate Associates Fellowships will probably be available.
National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

AGRICULTURAL ECONOMICS

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

AGRICULTURAL EDUCATION

Minnesota Vocational Agriculture Instructors Associate Fellowships at $100 in Agricultural Education for men of demonstrated ability who are currently teaching vocational agriculture in Minnesota. U.S. citizenship required. Application deadline March 31.

AGRICULTURAL ENGINEERING

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

AGRONOMY AND PLANT GENETICS

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

ANATOMY

National Institutes of Health Training Grant (about 4) at $2,400 to $2,800 for study leading to the Ph.D. degree in anatomical sciences. Dependency allowance of $500. Agency pays tuition. U.S. citizenship required. Application deadline February 8.
United States Public Health Service Training Grant for Research in Diabetes (4) at $2,400 to $2,800 for study leading to the Ph.D. degree. Dependency allowance of $500. Agency pays tuition. U.S. citizenship required. Applications preferred by February 8 but they may be received at other times.

ANIMAL SCIENCE

John Brandt Memorial Foundation Fellowship at $3,500 in Animal Science. U.S. citizenship required. Open to first-year Master's and first-year doctoral students.
National Science Foundation Traineeships will probably be available.
United States Public Health Service Graduate Traineeships are available to qualified students majoring in Genetics. Agency pays fees. U.S. citizenship required. Application deadline April 1.

ANTHROPOLOGY

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* probably will be available.

National Institute of General Medical Sciences Training Grants (4) in Anthropology, excluding Archaeology, at $2,400 to $2,800 for the calendar year. Allowance of $500 per dependent. Agency pays fees and dissertation field research costs. U.S. citizenship required.

National Science Foundation Dissertation Support, $1,000 to $10,000 adjusted to research expense. U.S. citizenship required. Application made by the student through department.

ARCHAEOLOGY

Ford Foundation Traineeships in Archaeological Excavation—a number of traineeships available for summer excavation at sites in foreign countries under the sponsorship of the University of Minnesota. Limited to doctoral students seriously committed to careers in archaeology. Provides stipend covering costs of transportation to and from site and per diem to cover living expenses at the site. Apply through the dean of the College of Liberal Arts.

ARCHITECTURE

The American Institute of Architects and the *American Institute of Architects Foundation, Inc., Scholarship Program* (normally 3 stipends) in varying amounts. Application deadline late October.

Rollin B. Child Education Fund—a number of stipends in varying amounts. Limited to residents of Minnesota, North and South Dakota, and Wisconsin. Application deadline October 15.

Corporate Associates Fellowships will probably be available.

Ellerbe Architectural Scholarships in varying amounts. Application deadline October 15.

Roy Child Jones Fund—a number of stipends in varying amounts. Application deadline October 15.

Minnesota Lathing and Plastering Scholarships—a limited number of stipends in varying amounts. Application deadline October 15.

Minnesota Society of Architects Scholarship Fund—a number of stipends in varying amounts. Application deadline October 15.

Northern States Power Company Award and Scholarship in varying amounts. Application deadline October 15.

Setter, Leach, and Lindstrom, Inc., Scholarship in varying amounts. Application deadline October 15.

ART HISTORY AND MUSEOLOGY

American Art Fellowship (1) $400 for the study of Modern American Art. Application deadline March 15.

Art History Department Fellowships (1 or more) up to $2,200 for students working on their doctoral dissertations. Application deadline March 15.

Kress Foundation Fellowships (3-5) at stipends varying from $400 to $3,000. Application deadline March 15.

Museology Fellowships (2) at $2,400 for students interested in museum work at the M.A. level. Tuition fees are waived.

National Defense Education Act Title IV Graduate Fellowships will probably be available.

Pioneer Fund Fellowships (1-2) $100 to $500. Application deadline March 15.

BIOCHEMISTRY (Minneapolis Campus)

National Institutes of Health Training Grants (10) at $2,400 to $2,800 for study in Biochemistry. Agency pays tuition. U.S. citizenship required. Application deadline April 1.

BIOCHEMISTRY (St. Paul Campus)

United States Public Health Service Predoctoral Trainee Fellowships (16) in Biochemistry at $2,400 to $2,800 on calendar-year basis; tuition paid; dependency allowance. U.S. citizenship required. Application deadline April 15.

BIOMETRY

United States Public Health Service Traineeships in Biometry at $3,000 with $600 allowance per dependent per year. U.S. citizenship required. Agency pays tuition and fees. Application deadline March 15.

United States Public Health Service Special Purpose Traineeships in Public Health Statistics at $2,400 to $3,600 per year, with $500 per year for each dependent. U.S. citizenship required. Agency pays tuition and fees. Application deadline April 1.

BOTANY

Alexander P. Anderson and Lydia Anderson Summer Fellowships (5) at $600 maximum each in botanical and zoological science. Open only to graduates of the University of Minnesota. Application deadline March 15.

Charles J. Brand, Class of 1902, Fellowship at approximately $3,600, preferably for a student in the final year of work for the Ph.D. in Botany.

Caroline M. Crosby Memorial Fellowships (5-6) in Botany provide tuition, room and board, travel, and miscellaneous expenses up to $400 for students majoring in Botany at the University of Minnesota and desiring instruction at the Lake Itasca Forestry and Biological Station or a similar biological station. Application deadline March 15.

National Defense Education Act Title IV Graduate Fellowships and *National Science Foundation Traineeships* will probably be available.

BUSINESS ADMINISTRATION

Corporate Associates Fellowships will probably be available.

Ernst and Ernst Accounting Scholarship at $1,200.

Haskins and Sells Foundation, Inc., Fellowship at $2,500 for a qualified instructor who is preparing for a career as an accounting teacher.

Ernest Heilman Memorial Fellowship in Accounting at $300. Preference given to those planning a teaching career.

Walter E. Heller Fellowship, provided by Walter E. Heller and Company, at $1,000 for a student with at least 1 year's remaining work toward the M.B.A. degree. Application deadline February 15.

Lutheran Brotherhood Fellowship at $1,500 in Business Administration for a student with field of concentration in risk management and insurance.

Minnesota Banker's Association Graduate Fellowship in Banking and Finance at $2,500 for a Master's candidate with an undergraduate major in business, economics, banking, or finance at a college or university in Minnesota. U.S. citizenship required.

Minnesota Mining and Manufacturing Company Graduate Fellowship in Accounting at $2,500.

National Defense Education Act Title IV Fellowships will probably be available.

Pillsbury Company Fellowship at $500 to be awarded annually to a graduate student in Business Administration with a major interest in marketing.

St. Paul Companies Fellowship at $1,500 in Business Administration for a student with field of concentration in risk management and insurance.

U.S. Department of Transportation—Program in Urban Transportation. Offered when funds are available.

Roland S. Vaile Fellowship in Business Administration at $500 for a graduate student with primary interest in marketing.

CHEMICAL ENGINEERING AND MATERIALS SCIENCE

The Chemical Engineering and Materials Science Department each year offers a number of departmental fellowships carrying a stipend of $4,000 per calendar year. Additional tuition and fees awards are also available. These fellowships may require some departmental service but in no event is more than 6 hours per week required. The nature of the duties are tailored to the desires of the students and the staffing requirements of the department.

Atomic Energy Commission Fellowships at $5,190 in Metallurgy. Application deadline April 15.

Corporate Associates Fellowships will probably be available.

National Science Foundation Traineeships will probably be available.

United States Steel Foundation, Inc. Fellowship in Metallurgical Engineering, Mineral Engineering, or Geology at $3,500 annually for 2 years plus $600 for supplies. Application deadline April 15.

CHEMISTRY

American Oil Foundation Fellowship at $5,500 in Chemistry for a Ph.D. candidate who plans a career in teaching. Agency pays fees.

Corporate Associates Fellowships will probably be available.

Dow Chemical Company Fellowship at $2,500 in Chemistry. Agency pays fees.

Lubrizol Fellowship in Organic Chemistry at $4,000. Agency pays fees.

Minnesota Mining and Manufacturing Company Fellowship at $3,500 in Chemistry. Agency pays fees.

National Defense Education Act Title IV Graduate Fellowships and *National Science Foundation Graduate Traineeships* will probably be available.

Procter and Gamble Summer Fellowships in Chemistry (11) at $375 per summer session.

Smith Kline and *French Laboratories Fellowship* in Organic Chemistry at $4,000. Agency pays fees.

Uniroyal Fellowship in Chemistry at $2,600.

CHILD PSYCHOLOGY

United States Public Health Service Training Stipends (16) for research in Child Psychology at $2,400 to $2,800 depending on student's year of training. Allowance of $500 per dependent. U.S. citizenship required. Agency pays tuition.

United States Public Health Service Training Stipends (9) for research in behavior and development of preschool children at $2,400 to $2,800 depending on student's year of training. Allowance of $500 per dependent. Postdoctoral fellowships also available. U.S. citizenship required. Agency pays tuition.

For Center for Research in Human Learning and Clinical Child Psychology, see Psychology.

CIVIL AND MINERAL ENGINEERING

American Petroleum Institute Research Assistantships (2) in Mineral and Geological Engineering at $5,190. Application deadline April 15.

Corporate Associates Fellowships will probably be available.

Federal Water Quality Administration Traineeships (6) for graduate study in Sanitary Engineering. Stipend is $2,400 per year plus $500 allowance for dependents. Agency pays all tuition and other fees. U.S. citizenship required. Application deadline May 1.

Edmund J. Longyear Memorial Fund Fellowship in Geological Engineering, Mineral Engineering, Geology, or Geophysics at $500. Application deadline April 15.

Mineral Resources Research Center Research Assistantships (3) at up to $3,222 for the academic year in mineral processing and extractive metallurgy. Application deadline April 15.

Minnesota Surveyors and Engineers Society Fellowship for a graduate student in Civil Engineering whose major work lies in the fields of transportation, mapping, or land development. Preference will be given to candidates who intend to pursue professional careers in the state of Minnesota. Stipend $2,000 for the 9-month academic year. Application deadline April 1.

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

National Steel Corporation Fellowship at up to $4,000 in Metallurgical Engineering under Professor Gust Bitsianes. U.S. citizenship required. Application deadline April 15.

St. Anthony Falls Hydraulic Laboratory Fellowships for graduate students in Civil Engineering whose major field of specialization is hydraulic engineering, hydrology, or fluid mechanics. Restricted to doctoral candidates in their final year of study. The purpose of these awards is to free men for study during their final academic year. Preference is given to applicants who have previously held 3-year appointments as research assistants or teaching associates at the University of Minnesota. Stipend commensurate with research assistant awards. Application deadline April 1.

U.S. Army Corps of Engineers Fellowships will be available. These are restricted to U.S. citizens in the final year of study for the Master's and Ph.D. degrees.

United States Bureau of Mines Research Assistantships in Mineral and Geological Engineering at up to $5,000. Open to U.S. citizens. Application deadline April 15.

U.S. Department of Transportation—Program in Urban Transportation. Offered when funds are available.

United States Steel Foundation, Inc., Fellowship in Mineral and Geological Engineering, Geology, or Metallurgical Engineering at $7,800 for 2 years. Application deadline April 15.

CLASSICS

John C. Hutchinson Scholarships in varying amounts awarded to graduate students in Classics.

National Defense Education Act Title IV Graduate Fellowships will possibly be available.

COMMUNICATION DISORDERS

United States Office of Education Fellowships (6) at $2,200 to $3,200 with dependency allowance of $600 in Speech Science, Pathology and Audiology. Agency pays fees.

United States Rehabilitation Services Administration Traineeships (10) in Speech and Hearing at $2,400 to $3,400. U.S. citizenship required. Agency pays fees.

Veterans Administration Traineeship in Speech Pathology (2) at $3,320 to $6,000. Application deadline, 3 months prior to appointment.

COMPUTER INFORMATION AND CONTROL SCIENCES

Corporate Associates Fellowships will probably be available.

National Science Foundation Traineeships will probably be available.

Pillsbury Industrial Fellowships (2-3). This is a service fellowship with industrial basis, ranging from one-quarter to one-half time at $5.50 per hour. Application deadline April 1.

DENTISTRY

Several fellowships with stipends are open to qualified students in Dentistry.

United States Public Health Service Clinical Research Training Grants (11) for combined Dental School-Graduate School study. The first 3 years of combined study begins after the sophomore year in Dental School at $2,200 per year plus all graduate tuition and fees. After receiving the D.D.S. degree the remainder of the program is completed at $6,000 to $7,000 with allowance of $500 per dependent. Agency pays all tuition and fees in the second half of the program. U.S. citizenship required. Application deadline February 1.

United States Public Health Service Human Oral and Dental Genetics Training Grants (4)—predoctoral at $2,400, postdoctoral at $6,000 with allowance of $500 per dependent. Agency pays tuition and fees. U.S. citizenship required. Application deadline May 1.

United States Public Health Service Postdoctoral Research Training Grants in Dentistry (about 8) at $6,000 plus $500 per dependent. Open to qualified persons registered in the Graduate School. U.S. citizenship required. Agency pays tuition and fees. Application deadline as available.

DIGHT INSTITUTE

United States Public Health Service Traineeships (4) in Behavior Genetics at $2,400 to $2,800 with dependency allowance at $500 for graduate students with a major in genetics and a minor in psychology, or the reverse. U.S. citizenship required. Agency pays fees.

For additional listings, see Genetics and Cell Biology.

EAST ASIAN LANGUAGES

National Defense Modern Foreign Language Title VI Fellowships will probably be available. U.S. citizenship required.

ECOLOGY AND BEHAVIORAL BIOLOGY

Josephine Herz Fellowships (2) at $800 to encourage research in the behavior of birds during the Lake Itasca Biology Session each spring and summer.

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

United States Public Health Service Traineeships (9) in Vertebrate Behavior and Ecology from $2,400 to $2,800 depending on student's year of training plus $500 for each dependent. Two postdoctoral positions at $5,000 are also available. U.S. citizenship required. Agency pays tuition and fees.

ECONOMICS

Department Fellowships (4) at $3,000 and (1) at $1,500 for 3 years.

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

U.S. Department of Transportation—Program in Urban Transportation. Offered when funds are available.

EDUCATION

Walter W. Cook Fellowship at $200 to $500 for a student doing Ph.D. thesis research in the fields of individual differences or measurements. Applicants must have had their thesis approved by the Graduate School and must have completed all preliminary examinations. Apply through the Graduate Fellowship Office.

Eva O. Miller Fellowship at $3,000 plus tuition for 1 academic year's work for research in individual differences and cognitive aspects thereof, with special reference to the study of research or scholarly or creative work. Apply through the Graduate School Fellowship Office.

National Defense Education Act Title IV Fellowships will probably be available in Counseling and Student Personnel Psychology; Education—Foreign Languages Education and Research; Educational Administration; English Education; Music Education; Physical Education; and Psychological Foundations of Education.

Preparation of Administrators for Indian Schools (15) at $3,000 plus $500 dependency allowance. Open only to American Indian students. Agency pays fees.

United States Office of Education—Training Research Practitioners for Educational Institutions (2) at $2,400 plus $500 allowance per dependent. U.S. citizenship required. Agency pays fees, tuition, and books.

United States Office of Education Graduate Assistantships in Special Education. U.S. citizen or U.S. national.

United States Public Health Service Traineeships (11) in School Psychology at $2,400 to $2,800. Dependency allowance of $500. Agency pays tuition.

ELECTRICAL ENGINEERING

Corporate Associates Fellowships will probably be available.

Mayo Engineering Graduate Fellowships (2) at $500 offered to first-year graduate students working toward a Master's degree in Electrical Engineering who are interested in medical instrumentation and allied pursuits.

Mayo Engineering Graduate Fellowship open to a major in Electrical Engineering who has completed the course requirements for the M.S. degree. Residence will be Rochester, Minnesota, for thesis work in the Engineering Division of the Mayo Graduate School of Medicine. May be held for a maximum of 2 years. Stipend commensurate with current salaries for graduates in electrical engineering.

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

U.S. Department of Transportation—Program in Urban Transportation. Offered when funds are available.

ENGLISH

National Defense Education Act Title IV Fellowships will proabably be available.

ENTOMOLOGY, FISHERIES, AND WILDLIFE

National Defense Education Act Title IV Fellowships will proabably be available.

FAMILY STUDY CENTER

National Institute of Mental Health Traineeships (9) in sociological research on the family at $2,400 to $2,800 depending upon year of graduate work. Basic training for careers in family research and teaching in a variety of occupational settings. Allowance of $600 per dependent. Agency pays fees. U.S. citizenship required. Renewable for a total of 3 years. Apply to Family Study Center. (See Sociology.)

FOOD SCIENCE AND INDUSTRIES

John Brandt Memorial Foundation Fellowship at $3,500 in Food Science and Industries. U.S. citizenship required. Open to first-year Master's and first-year doctoral students.

FORESTRY

Boise Cascade Graduate Fellowship at $1,500 for work in forest management in the College of Forestry. Application deadline April 1.

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

Northwest Paper Foundation Fellowship at $3,240 for work in forest management in the College of Forestry. Application deadline April 1.

GENETICS AND CELL BIOLOGY

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

United States Public Health Service Postdoctoral Trainee Fellowships (2) in Genetics. Stipend negotiated. U.S. citizenship required.

United States Public Health Service Predoctoral Trainee Fellowships (11) in Genetics at $2,400 to $2,800 with $500 dependency allowance. U.S. citizenship required.

For additional listings see Dight Institute.

GEOGRAPHY

Commission on Geography and Afro-America Fellowships (1-2) at $2,000 plus $400 per dependent may be available through the Association of American Geographers. Program is designed to support graduate training for students from predominantly black colleges in the southern United States. U.S. citizenship required. Application deadline March 15.

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

U.S. Department of Transportation—Program in Urban Transportation. Offered when funds are available.

GEOLOGY AND GEOPHYSICS

Thomas F. Andrews Fellowship at $500 to $1,000 in Geology, available at intervals of 2 or 3 years. Application deadline February 15.

Corporate Associates Fellowships will probably be available.

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

U.S. Department of Transportation—Program in Urban Transportation. Offered when funds are available.

GERMAN

Carl Schlenker Memorial Fellowship at $800 open to an unmarried American-born student majoring in German language and literature. Application deadline October 1.
National Defense Education Act Title IV Fellowships will probably be available.

HISTORY

National Defense Education Act Title IV Fellowships will probably be available.

HOME ECONOMICS

Allied Health Professions Advanced Traineeships (4-5) in clinical nutrition at $2,400 to $3,600 depending on previous professional experience and year of graduate work. Allowance of $500 per dependent. Agency pays fees. U.S. citizenship required.
Electrical Women's Round Table, Julia Kiene Fellowship at $1,500 for a student interested in household equipment or business-related areas of Home Economics. Application deadline in March.
United States Public Health Service Traineeships (2-3) in Nutrition at $2,400 to $2,800 will probably be available. U.S. citizenship required. Agency pays fees.
National Science Foundation Traineeships in Nutrition will probably be available.

HORTICULTURAL SCIENCE

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

INDUSTRIAL RELATIONS

National Defense Education Act Title IV Fellowships will probably be available.

JOURNALISM AND MASS COMMUNICATION

Carroll Binder Memorial Award (2) of approximately $500 for a graduate or undergraduate student who shows promise in the reporting and/or interpreting of international news and who expects to go into newspaper work. Application deadline April 1.
Gannett Foundation Scholarship at $500 in Journalism. Application deadline April 1.
Arle and Billi Haeberle Fellowship in an amount depending on availability of funds for a woman first-year graduate student to continue studies in Speech, Journalism, or Theatre for a career in broadcasting.
Minneapolis Star and Tribune "World Affairs Program" Teaching Assistantship at $3,240 in Journalism. Application deadline March 1.
Minnesota Mining and Manufacturing Co. Scholarships (2) at $500 for upper division or graduate students in Journalism. Application deadline April 1.
Modern Medicine Publications Scholarships (2) at $500 in Journalism. Application deadline April 1.
National Defense Education Act Title IV Fellowships will probably be available.
David Silverman Memorial Scholarship at $400 in Journalism for a student specializing in news-editorial aspects of journalism. Application deadline April 1.

LIBRARY SCIENCE

John C. Hutchinson Scholarship in Library Science of approximately $500. U.S. citizenship required. Application deadline March 1.
Lura C. Hutchinson Scholarship in Library Science of approximately $500. U.S. citizenship required. Application deadline March 1.
Irene Fraser Jackson Memorial Fellowship at $1,000 open to students in Library Science. U.S. citizenship required. Application deadline March 1.
H. W. Wilson Memorial Fellowship of $1,000 in Library Science. U.S. citizenship required. Application deadline March 1.

Inquiry should be addressed to the Library School before March 1 for information on other fellowships which may be available in 1972-73.

LINGUISTICS

Linguistics Scholarships (2-3) at $450 for resident students—$960 for nonresident students—will probably be available to full-time majors. Application deadline March 1.
National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

MATHEMATICS

Corporate Associates Fellowships will probably be available.
National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

MAYO GRADUATE SCHOOL OF MEDICINE

Mayo Fellowships for residency training beginning at $10,000 per year and internships beginning at $9,500 are available to medical graduates desiring graduate specialty. They are offered in internal medicine, general surgery, the medical and surgical specialties, and basic medical sciences. Appointments are made quarterly and are renewable annually. Applications are accepted 6 months or more prior to desired date of commencing fellowship. Address Director, Mayo Graduate School of Medicine, Rochester, Minnesota 55901.

National Institutes of Health Traineeships are available in the following fields: Dermatology, Endocrinology, Gastroenterology, Hematology, Neurology, Neurophysiology, Pediatric Cardiology, Psychiatry, Pulmonary Physiology and Thoracic Diseases, and Speech Pathology. U.S. citizenship required.

MECHANICAL AND INDUSTRIAL ENGINEERING

Corporate Associates Fellowships will probably be available.

Minnesota Mining and Manufacturing Company Fellowship at $2,000 to $2,800 in Mechanical Engineering.

National Defense Education Act Title IV Fellowships, National Science Foundation Traineeships and *National Institutes of Health Fellowships or Traineeships* will probably be available. U.S. citizenship required.

U.S. Department of Transportation—Program in Urban Transportation. Offered when funds are available.

Whirlpool Corporation Fellowships in Mechanical Engineering (2) at $2,400. Applicants must be involved in thesis research/writing.

MEDICINE

Graduate fellowships and assistantships are offered in all departments of the Medical School. Since the duration of support and stipend amounts vary, inquiry should be addressed to the specific department in which a fellowship is desired. The following general information is listed:

United States Public Health Service Training Grants for students holding their professional degrees and for predoctoral and postdoctoral graduate study in the basic sciences, including the Departments of Anatomy, Biochemistry, Microbiology, Pathology, Pharmacology, and Physiology. U.S. citizenship required. Approximately 50 fellowships are available.

United States Public Health Service Training Grants for graduate training in the fields of cancer, cardiovascular problems, psychiatry, hematology, diabetes, and arthritis under the supervision of these departments and divisions: Anesthesiology, Child Psychiatry, Clinical Psychology, Dermatology, Laboratory Medicine, Medicine, Neurology, Neurosurgery, Obstetrics and Gynecology, Ophthalmology, Pediatrics, Psychiatry, Radiation Therapy, Radiology, and Surgery. U.S. citizenship required. More than 100 fellowships are available.

United States Public Health Service and Office of Vocational Rehabilitation Traineeships are available in the Department of Physical Medicine and Rehabilitation. U.S. citizenship required.

Fellowships for combined medical-graduate study in the basic medical sciences are open to qualified applicants who have been accepted for admission to both the Graduate School and the Medical School and who wish to pursue graduate work while completing the standard medical curriculum leading to the M.D. degree. U.S. citizenship required. Renewable annually subject to faculty approval. Approximately four students are admitted to this program annually. Fellowship stipend support for a limited number of selected students on combined M.D.-Ph.D. programs, on application to national competition through the Medical School Faculty Committee.

Various individual fellowships are available from such sources as the Public Health Service, American Cancer Society, American Heart Association, and national foundations. Applicants must be sponsored by the departments responsible for their courses of study. The terms of support are from 1 to 5 years.

Numerous other special fellowships, sponsored by a variety of agencies, are available through departmental offices.

In all cases, the number of fellowships awarded is subject to the availability of funds.

MICROBIOLOGY

United States Public Health Service Postdoctoral Fellowships (4) at $6,000 with dependency allowance of $500. U.S. citizenship required.

United States Public Health Service Predoctoral Fellowships (25) at $2,400 with dependency allowance of $500 in Microbiology. U.S. citizenship required. Application deadline February 1.

MINERAL RESOURCES

Mines Experiment Station Research Assistantships (3) at up to $6,192 for the academic year in mineral processing. Application deadline April 15.

United States Bureau of Mines Research Assistantships in Mineral Engineering at up to $5,000. Open to male U.S. citizens. Application deadline April 15.

MUSIC

National Defense Education Act Title IV Fellowships will probably be available.

NUTRITION

Allied Health Professions Advanced Traineeships (4-5) in clinical nutrition at $2,400 to $3,600 depending on previous professional experience and year of graduate work. Allowance of $500 per dependent. Agency pays fees. U.S. citizenship required.

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

United States Public Health Service Predoctoral Traineeships (10) in Nutrition at $2,400 to $2,800 may be available. U.S. citizenship required. Agency pays fees. Application deadline April 1.

In addition, a number of research and teaching assistantships and other awards are available in the parent departments to which graduate students are attached while working toward degrees in Nutrition. These awards are listed under the parent departments, which include Animal Science, Biochemistry, and Home Economics.

PHARMACOLOGY

Multidisciplinary Training (4) in Clinical Pharmacology for students majoring in the Medical specialties. Stipend of $8,000 plus $500 dependency allowance. U.S. citizenship required. Application deadline July 1.

National Institutes of Health Training Grants in Pharmacology. Approximately 21 predoctoral traineeships at $2,400 first year, $2,600 intermediate years, and $2,800 final year. Six postdoctoral traineeships at $6,000 first year and $6,500 second year. Dependency allowance is $500 per dependent. U.S. citizenship required. Agency pays tuition.

United States Public Health Training Grants in Psychopharmacology. About 8 predoctoral grants at $2,400 to $2,800 for 12 months are available to Ph.D. candidates in Pharmacology and Psychology; 4 postdoctoral at $6,000 to $6,500 depending on year of study. Allowance of $500 per dependent. U.S. citizenship required. Agency pays fees. Application deadline February 1. (See Psychology section of this bulletin.)

PHARMACY

American Foundation for Pharmaceutical Education Graduate Fellowships at $1,800 maximum ($2,400 for married students). U.S. citizenship required. Agency pays fees. Application deadline March 15.

National Defense Education Act Title IV Fellowships in Medicinal Chemistry and Pharmaceutics and *National Science Foundation Traineeships* in Pharmaceutics may be available.

National Institutes of Health Training Grants in Pharmaceutical Sciences (Pharmaceutics, Pharmacognosy, and Medicinal Chemistry). Three predoctoral traineeships at $2,400 to $2,800. Two postdoctoral traineeships at $6,000. Dependency allowance is $500 per dependent. U.S. citizenship required. Agency pays tuition.

PHILOSOPHY

National Defense Education Act Title IV Fellowships will probably be available.

In addition, several dissertation fellowships are available to qualified students who have completed all other requirements for the Ph.D.

PHYSICS AND ASTRONOMY

Corporate Associates Fellowships will probably be available.

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

PHYSIOLOGY

National Institutes of Health Training Grants (about 25) at $2,400 for first year, $2,600 for intermediate years, and $2,800 for terminal year with dependency allowance of $500 per dependent. Postdoctoral fellowships (4-5) are available at $6,000 to $7,000 per calendar year. U.S. citizenship required. Agency pays fees.

PLANT PATHOLOGY

Minnesota Seed Potato Fund (1)—basic stipend $4,128.

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

POLITICAL SCIENCE

Asher N. Christensen Memorial Award of $100 for study abroad or research in American government and politics; available to either a graduate or an undergraduate.

Hubert H. Humphrey Fellowship at $2,500 open to an advanced graduate major with a distinguished record in political science in any area of specialization within the discipline.

National Defense Education Act Title IV Fellowships and *National Science Foundation Graduate Traineeships* will probably be available.

Political Science Fellowships—funded by a grant from the Ford Foundation. These fellowships are for beginning graduate students in Political Science and are for a 3-year period. Stipends are from $2,000 to $2,400 for the academic year, with $400 per dependent. Tuition and fees are paid, and support is available also for the summer. The fellowships are intended to support the student in a 4-year Ph.D. program. The student receives 3 years of fellowship support and 1 year of supervised teaching experience as a teaching assistant (in either his second or third year of work). The terms of the fellowship support are essentially the same as those of the NDEA IV fellowships.

Clara H. Ueland Memorial Fellowship at $2,500 open to a woman whose interests are in political science. (Offered in alternate years; offered 1972-73.)

U.S. Department of Transportation—Program in Urban Transportation. Offered when funds are available.

PSYCHOLOGY

Center for Research in Human Learning Traineeships—4 predoctoral at $2,400, $2,600, $2,800 for first, intermediate, and terminal years of study; 2 postdoctoral at $6,000 to $6,500 for persons interested in human learning. Dependency allowance is $500. U.S. citizenship is required. Agency pays fees. Application deadline February 1.

Clinical Psychology—Veterans Administration—10 work-study stipends at $3,660 to $6,790 for half-time psychological work under the joint training program of the University and the Veterans Administration open to doctoral students in adult clinical psychology. U.S. citizenship required. Application deadline February 1.

Clinical Psychology—United States Public Health Service—27 fellowships in Clinical Psychology at $2,400 to $2,800 for study for the Ph.D. degree. The amount depends upon year of graduate work. Allowance of $500 per dependent. U.S. citizenship required. Agency pays tuition and fees. Application deadline February 1.

National Defense Education Act Title IV Fellowships will probably be available.

Counseling Psychology—Veterans Administration—10 work-study stipends at $3,660 to $6,790 for half-time psychological work under the joint training program of the University and the Veterans Administration open to students in either the Department of Psychology or the Department of Educational Psychology. U.S. citizenship required. Application deadline February 1.

Counseling Psychology—United States Rehabilitation Services Administration—30 traineeships in vocational rehabilitation counseling at $1,800 to $3,400 for the academic year are available in the Departments of Psychology and Educational Psychology. The amount depends upon the year of graduate work. U.S. citizenship required. Agency pays tuition and fees. Students at the third- and fourth-year levels receive $500 per dependent. Application deadline February 1.

Counseling Psychology—Administrative Fellowships—3 at $4,500 for graduate students in Counseling Psychology, Educational Psychology, Student Personnel Work, Tests and Measurement, or Higher Education are available in the Student Counseling Bureau. Application deadline February 15.

United States Public Health Traineeships in Psychopharmacology—several predoctoral at $2,400 to $2,800 for 12 months are available to Ph.D. candidates in Psychology and Pharma-

cology; several postdoctoral at $6,000 to $6,500, depending on year of study; allowance of $500 per dependent. U.S. citizenship required. Agency pays fees. Application deadline February 1. (See Pharmacology section of this bulletin.)

Behavior Genetics Traineeships—National Institute of Mental Health—4 new 12-month traineeships each year for psychology and genetics Ph.D. candidates at $2,400 to $3,000 (depending on level). U.S. citizenship required. Allowance of $500 per dependent. Agency pays fees. Application deadline February 1.

See Child Psychology and Education sections.

PUBLIC AFFAIRS

Administration of Programs for the Aging—United States Administration on Aging, 12 traineeships (fellowships) at $2,600 to $3,400 for 12 months. Allowance of $500 for each dependent. U.S. citizenship required. Agency pays tuition and fees.

National Science Foundation Traineeships will probably be available.

Students in Public Affairs occasionally receive Urban Transportation Fellowships (DOT) and Urban Studies Fellowships (HUD). Interested students who wish to be sponsored by the School of Public Affairs should contact the school before January 1.

PUBLIC HEALTH

Children's Bureau Graduate Traineeships (3) in Maternal and Child Health at $6,000 to $7,000 plus allowance of $500 per dependent. Agency pays fees. U.S. citizenship required. Prefer applications by April 1. Open to physicians and dentists.

Children's Bureau Graduate Traineeships (4) in Public Health Nutrition at $2,400 to $3,600 per year plus allowance of $500 per dependent. Agency pays fees. U.S. citizenship required. Applications preferred by April 1.

United States Department of the Interior Traineeships (10) in Water Supply and Pollution Control at approximately $250 per summer term plus $47.50 dependency allowance per term, tuition, and travel allowance. Open to water supply engineers, aquatic biologists, forestry personnel, hydraulic engineers, chemists, geologists, and other professionals interested in water quality, water resources, and water management. U.S. citizenship required. Programs run through one or both summer terms of each year. Applications preferred by April 1.

United States Public Health Service Traineeships (8) in Air Pollution Control at $3,000 with allowance of $500 per dependent. U.S. citizenship required. Agency pays fees. Prefer applications by April 1.

United States Public Health Service Traineeships (5) in Health Care Research for M.P.H. or Ph.D. candidates in the field of hospital and health care administration at $3,000 to $4,000 plus $600 dependency allowance, tuition, and fees. U.S. citizenship required. Application deadline April 1.

United States Public Health Service Professional Nurse Traineeships Program (Division of Nursing) (25) stipends in Public Health Nursing at $2,400 to $3,600 plus $500 dependency allowance and tuition. Open to graduate nurses preparing for leadership positions. Also open to public health nursing personnel seeking short-term preparation for later graduate level professional training. U.S. citizenship required. Prefer applications by April 1. Program extends over 2 academic years.

United States Public Health Service Professional Nurse Traineeships (Division of Nursing) (10) at $2,400 to $3,600, plus $500 dependency allowance, tuition, and fees. Open to graduate nurses preparing to work in Ambulatory Child Health Care. This is a 9-month program. Upon completion, a certificate will be issued and credits earned may be transferred to the M.P.H. degree in Public Health Nursing. U.S. citizenship required.

United States Public Health Service Traineeships (25) in Public Health at $2,400 to $3,600 per year for predoctoral and $6,000 to $7,000 per year for postdoctoral study. Allowance of $500 per dependent. U.S. citizenship required. Prefer applications by April 1. Renewable at higher rates for additional years of study.

United States Public Health Service Traineeships (4) in Occupational Health at $2,400 to $3,600 plus $500 dependency allowance, tuition, and fees. U.S. citizenship required. Application deadline April 1.

United States Public Health Service Traineeships (6) in Radiological Health at $3,000 to $4,100 per year plus allowance of $500 per dependent. U.S. citizenship required. Prefer applications by April 1. Renewable at higher rates for additional years of study.

United States Public Health Service Special Purpose Traineeships (10) for study in hospital administration and health statistics at $2,400 to $3,600 per year for predoctoral students, depending upon education and experience. Allowance of $500 per dependent. Agency pays tuition. U.S. citizenship required. Prefer applications by April 1. Renewable at higher rates for additional years of study.

SCANDINAVIAN

National Defense Education Act Title IV and *National Defense Foreign Language Title VI Fellowships* will probably be available.

SOCIAL WORK

United States Children's Bureau Traineeships (7) at $2,000 (for 2 graduate years to earn the M.S.W. degree) for students whose career objective is work in Child Welfare. In addition there are two traineeships at $3,400 plus dependency allowance of $500 for a post-M.S.W. student working toward the Ph.D. degree. U.S. citizenship required. Agency pays tuition and fees. Application deadline April 1 for Ph.D. candidates, May 1 for M.S.W. candidates.

United States Public Health Service, Mental Health Act, Traineeships (20) which provide tuition, allowance of $375 per dependent, plus $1,800 (for first graduate year), $1,950 (for second graduate year), for Social Work students whose career objective is to work in the psychiatric or correctional or school social work (visiting teacher) fields. In addition there are traineeships at $3,600, plus payment of tuition by the agency, for qualified holders of the M.S.W. degree whose objective is the Ph.D. degree. For the latter a $500 dependency allowance is offered for 12-month tenure. U.S. citizenship required. Application deadline April 1 for post-M.S.W., May 1 for M.S.W.

United States Rehabilitation Services Administration Traineeships (8) at $1,800 (for first graduate year) and $2,000 (for second graduate year) for Social Work students whose career objective is to work in the rehabilitation field. U.S. citizenship required. Agency pays tuition. Application deadline May 1.

A few stipends of about $170 per month in cooperation with the Veterans Administration are available for medical and psychiatric social work students.

SOCIOLOGY

National Institute of Mental Health Traineeships (12) in deviant behavior at $2,400 to $2,800, depending on year of graduate work. Basic training for careers in teaching and research. Dependency allowance of $500. Agency pays fees. U.S. citizenship required.

National Institute of Mental Health Traineeships (9) in sociological research on the family of $2,400 to $2,800, depending on year of graduate work. Basic training for careers in family research and teaching in a variety of occupational settings. Allowance of $600 per dependent. Agency pays fees. U.S. citizenship required. Renewable for a total of 3 years. Apply to Family Study Center. (See Family Study Center.)

SOIL SCIENCE

National Science Foundation Traineeships will probably be available.

SOUTH ASIAN LANGUAGES

National Defense Modern Foreign Language Title VI Fellowships will probably be available. U.S. citizenship required.

SPANISH AND PORTUGUESE

National Defense Education Act Title IV Fellowships and *National Defense Foreign Language Title VI Fellowships* will probably be available in Spanish.

SPEECH-COMMUNICATION

Arle and Billi Haeberle Fellowship in amount depending on availability of funds for a female graduating senior or current female graduate student for study in Speech-Communication, Theatre Arts, or Journalism and Mass Communication at the University of Minnesota. Intended to encourage young women to continue their studies at the graduate level for a career in broadcasting. Award based on outstanding scholastic performance and ability on a merit basis only. Apply to Graduate School Fellowship Office by May 1.

National Defense Education Act Title IV Fellowships will probably be available.

STATISTICS

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

THEATRE ARTS

Bush Foundation Graduate Theatre Fellowships (10-15) at $1,700 to $3,000 annually for 2 years in Theatre Arts. Candidates must be nominated by a director of a college theatre from which their degrees were received. Holders devote the first academic year to gradu-

ate study and work in the University Theatre and in the second year continue studies at the University until internship at the Tyrone Guthrie Theatre begins. Nomination deadline December 15. Those nominated must complete special application form by January 15.

Oscar W. Firkins Scholarship of $1,200 for an outstanding senior or graduate student in theatre, on the basis of service, potential in theatre, and need. Application deadline May 1.

Arle and Billi Haeberle Fellowship in amount depending on availability of funds for a female graduating senior or current female graduate student for study in Speech-Communication, Theatre Arts, or Journalism and Mass Communication at the University of Minnesota. Intended to encourage young women to continue their studies at the graduate level for a career in broadcasting. Award based on outstanding scholastic performance and ability on a merit basis only. Apply to Graduate School Fellowship Office by May 1.

Elsie Kelly Lindquist Theatre Fellowship of $500, depending on availability of funds, for an outstanding student in theatre, to be selected by the director of the University Theatre.

National Defense Education Act Title IV Fellowships will probably be available. See page .

Frank M. Rarig, Sr., Graduate Fellowship of approximately $500 for a worthy graduate student with a major interest in oral interpretation of literature. Application deadline May 1.

Sam S. Shubert Foundation Fellowship of $3,000 for a student interested in pursuing a graduate degree and in writing a full-length play. Application deadline February 1.

VETERINARY MEDICINE

Graduate fellowships are offered in all departments of the College of Veterinary Medicine: Veterinary Anatomy, Veterinary Microbiology and Public Health, Veterinary Diagnostic Laboratories, Veterinary Medicine, Veterinary Obstetrics and Gynecology, Veterinary Pathology and Parasitology, Veterinary Physiology and Pharmacology, and Veterinary Surgery and Radiology. Since the duration of support and amounts of stipend vary, inquiries should be addressed to the specific department in which a fellowship is desired.

The College of Veterinary Medicine, through the Office of the Dean, has a limited amount of stipend support available from several sources.

United States Department of Agriculture—Research fellowships are available in several departments from funds provided by this source.

United States Public Health Service—Postdoctoral research fellowships are available in several departments from funds provided by this source.

Other special fellowships, sponsored by a variety of agencies, may be available through departmental offices.

United States Public Health Service Postdoctoral Fellowships (3) at $6,000 to $7,000 plus a dependency allowance are available in Veterinary Anatomy. U.S. citizenship required. Agency pays tuition.

ZOOLOGY

Alexander P. Anderson and Lydia Anderson Summer Fellowships (5) at $600 maximum each in botanical and zoological science. Open only to graduates of the University of Minnesota. Application deadline March 15.

National Defense Education Act Title IV Fellowships and *National Science Foundation Traineeships* will probably be available.

Charles Peter Sigerfoos Fellowship of about $500 for a graduate student in Zoology who is a prospective doctoral candidate to enable him to pursue work at a marine or tropical biological laboratory. Application deadline March 15.

COUNCIL OF GRADUATE SCHOOLS IN THE UNITED STATES

Resolution Regarding Scholars, Fellows, Trainees, and Graduate Assistants

Acceptance of an offer of a graduate scholarship, fellowship, traineeship, or graduate assistantship for the next academic year by an actual or prospective graduate student completes an agreement which both student and the graduate school expect to honor. In those instances in which the student indicates his

acceptance prior to April 15 and subsequently desires to change his plans, he may submit in writing a resignation of his appointment at any time through April 15 in order to accept another scholarship, fellowship, traineeship, or graduate assistantship. However, an acceptance given or left in force after April 15 commits him not to accept another appointment without first obtaining formal release for the purpose.

It is further agreed by the institutions and organizations subscribing to the above Resolution that a copy of this Resolution should accompany every scholarship, fellowship, traineeship, and assistantship offer sent to a first-year graduate student before April 15.

MISCELLANEOUS ASSISTANCE

General College Assistantships

Graduate students are eligible to apply for teaching assistantships and associateships in the following divisions of General College: Business Studies; General Arts; Literature, Writing, and Speech; Natural Science and Mathematics; Psychology, Philosophy, and Family Studies; Social Studies. Inquiries should be addressed to the head of the division in which the student is interested.

Note—Application for General College assistantships is a process which is entirely separate from Graduate School admission procedures. However, no assistantship will be awarded to any student until the student has been admitted to the Graduate School.

Honorary Fellowships

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

Honorary fellows shall not be required to pay any fees except to cover the cost of unusually expensive supplies or equipment.

Postdoctoral Associate

Postdoctoral fellows who are not already entitled to normal faculty privileges can be appointed by the Graduate School as postdoctoral associates, a position which carries no stipend from the Graduate School but does entitle associates to the use of University facilities, to purchase athletic tickets at the staff rate, and, if they have private health insurance, does make them eligible 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.

Possibilities for Employment

The Student Employment Service of the University, 30 Wulling Hall, University of Minnesota, Minneapolis, Minnesota 55455, maintains a file of available jobs on the Minneapolis Campus and in the Twin Cities. Further information may be found in the *General Information Bulletin*.

Students in the Graduate School may also find it profitable to explore through other channels the possibility of part-time employment in the Twin Cities area in business, professional, or other fields.

Note—Persons married to graduate students may also obtain employment information from the Student Employment Service.

Services of the Office of Student Financial Aid

The University has Trust Fund Loans available for personal loans to graduate students. No security is required other than the student's integrity and his ability to do graduate work. A student may borrow up to $1,500 during any one year. All applications should be made to the Office of Student Financial Aid, 107 Armory, University of Minnesota, Minneapolis, Minnesota 55455.

Graduate students may be eligible for loan assistance under the National Defense Student Loan Program; inquiries concerning this program should be directed to the Office of Student Financial Aid. Awards under this loan program and the Trust Fund Loan Program are made on the basis of financial need to students who are on at least a half-time or equivalent student status.

If students wish assistance in planning their finances during residence in the Graduate School and in working out a program of part-time employment and supplementary financial aid, the counselors in the financial aid office will be available to help by personal interview or by correspondence.

Services for Students from Abroad

Counseling and advisory services are provided for students from other countries by the adviser to foreign students. Assistance is given in meeting English language requirements; orientation to federal, state, and local regulations; and other problems, educational, social, and financial in nature. All foreign students are invited to address inquiries concerning these matters to the Office of the Adviser to Foreign Students, 717 E. River Road, University of Minnesota, Minneapolis, Minnesota 55455.

Placement of Graduate Students

Aid and counsel to graduate students who wish college, university, or other positions may be had from advisers and departments, the deans of various colleges of the University, and through the Bureau of Recommendations, which receives reports of vacancies for *college teaching* in all fields as well as in counseling, administration, and research. For further information, students may address the Director, Bureau of Recommendations, 400 - 12th Avenue S.E., University of Minnesota, Minneapolis, Minnesota 55414.

Housing Facilities

Most out-of-town students live either in University-maintained residence halls, in private housing, or in fraternities or sororities. Student residences are inspected regularly to assure safe and healthful quarters as well as good study conditions. Refer to the *General Information Bulletin* for details.

Information concerning residence halls may be obtained from the Director of Housing, 312 - 15th Avenue S.E., University of Minnesota, Minneapolis, Minnesota 55455. Information about private housing and fraternities or sororities may be ob-

tained from the Offcampus Housing Office, 312 - 15th Avenue S.E., University of Minnesota, Minneapolis, Minnesota 55455; or 1818 - 4th Street S., Minneapolis, Minnesota 55455; or 190 Coffey Hall, St. Paul, Minnesota 55101.

The Council of Graduate Students

The Council of Graduate Students at the University of Minnesota provides a unique opportunity to organize graduate students across many fields. The goals it seeks are as follows: (a) to unite the forces of all graduate and professional students, thus making a powerful, formally recognized body to represent and negotiate for all graduate students; (b) to assimilate, coordinate, and disseminate information to all graduate students; (c) to provide student representatives for university committees; (d) to make the graduate students aware of mutual problems and to help find solutions for these problems; and (e) to make the Council of Graduate Students part of the Graduate School structure and organization.

The Council of Graduate Students has an office on the third floor of Johnston Hall (phone 373-7909) and invites graduate students to contact them with any ideas, questions, grievances, or problems they may have.

ARMY AND AIR FORCE ROTC PROGRAMS

Students in the Graduate School may pursue the 2-year Army or Air Force ROTC program. To be eligible, applicants must have 6 quarters of academic work remaining, after successful completion of a required 6-week summer encampment. Students successfully completing the entire program earn their commissions in 2 years. Applications are accepted each winter quarter. No graduate credit may be earned.

FIELDS OF INSTRUCTION

See inside back cover for an explanation of symbols used in course descriptions in this bulletin. Departmental abbreviations are listed alphabetically, preceding the Index.

Students should consult the *Class Schedule* for each quarter and special college and departmental statements to learn the hour and place of specific courses.

AEROSPACE ENGINEERING AND MECHANICS (AEM)

AEROSPACE ENGINEERING

Professor

Patarasp R. Sethna, *head, director of graduate study*
Abraham S. Berman
Roger L. Fosdick
Lawrence E. Goodman
Helmut G. Heinrich
Philip G. Hodge, Jr.
C. C. Hsiao
Daniel D. Joseph
Thomas S. Lundgren
Robert Plunkett
William H. Warner

Associate Professor

Gordon S. Beavers
John P. Moran
Peter C. Patton
Eugene Stolarik
Theodore A. Wilson

Assistant Professor

Jack L. Dais
William L. Garrard
Harold York

MECHANICS

Professor

Patarasp R. Sethna, *head, director of graduate study*
Abraham S. Berman
Roger L. Fosdick
Lawrence E. Goodman
Philip G. Hodge, Jr.
C. C. Hsiao
Robert Plunkett
William H. Warner

Associate Professor

John P. Moran
Peter C. Patton
Theodore A. Wilson

Assistant Professor

Jack L. Dais
William L. Garrard
Harold York

The Department of Aerospace Engineering and Mechanics offers advanced degrees in the major fields of aerospace engineering and of mechanics. Students who wish to major in either of these fields should consult the chairman of the Departmental Graduate Admissions Committee, 117 Aerospace Engineering Building.

Aerospace Engineering

Prerequisites—For work in the major field of aerospace engineering, adequate preparation in fundamental engineering sciences (mathematics, physics, mechanics, and chemistry) is required. Students without an engineering degree but with appropriate qualifications are admissible. For minor work, course prerequisites govern.

Language Requirement—There is no foreign language required, but individual doctoral candidates may find that reading proficiency in one or more languages is essential.

Master of Science—Offered under both Plan A and Plan B. The Plan B paper requirements may be met in connection with any course accepted for graduate credit, seminar, or independent work under faculty supervision, subject to

the prior approval of the student's adviser and of the faculty member supervising the preparation of the paper. The master of science program can normally be completed in 1 year.

Doctor's Degree—Programs leading to the Ph.D. degree in the major field of aerospace engineering are offered in several areas of specialization, including aerodynamics, aerospace structures, astrodynamics, control theory, dynamical systems, fluid mechanics, gas dynamics, stability theory. Degree candidates normally concentrate the major part of their work in one of these areas. The supporting program is developed in consultation with the adviser.

Master of Aerospace Engineering—This degree program is primarily for students who require advanced training with a professional or applied emphasis. The program involves both course work and a project. A 4-year B.S. degree from an accredited engineering curriculum is a requirement for admission to the program.

Mechanics

Prerequisites—For work in the major field of mechanics, adequate preparation in fundamental engineering sciences (mathematics, physics, mechanics, and chemistry) is required. Students without an engineering degree but with appropriate qualifications are admissible.

Language Requirements—There is no foreign language required, but individual doctoral candidates may find that reading proficiency in one or more languages is essential.

Master of Science—Offered under both Plan A and Plan B. The Plan B paper requirements may be met in connection with any course accepted for graduate credit, seminar, or independent work under faculty supervision, subject to the prior approval of the student's adviser and of the faculty member supervising the preparation of the paper. The master of science program can normally be completed in 1 year by a full-time student.

Doctor's Degree—Programs leading to the Ph.D. degree in the major field of mechanics are offered in several areas of specialization, including continuum mechanics, control theory, dynamics, dynamical systems, elasticity, fluid mechanics, fracture mechanics, plasticity, stability theory, vibrations, viscoelasticity.

Note—The courses listed below are appropriate for both major fields of aerospace engineering and mechanics.

5-200. KINEMATICS AND DYNAMICS OF FLUID FLOW. (4 cr, §CE 3-400; prereq mathematics including vector calculus; 3 lect and 2 rec hrs per wk)
Kinematics of fluid field including continuity equation, vorticity, circulation, velocity potential, source and doublet. Application of Gauss's and Stokes' theorem to fluid flow. Flow about cylinder. Potential flow in two and three dimensions. Dynamics, Euler's equation, Bernoulli's equation Aerostatics.

5-201. SHOCK WAVES AND COMPRESSIBLE FLUID FLOW. (4 cr; prereq 5-200; 3 lect and 2 rec hrs per wk)
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.

5-202. INCOMPRESSIBLE BOUNDARY LAYER THEORY. (4 cr; prereq 5-200; 3 lect and 2 rec hrs per wk)
Curvilinear coordinate systems, cylindrical and spherical. Viscous incompressible flow. Thin airfoil theory. Stress and strain rate. Navier-Stokes' equation. Boundary layer equation and Blasius solution. Von Karman momentum integral. Pohlhausen method. Turbulent boundary layer.

5-204. INCOMPRESSIBLE POTENTIAL FLOW. (4 cr; prereq 5-200 or ‡)
Irrotational, incompressible flows in two dimensions are solved by complex variable methods. These methods are applied to analysis of airfoils and to other motions of interest in aerodynamics.

5-206. AERODYNAMICS OF LIFTING SURFACES. (4 cr; prereq 5-200)
Thin airfoil theory finite wing, aspect ratio, plan form, lift distribution, effect of viscosity, the boundary layer, skin friction drag, polar diagrams, dimensional analysis and dynamic similarity. Review of linearized supersonic theory.

5-220. INTERMEDIATE INVISCID FLOW. (4 cr; prereq 5-200 or ‡)
Motion and interaction of two-dimensional vortices. Vortex streets and wakes. Application to ground effects, biplane, wakedrag. Vector potentials applied to airfoil theory. Three-dimensional flows induced by the motion of solids. Induced mass and impulsive motion.

5-240. RAREFIED GAS DYNAMICS. (4 cr; prereq 5-201 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.

5-241. HIGH SPEED GAS DYNAMICS. (4 cr; prereq 5-201)
One-dimensional unsteady flow. Shock tube flows. Characteristics. Weak wave theory. Two-dimensional supersonic airfoil theory. Blast wave theory. Hypersonic similarity. Hypersonic flow past slender bodies with sharp leading edges. Effects of slight leading edge blunting. Resistance and drag. Viscous effects.

5-242. ONE-DIMENSIONAL GAS DYNAMICS. (3 cr; prereq 5-202)
Properties of normal shocks. Flows through nozzles. One-dimensional channel flow with friction and energy addition. Continuous unsteady one-dimensional flow of perfect fluids. Flow in wind tunnels and diffusers. Shock tube flow.

5-270. TURBULENCE AND ATMOSPHERIC FLUID DYNAMICS. (4 cr; prereq some background in viscous flow, such as 5-202 or ‡)
General survey of the large-scale circulation of the earth's atmosphere. Review of laboratory turbulence and application to the atmospheric boundary layer. Eckman layer. Thermal stratification. Diffusion of pollutants in the atmosphere.

5-290. INTRODUCTION TO MAGNETOHYDRODYNAMICS. (4 cr; prereq 5-200 or ‡)
Fundamental equations and concepts of magnetohydrodynamics and electrohydrodynamics. Transport of magnetic field, MHD channel flow, Alfven waves, transverse waves, and magnetogasdynamic flow over thin bodies. Steady electrohydrodynamic convection in drops and around bubbles, cellular convection.

5-300. FLIGHT MECHANICS. (4 cr; prereq 5-206)
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.

5-309. MISSILES AND SPACECRAFT PERFORMANCE. (4 cr; prereq 5-200 and 3-036)
Single and multistage vehicle configurations; gimbal motors, Vernier engines and other means of stabilization and control. Rocket thrust, burn-out velocity and altitude as functions of specific impulse and mass ratios of single and multistage rockets. Orbital and escape velocities, long-range terrestrial trajectories, circular and elliptical orbits; orbit determinations.

5-319. DYNAMIC STABILITY OF SPACECRAFT. (4 cr; prereq 5-206 and 5-430)
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. Ruth's discriminant. Aerospace vehicle working equations and solutions. Vehicle response to control actions.

5-330, 5-331. DESIGN OF AEROSPACE ELEMENTS AND SYSTEMS. (4 cr per qtr; prereq 4th yr engineer and ‡)
Interdisciplinary projects with students from other departments.

5-359. AERODYNAMIC DECELERATOR PERFORMANCE. (4 cr; prereq 5-200 and 3-036)
Structurally integrated decelerators, reverser propellers, jet thrust reversers, retrorockets. Types of subsonic and supersonic and gliding parachutes. Aerodynamic coefficients as function of geometric and cloth porosity. Nominal and effective porosity. Aircraft antispin, brake and landing parachutes. Terrestrial and reentry trajectories, serial delivery, and recovery systems.

5-360. DYNAMICS AND STRESS ANALYSIS OF AERODYNAMIC DECELERATORS. (4 cr; prereq 5-200 and 3-036)
Snatch force and opening shock calculations. Effects of included and apparent masses and similarity conditions. Air resistance of porous screens as function of Mach, Reynold, and Knudsen-numbers. Dynamic stability of parachutes, drag and stability of two-body systems. Combinations of parachutes and retrorockets. Stress analysis and stress measurements.

5-370, 5-371. AERODYNAMICS OF V/STOL FLIGHT. (4 cr per qtr; prereq 5-206)
Aerodynamic characteristics of the classical rotor are considered. Combinations of rotor-wing and direct thrust-wing configurations are analyzed for high speed V/STOL aircraft. The jet flap, boundary layer control, and ground effect machines are also considered.

5-410. INTRODUCTION TO CELESTIAL MECHANICS. (4 cr; prereq 3-036 or ‡)
Review of central force motion, the two-body problem, classical and modern methods of orbit determination, celestial coordinates, orbital elements and Eulerian angles, transfer orbits based on a two-body model, introduction to the three-body problem.

5-430. INTRODUCTION TO DYNAMICAL SYSTEMS. (4 cr; prereq 3-036)
Modeling of simple mechanical, hydraulic, and electro-mechanical systems, transfer functions, concepts of stability and free vibrations, response to periodic and simple non-periodic inputs, elementary concepts in feedback control.

5-435. INTRODUCTION TO RANDOM VIBRATION THEORY. (3 cr; prereq 5-430)
Statistical descriptions of response of single-degree-of-freedom damped vibrators to non-deterministic forces. Effects of damping and frequency spectra. Measurable quantities. Response of two-degree-of-freedom systems. Impedance methods. Response of linear continuous systems. Comparison higher approximations, descriptions of damping, modal coupling, and spectrum shaping. Acoustic excitation. Fatigue failure criteria.

5-438. INTERMEDIATE DYNAMICS. (4 cr; prereq 3-036)
Three-dimensional Newtonian mechanics, kinematics of rigid bodies, dynamics of rigid bodies, analytical mechanics, generalized coordinates, holonomic constraints, Lagrange's equations, application of Lagrange's equations to systems of technological interest.

5-440. INTERMEDIATE DYNAMICAL SYSTEMS. (4 cr; prereq 5-430)
Modeling of multidegree of freedom systems in vector-matrix form, concept of stability and free vibrations, forced and unforced response of mechanical systems with conservative, dissipative, and gyroscopic forces, response to arbitrary forcing functions, intermediate concepts in feedback control.

5-515. AEROSPACE STRUCTURES I. (4 cr; prereq 3-016)
Bending of slender, reinforced, thin-wall beams. Shear flow, shear center, thermal stresses. Torsion of slender members; membrane analogy; open and closed thin-wall sections. Energy methods. Bending of thin plates. Buckling of columns and plates. Matrix methods of deflection analysis.

5-516. AEROSPACE STRUCTURES II. (4 cr; prereq 5-515)
Application of matrix methods to analysis of flight structures. Computer programming and solution of structural problems. Stability analysis of thin-wall columns, plates, and stiffened shells; buckling. Introduction to finite-element methods.

5-517. APPLIED ELASTICITY. (4 cr; prereq 5-515 or ‡)
Stress distribution in bars, beams, and rings. Buckling. Axisymmetric problems. Bending and buckling of thin plates. Bending of shells. Energy methods and approximation techniques. Vibration of beams and plates.

5-550. MECHANICAL BEHAVIORS OF SOLIDS. (4 cr; prereq 3-016; 3 lect and 1 lab period per wk)
Structure of metals and polymers. Plastic deformation of crystalline and amorphous material. Time-dependent deformation. Composites. Response to tensile, compressive, torsion, and bending loads. Theories of failure under combined stresses. Response to dynamic loading. Tests for mechanical properties.

5-551. FATIGUE AND FRACTURE MECHANICS. (4 cr; prereq 5-550 or MatS 5-301 or ‡; 3 lect and 1 lab period per wk)
Theories of strength and mechanical failure. Brittle, ductile, and transitional modes of fracture. Fracture toughness. Time-dependent fracture. Fatigue crack nucleation and propagation. Effects of active and passive environments. Stress corrosion.

5-580. MECHANICS OF ELASTIC SOLIDS I. (4 cr; prereq 3-016)
Kinematics of deformation and strain; strain invariants; compatibility. Stress; equations of equilibrium and motion; stress invariants. Stress-strain-temperature relations; isotropy; strain energy. Fundamental boundary value problems of elasticity and thermoelasticity; uniqueness. Curvilinear coordinates. Simple exact solutions. St. Venant problems of extension bending, torsion, and flexure.

5-581. MECHANICS OF ELASTIC SOLIDS II. (4 cr; prereq 5-580)
Plane theories; plane strain; generalized plane stress; Airy's stress function. Example problems; stress concentration; half-plane; long cylinders; layered media. Thermoelasticity in two dimensions. Elastodynamics; Lame separation. Waves; F and S waves; boundary reflection and refraction; Rayleigh waves. Vibration of bounded regions.

5-582. ENERGY METHODS IN SOLIDS. (4 cr; prereq 5-580)
Elements of variational calculus. Virtual work. Reciprocal theorem. Energy principles in elasticity; potential energy; complementary energy; principle of least work; Prager-Synge method. Variational formulation of bending and buckling of beams and plates. Direct methods of the calculus of variation; Rayleigh-Ritz; Galerkin; error estimates. Energy principles of elastodynamics. Waves and vibrations in bounded media.

5-585. MECHANICS OF INELASTIC SOLIDS. (4 cr; prereq 5-580 or ‡)
Topics to include basic concepts and applications of viscoelastic and/or plastic materials. Linear viscoelastic behavior, linear viscoelastic constitutive assumptions; viscoelastic stress analysis; problems of quasi-static and sinusoidal square; correspondence principle. Plasticity; yield conditions and flow laws for perfect plastic and strain-hardening materials; limit analysis theorems; simple structures. Applications to trusses, beams, frames, plates, and torsion of cylinders.

5-645/5-646. AEROMECHANICS LABORATORY I-II. (3 cr per qtr; prereq 5-200, 3-016; 4 lab hrs per wk)
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.

5-647. AEROMECHANICS LABORATORY PROJECTS. (3 cr; prereq 5-200 and ‡; 4 lab hrs per wk)
Individual experimental projects of a research nature.

5-649. EXPERIMENTAL MECHANICS I. (2 cr; prereq 3-016; 1 lect and 2 lab hrs per wk)
Strain gauges. Photoelasticity. Experimental stress analysis. Deformation of beams and columns. Torsion, tension, and shear tests.

5-650. AEROELASTICITY I. (4 cr; prereq 5-206)
Static aeroelastic phenomena, torsional divergence of a lifting surface, control surfaces reversal and elastic efficiency. Effects of elastic deformations on stability, aeroelastic twisting or propeller blades and rotary wings, theory of lifting surface flutter, problems of gust response and buffeting, scaling of aeroelastic force models.

5-680. RANDOM PROCESSES. (3 cr; prereq Math 5-357 or equiv or ‡)
Probability densities, averages, correlations, power spectra; interrelations. White noise. Gaussian processes. Random walk problems. Wiener-Hermite functionals for nonlinear processes. Examples for discrete systems and fluid systems.

5-687. FUNDAMENTALS OF ACOUSTICS. (4 cr; prereq Phys 1-291, Math 3-221 or equiv or ‡)
Derivation of the wave equation, plane wave solution, dissipative and nonlinear effects, energy and momentum balance, reflection and transmission at boundaries, resonators, spherical waves, and multipole analysis.

5-688. INTERMEDIATE ACOUSTICS. (4 cr; prereq 5-687)
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.

5-689. SPECIAL TOPICS IN ACOUSTICS. (4 cr; prereq 5-688)
Selected topics of current interest to students and staff.

5-800/5-801/5-802.† PROBLEMS IN MECHANICS AND MATERIALS. (0-3 cr per qtr; prereq ‡; faculty sponsor required before regis)
Short-duration individual research problems, literature studies, and reports.

5-810, 5-811, 5-812. PROBLEMS IN FLUID MECHANICS. (0-3 cr; prereq ‡; faculty sponsor required before regis)
Investigation of analytical experimental problems approved by faculty member. Undergraduate thesis.

5-838, 5-839. SUMMER ENGINEERING EMPLOYMENT. (1-3 cr per qtr; prereq ‡, completion of 3rd yr and ‡ prior to regis)
Written report based on summer work in an engineering field (not less than 360 hours per summer).

8-001, 8-002, 8-003. SEMINAR: AEROSPACE ENGINEERING AND MECHANICS. (0-1 cr)
Discussion of recent work and current departmental research by students and staff. Review of current literature.

8-201. FOUNDATIONS OF FLUID MECHANICS. (4 cr; prereq 1 yr undergrad fluid mechanics, ¶Math 5-457 or 5-571 or ‡)
Kinematics of deformable media. Thermodynamics of liquids and gases. Equations governing the motion of fluids. Dynamical similarity. Special solutions illustrating the effects of viscosity, inertia, and compressibility.

8-202, 8-203. INVISCID FLUID MECHANICS. (4 cr per qtr; prereq 8-201 or ‡)
Perfect fluids. Vorticity theorems. Incompressible potential flow. Water waves. Stratified fluids. Effects of compressibility; acoustics, effects at low Mach number. Hodograph transformation. Method of characteristics. Shockwaves and shockwave interactions.

8-207. INSTABILITY OF FLOW OF VISCOUS FLUIDS. (3 cr; prereq 8-201 or ‡)
Stability of parallel flow and flow over curved surfaces discussed and applied to boundary layers. Demonstration of use of boundary layer (singular pertubation) techniques to determine stability characteristics of general parallel flows. Stability characteristics of various viscous flows are classified and physical mechanisms which lead to instability discussed.

8-208. NONLINEAR THEORIES OF HYDRODYNAMIC STABILITY. (3 cr; prereq 8-207 or ‡)
Methods of energy, modal evolution, and parametric expansions applied to problems of stability of hydrodynamic systems to finite amplitude disturbances. Application to thermoconvective systems.

8-209. ROTATING FLUIDS. (3 cr; prereq background in fluid mechanics especially boundary layer theory)
Geostrophic flow. Eckman layer. Stewartson layer. Spin up. Stratified flow. Application to geophysical flows.

8-210/8-211. VISCOUS FLUID MECHANICS. (3 cr per qtr; prereq 8-201 or ‡)
Equations of motion. Low Reynolds' number flow; Stokes-Oseen flow, pipe and channel flow. High Reynolds' number flow; boundary layers, jets, wakes. Compressible and thermal boundary layers. Some aspects of turbulent flow.

8-216. THEORY OF TURBULENCE. (3 cr; prereq 5-680, Math 5-211 or equiv or ‡)
Correlation tensors. Karman-Howarth equations. Major theories of turbulence: Heisenberg, Chandrasekhar, Kolmogoroff; similarity results.

8-217. APPLICATIONS OF TURBULENCE THEORY. (3 cr; prereq 8-216 or equiv or ‡)
Magnetofluiddynamic turbulence, characteristics of correlations. Lighthill theory of sound and turbulence. Turbulence-produced sound; sound scattered by turbulence. Turbulent boundary layer noise.

8-230/8-231/8-232. TRANSONIC AND HYPERSONIC FLOW. (3 cr per qtr; prereq 8-203)
Transonic similarity rules. Curved shocks, ionization effects, chemical reaction.

8-240. PERTURBATION METHODS IN FLUID MECHANICS. (3 cr; prereq 8-202 or ‡)
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.

8-250/8-251/8-252. MAGNETOFLUIDDYNAMICS. (3 cr per qtr; prereq 8-203 or Phys 5-012)

8-280. INTERNAL RAREFIED GAS FLOW. (3 cr; prereq 5-240 or ‡)
Techniques for obtaining bounded solutions to internal free molecule flow problems; applications to special geometries; use of the BGK model equation for solution of internal rarefied gas flow problems.

8-285/8-286. SELECTED TOPICS IN RAREFIED GAS DYNAMICS. (3 cr for 8-285, 1-3 cr for 8-286; prereq 5-240, 8-201 or ‡)
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 treated will include shockwave structure, high frequency sound propagation, low density Couette flow, Knudsen layer, and others.

8-410. DYNAMICAL SYSTEMS I: CLASSICAL MECHANICS. (4 cr; prereq ‡)
Kinematics and dynamics of rigid body motion. Lagrange's equations. Routhian, Hamilton's principles, canonical equations, and introduction to Hamilton-Jacobi theory. Applications.

8-411. DYNAMICAL SYSTEMS II: LINEAR SYSTEMS. (4 cr; prereq 8-410 or ‡)
Motion in the neighborhood of equilibrium and in the neighborhood of steady motions. Analysis of linear systems with many degrees of freedom. Diagonalization procedures and normal modes. Free and forced motions. Stability. Approximate methods for determination of eigenvalues. Linear gyroscopic systems.

8-412. DYNAMICAL SYSTEMS III: NONLINEAR SYSTEMS. (4 cr; prereq 8-411 or ‡)
Phase plane. Singular points. Global study of conservative systems. Weakly nonlinear systems. Poincare perturbation procedure. Method of averaging. Transient motions. Steady state motions and their stability.

8-413/8-414/8-415. DYNAMICAL SYSTEMS IV, V, VI: ADVANCED TOPICS. (3 cr each; prereq 8-410, 8-411, 8-412 or ‡)
Topics will include some or all of the following: advanced topics in nonlinear oscillation theory; calculus of variations and optimum control theory; theory of stability of dynamical systems—Liapunov theory; celestial mechanics and applications; advanced topics in classical mechanics.

8-510. CONTINUUM MECHANICS I. (4 cr; prereq ‡)
Unified treatment of those concepts which 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.

8-511, 8-512. CONTINUUM MECHANICS II, III. (4 cr per qtr; prereq 8-510 or ‡)
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.

8-522. PERFECTLY PLASTIC SOLIDS. (3 cr; prereq 8-510)
Inelastic behavior, model materials. Yield criteria and flow rules. Axial symmetry and plane strain. Slip line fields. Applications to metal-forming processes. Limit analysis and uniqueness theorems.

8-523. SPECIAL TOPICS IN PLASTICITY. (3 cr; prereq 8-522)
Selected topics such as work-hardening constitutive equations and associated energy principles, elastic, perfectly plastic materials, contained deformation and shakedown, anisotropic plasticity, viscoplasticity, plastic wave propagation, plastic structural analysis, optimal plastic design, collapse load theory for rocks and soils, channel flow of granular materials, modern mathematical theories for rate-independent materials, high energy forming.

8-527. THEORY OF ELASTIC STABILITY. (3 cr; prereq 5-580)
Different concepts of static stability and their interrelations. Dynamical stability criteria and relation to static stability. Bifurcation and snap-through buckling. Stability of elastic continua, energy criteria. Current research topics.

8-541/8-542. THEORY OF VISCOELASTICITY. (3 cr; prereq 8-510 or equiv)
Mathematical preliminaries, analysis of nonlinear deformation of a continuum, general balance and field equations, theory of material behavior, viscoelastic constitutive equations, principle of fading memory, nonlinear viscoelasticity, finite linear viscoelasticity, infinitesimal viscoelasticity, second order viscoelasticity, methods of solving anisotropic viscoelastic problems, microstructural considerations.

8-545. LINEAR VISCOELASTICITY. (3 cr; prereq ‡)
Linear viscoelastic behavior; linear viscoelastic constitutive laws; methods of viscoelastic stress analysis; and applications to simple quasi-static and dynamic viscoelastic problems.

8-546. NONLINEAR VISCOELASTICITY. (3 cr; prereq 8-545 or ‡)
Time- and temperature-dependent viscoelasticity behavior. Different constitutive representations. Temperature-dependent dynamic mechanical relaxation and damping at modulus transition regions. Modifications of constitutive laws and analyses of thermal stresses.

8-570. FRACTURE MECHANICS. (3 cr; prereq ‡)
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.

8-585, 8-586, 8-587. ADVANCED TOPICS IN CONTINUUM MECHANICS. (3 cr per qtr; prereq 8-510, 8-511, 8-512, ‡)
Topics will include 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 which illus-

trate the normal stress effects. Selected experimental results. Other topics might include: cosserat materials, multipolar continuum mechanics, modern theories of plasticity, mixtures, hypoelasticity, elastic dielectric and electrified materials.

8-590. THEORY OF PLATES AND SHELLS. (3 cr; prereq 8-594)
Stress analysis of medium-thick flat slabs. Finite difference and energy methods of analysis. Concentrated loads. Relation between theory and model tests. Membrane theory of shells. Flexure of cylindrical shells. Pressure vessels.

8-591. ADVANCED THEORY OF SHELLS I. (3 cr; prereq 8-590)
Theory of surfaces. General bending equations of arbitrary thin shells. Determination of boundary conditions. Validity and examination of assumptions. Axisymmetric classical theory. Methods of solution of general bending theory. Shallow shells.

8-592. ADVANCED THEORY OF SHELLS II. (3 cr; prereq 8-591)
Deformation and strain. Compatibility equations. Constitutive equations. Some general theorems. Thermodynamics of elastic shells. Nonlinear theories.

8-594. ELASTICITY I. (3 cr; prereq 8-510)
Principles and field equations of elasticity using Cartesian tensors. Uniqueness; energy theorems; reciprocal theorem. Fundamental problems of elastostatics and elastodynamics. St. Venant beam theory.

8-595. ELASTICITY II. (3 cr; prereq 8-594)
Potential and complex variable methods in elasticity. Plane strain and plane stress. Papkovich-Neuber, Galerkin, Morera-Maxwell functions. Kelvin's problem. Contact stresses. Special topics.

8-596. ELASTICITY III. (3 cr; prereq 8-595)
Elastodynamics; wave propagation in solids. Volume and surface waves. Bounded media; beam and plate vibrations.

8-606. NUMERICAL METHODS IN MECHANICS. (3 cr; prereq CICS 5-301 or ♯)
Application of numerical methods to a wide range of problems in mechanics, including boundary-value problems for ordinary differential equations and initial- and boundary-value problems for partial differential equations. Methods include complementary functions, shooting, quasilinearization, finite-difference methods, method of characteristics.

8-607. ADVANCED NUMERICAL METHODS IN MECHANICS. (1-3 cr; prereq 8-606 or ♯)
(Continuation of 8-606) Alternatives to finite-difference methods, such as finite elements, Galerkin methods, series expansions. Other topics of interest to participants. Individual projects under guidance of instructor.

8-800, 8-801, 8-802. SELECTED TOPICS IN MECHANICS AND MATERIALS. (0-3 cr per qtr; prereq ♯)
Topics of current interest.

8-810, 8-811, 8-812. SELECTED TOPICS IN FLUID MECHANICS. (0-3 cr per qtr; prereq ♯)
Topics of current interest.

AFRO-AMERICAN STUDIES (Afro)

Professor
George D. King
John P. Ward

Associate Professor
Lillian D. Anthony

Courses in Which Graduate Credit May Be Earned When Program Related

5-001. LAW AND SOCIETY: A MINORITY POINT OF VIEW. (5 cr) Ward
Afro-American history from the point of view of American constitutional development as it relates particularly to the American Black community.

5-002. LAW AND SOCIETY: A MINORITY POINT OF VIEW—RESEARCH. (5 cr; prereq 5-001) Ward
(Continuation of 5-001) Research seminar with principal emphasis on major piece of investigation requiring and showing scholarship.

5-101, 5-102, 5-103. BLACK WOMEN. (4 cr per qtr; prereq ‡) Anthony
Novels, poetry, psychology, history, sociology, and musicology bearing on the experience of Black women in Africa, America, and the third world during the last two centuries. Interdisciplinary and cross-cultural course.

5-401. INSTITUTIONALIZATION OF RACISM, 1877-1900. (5 cr) King
Social, political, and economic forces which resulted in the imposition of second-class citizenship on Black Americans.

5-900. SENIOR SEMINAR. (2-4 cr; prereq jr, sr, or grad)
Students will study and hear important scholars within the field of Afro-American studies and develop research projects of their own for presentation to the seminar.

AGRICULTURAL AND APPLIED ECONOMICS (AgEc)

Professor

W. B. Sundquist, *head*
Harald R. Jensen, *chairman, graduate committee*
Martin E. Abel
James L. App
Sherwood O. Berg
John Blackmore
O. Uel Blank
W. Keith Bryant
Willard W. Cochrane
Dale C. Dahl
Reynold P. Dahl
Selmer A. Engene
Darrell F. Fienup
Earl I. Fuller
Paul R. Hasbargen
John D. Helmberger
Clifford C. Hildreth
James P. Houck
John S. Hoyt
Jay M. Hughes
E. Fred Koller
Wilbur R. Maki
Lee R. Martin
Truman R. Nodland
Willis L. Peterson
Philip M. Raup
Vernon W. Ruttan
Francis J. Smith, Jr.
Arley D. Waldo
Delane E. Welsch

Associate Professor

Boyd M. Buxton
Martin K. Christiansen
Charles H. Cuykendall
K. William Easter
Kenneth E. Egertson
Hans A. Gregersen
Jerome W. Hammond
Edgar A. Persons
Malcolm J. Purvis
Robert W. Snyder
Kenneth H. Thomas
John S. Waelti

Assistant Professor

Willis E. Anthony
Walter L. Fishel
Terry L. Roe
Matthew D. Shane

Prerequisites—For major work, 18 quarter credits in courses acceptable to the student's adviser. Further courses may be required if the adviser thinks necessary. For minor work, 9 quarter credits.

Major and Minor—The thesis may be in any subfield of agricultural economics (marketing, farm management, economics of agricultural production, economics of international agricultural development, agricultural prices, agricultural policy, farm finance, and resource economics). Candidates will be expected to take work in different subfields, the program depending upon the subfield of specialization. With the approval of the adviser, certain courses in general economics and business administration may be accepted as major work. For the Ph.D., the preliminary examination for the minor in general economics must be taken. However, the minor or the supporting program may be taken in any subject. If the minor is in economics, 9 credits (with a grade of C or better) must be taken in a "special field"—a foreign language (can be satisfied by a competency test), a field other than economics (e.g., sociology, geography, law, a field of agriculture), or advanced work in economics, mathematics, or statistics (beyond the level normally included in the Ph.D. programs in the department).

Master's Degree—Offered under both Plan A and Plan B.

Doctor's Degree—Work leading to the Ph.D. degree is offered.

Note—For courses in general economics and business administration, see sections on Business Administration and Economics.

5-010. STATISTICAL METHODS FOR SOCIAL SCIENCE. (4 cr for grads; prereq Biom 5-010 or QA 3-050 or equiv) Bryant
Application of statistical methods to research in the social sciences; time series analysis, index numbers, multiple regression and correlation, elementary sampling procedures, analysis of variance and covariance.

5-110. AGRICULTURAL ECONOMIC ANALYSIS. (3 cr; not open to students majoring in agricultural economics; prereq 1-030)
Economic behavior of households, firms, and industries with special applications to agriculture; competition and monopoly power; factors affecting pricing and production decision.

5-120. AGRIBUSINESS MANAGEMENT AND MARKETING. (3 cr; not open to students majoring in agricultural economics; prereq 5-110 or ‡)
Business management and marketing problems in the firms and industries serving agriculture; economic interrelationships among industries supplying agriculture and those processing and distributing farm products.

5-130. LAND RESOURCE USE. (3 cr; not open to students majoring in agricultural economics; prereq 5-110 or ‡)
Land as a factor of production; rural and urban utilization; rents and land values; land classification, taxation, exchange; public land management.

5-140. AGRICULTURAL PRODUCTION. (3 cr; not open to majors in agricultural economics; prereq 1-030 or 5-110)
Application of economic analysis to planning and evaluation of operation of agricultural businesses, with emphasis on the farm; economic principles, budgeting, linear programming, practice.

5-150. AGRICULTURAL POLICY. (3 cr; not open to students majoring in agricultural economics; prereq 5-110 or ‡)
Application of economic analysis to agricultural prices and income policy issues; development of present-day price and income programs.

5-290. AGRIBUSINESS MANAGEMENT. (3 cr for grads; prereq Econ 3-101, 3-102 or ‡)
Application of economic, other social science, and technical concepts to decision-making process of firms supplying inputs to agriculture and/or processing and distributing agricultural products.

5-400. INTERMEDIATE MARKET AND PRICE ANALYSIS. (3 cr for grads; prereq 1-400)
Development of analytical models and their application in various market situations. Unique market institutions developed in response to marketing problems and policies.

5-401. SEMINAR: MARKETING OF DAIRY PRODUCTS. (1 cr; prereq ¶5-400)
Institutional and functional variations in market and price analysis unique to study of dairy products.

5-402. SEMINAR: MARKETING OF GRAIN CROPS. (1 cr; prereq ¶5-400)
Institutional and functional variations in market and price analysis unique to study of grain.

5-403. SEMINAR: MARKETING OF LIVESTOCK. (1 cr; prereq ¶5-400)
Institutional and functional variations in market and price analysis unique to study of livestock.

5-404. SEMINAR: MARKETING OF FRUITS AND VEGETABLES. (1 cr; prereq ¶5-400)
Institutional and functional variations in market and price analysis unique to study of fruits and vegetables.

5-440. COOPERATIVES AND AGRIBUSINESS ORGANIZATION. (3 cr for grads; prereq 1-400)
Economic problems and issues facing agricultural cooperatives including changing market organization, financing, taxation, antitrust regulations, and others.

5-480. COMMODITY MARKETS AND FUTURES TRADING. (3 cr for grads; prereq Econ 1-400 or ‡)
Economics of cash and futures trading on organized markets; futures trading theory; hedging and speculation.

5-510. AGRICULTURAL CAPITAL MARKETS. (3 cr for grads; prereq Econ 3-102) Shane
Capital accumulation in agriculture; finance and credit institutions; farm appraisal and agricultural credit policies.

5-580. ECONOMIC ORGANIZATION OF THE HOUSEHOLD. (3 cr for grads; prereq Econ 3-101)
Family as economic unit marshaling resources of labor, capital goods, location and accompanying public goods, and purchased consumer goods and services to produce labor, capital, money and in-kind income, and satisfaction. Modern adaptations of consumer behavior and firm theory, time series and cross-section data on families to explain and interpret changes in organization of family production activities and resources consequent upon changes in wage rates, returns to capital, consumer goods and services prices, land prices, consumer and producer technology, the environment, public sector and family preferences.

5-590. GOVERNMENT AND CONSUMERS. (3 cr for grads; prereq Econ 3-101...Econ 3-102 recommended)
Demand and consumption relations for publicly supplied goods and services and with government policies and actions as they affect individuals as consumers, not as taxpayers or purchasers of products of regulated industries. Markets for publicly supplied foods and services; demand and consumption relations and effects on consumers of governmental policies and behavior. Informational defects in public and private markets; alternative means of consumer redress.

5-600. LAND ECONOMICS. (3 cr for grads; prereq Econ 3-101, 3-102 or ‡) Raup
Land as a factor of production; land use, classification, and value; sale and rental markets for land; domestic and foreign land policies.

5-620. REGIONAL ECONOMIC ANALYSIS. (3 cr for grads; prereq 1-030 or Econ 1-002) Hoyt
Basic concepts and theories used and problems encountered in economic study of subregions, including those applicable to space and planning, population and employment change, income estimation and social accounting, industrial location, identification of the planning region, intraregional and interregional analyses, planning goals, and national and regional planning programs.

5-630. REGIONAL DEVELOPMENT SYSTEMS. (3 cr for grads; prereq 1-030 or Econ 1-002) Maki
Regional subsystems in resource productivity cycle. Public service delivery subsystems. Public intervention strategies in environmental management. Settlement planning and resource development.

5-640. FINANCING PUBLIC SERVICES IN RURAL AREAS. (3 cr for grads; prereq Econ 3-101)
Public financing potentials in rural and urban areas. Flow of funds accounts. Public expenditure criteria. Implications of regional financing alternatives.

5-720. ECONOMICS OF WORLD AGRICULTURE. (3 cr for grads; prereq Econ 3-101, 3-102 or ‡) Raup
Distribution, quality, and utilization of agricultural resources, agricultural organization and structures; location of agricultural activity; national and international agricultural policies.

5-750. AGRICULTURAL TRADE AND COMMERCIAL POLICY. (3 cr for grads; prereq Econ 3-101, 3-102) Houck
Patterns of trade in agricultural products; trade policies and practices of export and import nations; commodity agreements; agricultural trade policies of common market areas; negotiations and potential trade developments.

5-790. WORLD FOOD SUPPLY PROBLEMS. (4 cr; prereq major in agriculture, veterinary medicine, social science field or ‡...agricultural economics grad by ‡ only)
(Same as PlPa 5-220, Soc 5-675, VM 5-790, HE 5-381) A multidisciplinary approach will examine the social, economic, and technical problems of feeding the world's growing population. Principles will be sought from social and economics sciences, plant sciences, and animal sciences for their application to food problems.

5-800. FARM RECORDS AND BUSINESS ANALYSIS. (4 cr; prereq 1-030 or ‡) Nodland
Analysis of farm records and their role in management of farm business; types of farm records; calculations of farm earnings by various measures.

5-830. FARM PLANNING. (3 cr; prereq 3-820 or ‡) Nodland
Special problems in farm planning.

5-860. ECONOMICS OF AGRICULTURAL PRODUCTION. (3 cr for grads; primarily for grads; prereq 21 cr in economics or agricultural economics) Buxton
Production economics applied to agriculture, profitable combination of production factors; comparative advantage and location of production.

8-200, 8-201, 8-202. GENERAL SEMINAR: AGRICULTURAL ECONOMICS. (Cr ar; offered when demand warrants) Staff
Special seminars or individual work may be arranged on subject suited to needs of particular groups of students.

8-205. RESEARCH METHODOLOGY IN AGRICULTURAL ECONOMICS. (3 cr) Jensen, Bryant
Examination of various philosophical positions in research; methodological problems in social science generally, and in agricultural economics specifically.

8-206. FOUNDATIONS OF APPLIED ECONOMICS. (5 cr; prereq Econ 5-164, 5-163 or equiv or ‡) Shane, Purvis
Model-building strategies for investigating abstract and particular applied economic problems by studying how to develop relevant economic frameworks, incorporate empirical evidence, and consider data, time, and other restraints on the model.

8-231. AGRICULTURAL PRICES. (3 cr; prereq Econ 5-151, 5-152 or equiv) Houck
Nature of demand for farm products; supply considerations; price formation and markets; price variation and instability; dynamic analysis; methodological considerations.

8-245. AGRICULTURAL MARKETING ECONOMICS. (3 cr; prereq Econ 5-161 or ‡) D Dahl
Economic theory and analytical tools used in coordinated, cross-commodity analysis of marketing of farm supplies and products; factor-product relationship under varying conditions of imperfect competition, market structure-conduct-performance relationship in agricultural markets, private and public policies to regulate and facilitate marketing processes.

8-264. RESOURCE ECONOMICS. (3 cr; prereq Econ 5-162 or ¶Econ 5-162 or ‡) Martin
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 in water resources, outdoor recreation, forestry, and fisheries; economic problems of air pollution and environmental quality.

8-273. AGRICULTURAL POLICY. (3 cr; prereq Econ 5-151, 5-152 or equiv)
Definition, formulation, and execution of policy in agriculture; application of economic analysis to agricultural policy; critical review and analysis of farm policies past and present; future of agricultural policy.

8-278. AGRICULTURAL AND ECONOMIC DEVELOPMENT. (3 cr; prereq Econ 5-301 or equiv) Ruttan
Theories of socioeconomic growth; models of economic growth; consumption, production, and supply relations in agricultural development; agricultural development policy.

8-287. PRODUCTION ECONOMICS I. (3 cr; prereq Econ 5-161 or ‡) Peterson
Static and dynamic production theory; applications to the farm firm and household; extension to nonfarm enterprises; aggregate production functions; analysis of technological change; methodological and measurement consideration.

8-288. PRODUCTION ECONOMICS II. (3 cr; prereq 8-287 or ‡) Jensen
Equilibrium conditions in static production economics; introduction of risk and uncertainty into production theory; theory of choice in production under relaxed assumptions.

8-335. SEMINAR: PRICE ANALYSIS. (3 cr; offered when demand warrants)

8-344. SEMINAR: COOPERATIVE MARKETING. (3 cr; offered when demand warrants) Koller

8-345. SEMINAR: AGRICULTURAL MARKETING. (3 cr; offered when demand warrants) D Dahl

8-346. SEMINAR: LAW AND AGRICULTURAL ECONOMICS. (3 cr; open to both law and grad students) D Dahl

8-356. SEMINAR: CONSUMPTION ECONOMICS. (3 cr; offered when demand warrants)

8-360. SEMINAR: LAND ECONOMICS AND TENURE. (3 cr; offered when demand warrants) Raup

8-364. SEMINAR: RESOURCE AND REGIONAL ECONOMICS. (3 cr; offered when demand warrants) Maki, Martin

8-373. SEMINAR: AGRICULTURAL POLICY. (3 cr; offered when demand warrants)

8-378. SEMINAR: AGRICULTURAL DEVELOPMENT. (3 cr; offered when demand warrants) Ruttan

8-382. SEMINAR: FARM MANAGEMENT AND PRODUCTION ECONOMICS. (3 cr; offered when demand warrants) Engene, Jensen, Nodland

AGRICULTURAL ENGINEERING (AgEn)**

Professor

Landis L. Boyd, *head*
Cletus E. Schertz, *director of graduate study*
Evan R. Allred
W. Forrest Bear
Harold A. Cloud
Arnold M. Flikke
Kenneth A. Jordan
William A. Junnila
Curtis L. Larson
Russell E. Larson
Roger E. Machmeier
Jesse H. Pomroy
John Strait

Assistant Professor

James R. Gilley
Philip R. Goodrich
R. Vance Morey
John R. Rosenau
David R. Thompson

Prerequisites—For major work, adequate preparation in undergraduate subjects and in the sciences fundamental to agricultural engineering in addition to the general admission requirements. For minor work, the prerequisites to the courses to be taken and approval of the department faculty.

Major and Minor—With the approval of the adviser, courses in other fields of engineering, the physical sciences, the biological sciences, or agricultural sciences may be included in the major. For the Ph.D., the minor must be taken outside of the field of agricultural engineering. However, a supporting program of study may replace the minor.

Language Requirement—The department has no requirement but has an enrichment program which is outlined below.

Enrichment Program Options—The Agricultural Engineering Department requires the completion of an enrichment program for the Ph.D. degree. Its purpose is to help each student prepare to meet societal responsibilities. The program consists of a minimum of 9 credits, the equivalent in independent study, or a combination of formal study and independent study. Possible options include the general areas of: (a) sociology-psychology-humanities; (b) higher education-instructional methods, administration, etc.; (c) foreign culture and/or foreign language; and (d) other programs supporting the student's career objectives and approved by the department faculty.

Master's Degree—Both the master of science and the master of agricultural engineering degrees are offered. The M.S. degree is offered primarily under Plan A, but also under Plan B if approved in advance by the department faculty. If Plan B is approved, the candidate is required to complete three written reports of the same quality but not the extent of the Master's thesis. These reports may be prepared as an additional requirement in advanced courses and seminars, or in courses which permit independent effort under faculty guidance and involve 9 credits. The master of agricultural engineering degree program is available for those desiring design-oriented study beyond the B.S. degree. A description of the master of engineering program is given on page 11.

Doctor's Degree—Work leading to the Ph.D. degree is offered. The general requirements of the University as listed previously in this bulletin apply.

Graduate Credit for Majors or Minors

5-060. PROCESSING. (4 cr; prereq 3-060, ME 5-342 or ‡)
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.

** Professional degrees in engineering are administered by the Institute of Technology.

5-070. AUTOMATIC CONTROL AND INSTRUMENTATION. (4 cr; prereq 3-050, EE 3-000)
Control of machines and processes. Linear feedback control. Linking of physical and biological control systems. Instrumentation for control systems and industrial development studies.

5-130. FOOD ENGINEERING I. (4 cr; prereq knowledge of growth, survival of microorganisms, food spoilage, poisoning, food chemistry, thermodynamics of mixtures, 5-060 or ¶5-060 or ‡)
Fundamental requirements for handling food products. Separation processes in food industry. Dehydration and storage of foods.

5-140. FOOD ENGINEERING II. (4 cr; prereq FScI 3-120, chemistry of basic food components and their reactions, introductory electromagnetics or ‡)
Engineering principles of thermal processing of food, pasteurization, sterilization, heat exchange, baking, and microwave heating. Sanitation and microbiological aspects of food engineering.

5-330. AGRICULTURAL MACHINERY. (4 cr; prereq 3-050, 3-060...knowledge of basic dynamics and kinematics of mechanical systems [ME 3-201, 3-203] desirable)
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.

5-340. AGRICULTURAL TRACTORS. (4 cr; prereq 3-050 or equiv...knowledge of thermodynamics with engineering applications [ME 3-303] desirable)
Tractor engines. Cycle analysis, combustion fuels and accessory systems. Chassis mechanics. Hitches and implement control systems. Power transmission systems. Tractor performance.

5-390.* PROBLEMS IN AGRICULTURAL ENGINEERING: POWER AND MACHINERY. (2-5 cr; prereq ‡) Morey, Schertz, Strait

5-540. EROSION CONTROL, WATERSHED ENGINEERING. (4 cr; prereq 3-050, 3-060, CE 5-401)
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.

5-550. DRAINAGE AND IRRIGATION ENGINEERING. (4 cr; prereq 3-050, 3-060, CE 5-401)
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.

5-590.* PROBLEMS IN AGRICULTURAL ENGINEERING: SOIL AND WATER. (2-5 cr; prereq ‡) Allred, Flikke, Gilley, Goodrich, Larson, Machmeier

5-730. AGRICULTURAL STRUCTURES DESIGN. (4 cr; prereq 3-050, AEM 3-016)
Building types and materials for agricultural production. Snow and wind loads. Loads associated with agricultural materials in storage. Codes and standards. Foundations and footings. Sanitation. Determinant analysis and indeterminate concepts. Computer-aided design.

5-740. ENVIRONMENTAL CONTROL FOR AGRICULTURAL PRODUCTION. (4 cr; prereq 3-050, 3-060, ME 5-603...completion of biological requirement of agricultural engineering curriculum desirable)
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 of environmental conditions.

5-790.* PROBLEMS IN AGRICULTURAL ENGINEERING: STRUCTURES AND PROCESSING. (2-5 cr; prereq ‡) Boyd, Flikke, Jordan, Moore, Pomroy

5-910. AGRICULTURAL WASTE MANAGEMENT ENGINEERING I. (4 cr; prereq 3-050, 3-060)
Sources and characteristics of agricultural wastes including animal manures, crop residues, sediments, processing wastes, and domestic wastes. Effects on environment. Sanitary collection storage, treatment, and disposal. Utilization of liquid and solid wastes. Nonurban water supply and quality.

5-920. AGRICULTURAL WASTE MANAGEMENT ENGINEERING II. (4 cr; prereq 5-910)
Design of systems for collection, storage, treatment, utilization, and disposal of agricultural wastes.

8-100. SEMINAR. (1 cr; prereq ‡) Boyd
Reports on current topics and department research.

8-140.* AGRICULTURAL ENGINEERING SIMILITUDE. (3 cr; prereq Math 5-512 or 5-521) Boyd
Use of dimensional analysis to develop general equations to define phenomena. Principles of similitude. Introduction to analog methods.

8-190/8-191/8-192. ADVANCED PROBLEMS AND RESEARCH. (2-6 cr per qtr; prereq 5-390 or 5-590 or 5-790 or △) Staff
Research problems in agricultural engineering.

8-500. HYDROLOGIC MODELING—SMALL WATERSHEDS. (4 cr; prereq CE 5-405) Larson
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.

8-700. MOISTURE AND HEAT TRANSFER. (3 cr; prereq 5-060, Math 1-260, ME 5-603) Flikke, Gilley
Mathematical study of transfer of moisture and heat in agricultural crops and soils.

Graduate Credit for Nonengineering Students Only

5-000. PRINCIPLES OF RADIOISOTOPE MEASUREMENT. (2 cr; prereq ‡)
Theory and technique of radioisotope measurement including atomic and nuclear structure; properties of radiation; interaction of radiation with matter. Use of monitoring equipment. Course taught for approximately 4 weeks at beginning of quarter. Graduate students in plant science should register for PlPh 8-285 for balance of quarter. Other students should consult instructor for additional course requirements.

5-015. ANALOG COMPUTER TECHNIQUES. (2 cr; prereq ‡) Jordan
Principles of analog computers. Emphasis placed on usefulness to solution of biological problems. Selection of computing technique (analog, digital, and/or hybrid) dependent upon the nature of the problem. Laboratory experience.

5-020. PROGRAM PLANNING AND INSTRUCTIONAL METHODS IN AGRICULTURAL MECHANICS. (4 cr; prereq 10 cr in agricultural engineering technology, AgEd 3-031 or ¶AgEd 3-031) Bear
Planning and designing high school vocational agriculture facilities, organizing equipment, tools, supplies, and storage as demanded by the instructional program. Administering agricultural mechanics program. Developing teaching techniques and program planning as related to student-supervised study programs in agricultural mechanics.

5-030, 5-031, 5-032, 5-033, 5-034, 5-035. PROBLEMS AND FIELD STUDIES IN ADVANCED AGRICULTURAL MECHANICS. (3 cr per qtr [max 9 cr]; prereq 5-020 or ‡) Bear
Principles and practices pertaining to implementation of instructional programs in agricultural mechanics. Selection, application, operation, service, and maintenance of equipment used in agricultural mechanics pertaining to the specific instructional program. 5-030: Agricultural tractor and engine power. 5-031: Agricultural machinery and mechanization. 5-032: Electrical power and processing. 5-033: Farm buildings and environment control. 5-034: Natural resources development and management. 5-035: Metal fabrication materials and techniques.

5-040. ADVANCED METHODS FOR TEACHING AGRICULTURAL MECHANICS. (3 cr; prereq ‡; off-campus [f,s], on-campus [1st term SU]) 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.

5-230. MECHANISMS IN AGRICULTURAL MACHINERY. (5 cr; prereq 1-000, 1-010, 3-021)
Analysis of motion (position, velocity, and acceleration), forces, energy and power transmission, and control mechanisms in agricultural machinery.

5-240. AGRICULTURAL POWER. (4 cr; prereq 3-021, 3-022, 3-023)
Tractor engines and chassis, chassis mechanics, accessory systems, fuels and lubricants. Traction. Electrical power selection and utilization.

5-290.* PROBLEMS IN POWER AND MACHINERY. (2-5 cr; prereq 5-230, 5-240, ‡; hrs ar) Morey, Schertz, Strait
Individual problems in agricultural power and machinery based on work given in prerequisite courses.

5-400. DRAINAGE AND IRRIGATION. (4 cr; prereq Math 1-142 or △, Phys 1-032, Soil 1-122) Allred
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.

5-490.* PROBLEMS IN SOIL AND WATER MANAGEMENT. (2-5 cr; prereq 3-410, 5-400, ‡; hrs ar) Allred, Gilley, Goodrich, Larson, Machmeier
Individual problems in engineering phases of soil and water management, based on work given in prerequisite courses.

5-620. FARMSTEAD ENGINEERING. (4 cr; prereq 3-021, 3-022)
Basic structural, functional, and environmental requirements for crops and animals; materials of construction and construction details; materials handling systems, controlled environment systems and design problems.

5-690.* PROBLEMS IN AGRICULTURAL BUILDINGS. (2-5 cr; prereq 5-620, ‡; hrs ar) Flikke, Jordan, Moore, Pomroy
Individual problems, studies, and applications based on work given in prerequisite courses.

5-810. AGRICULTURAL WASTE MANAGEMENT. (4 cr; prereq Phys 1-031, Chem 1-005, Biol 1-011)
Characteristics of various animal manures, plant materials, and processing wastes. Sanitary collection, storage, treatment, and utilization or disposal of liquid and solid agricultural waste.

AGRONOMY AND PLANT GENETICS (Agro)

Professor
Herbert W. Johnson, *head, director of graduate study*
Robert N. Andersen
Richard Behrens
Laddie J. Elling
Arne W. Hovin
Jean W. Lambert
Gordon C. Marten
Dale N. Moss
Donald C. Rasmusson
Alois R. Schmid
Lawrence H. Smith

Associate Professor
Donald K. Barnes
William A. Brun
Verne E. Comstock
Robert E. Heiner
Ronald L. Phillips
Robert G. Robinson
James C. Sentz
Robert E. Stucker
Deon D. Stuthman

Assistant Professor
David E. Polson

Master's Degree—Offered under both Plan A and Plan B in agronomy, genetics, plant physiology, and plant breeding.

Doctor's Degree—Work leading to Ph.D. degree is offered in agronomy, genetics, plant physiology, and plant breeding.

Prerequisites—A good background in biological and other sciences.

Language Requirements—No foreign language is required for Master's or Ph.D. degrees.

Course Requirements—The courses listed below as well as courses in biochemistry, biometrics, botany, genetics, horticulture, plant pathology, soil science, and others may be included as major work. Course programs are planned according to the student's major and specific interests.

Members of the faculty of the department are involved in teaching the courses listed below. However, students planning to major in genetics, plant breeding, or plant physiology should refer to these sections of this bulletin for a more complete listing of courses in these areas.

Agronomy

5-010s. PASTURE AND GRASSLAND CROPS. (3 cr; prereq 3-030 or ‡) Schmid
Nature and extent of grasslands, productivity measurements of natural grasslands, theory and concepts of range management, pasture renovation, systems of grazing management, animal toxicities peculiar to forage crops. Lecture and laboratory.

5-030w. WEED CONTROL. (5 cr; prereq 1-010 or ‡) Behrens
Regulatory aspects of weed control and herbicide usage. Outline of principles and methods of weed control.

5-050f. PHYSIOLOGY OF FIELD CROPS. (3 cr; prereq Bot 3-131, Phys 1-020 or ‡) Moss
Physiological and ecological principles as they are applicable to growing field crops, doing field research, and to developing new varieties or cultural practices to take best advantage of the microenvironment in which plants grow.

8-010w,s,su.° RESEARCH IN AGRONOMY. (Cr ar; prereq ‡) Staff
Problems in physiology and production of crop plants.

8-020f.° SEMINAR: AGRONOMY. (1 cr per qtr) Staff
Reviews and discussions of important agronomic literature.

8-100w. PASTURE AND FORAGE RESEARCH TECHNIQUES. (3 cr; prereq Stat 5-021 or equiv, Agro 5-010 or ‡; offered 1972-73 and alt yrs) Marten
Potentialities and limitations of grazing trials: *in vivo* and laboratory methods for estimating forage quality.

8-380w. APPLIED STATISTICS. (3 cr; prereq Stat 5-021 or PubH 5-450) Staff
Design of experiments and application of statistical methods to analysis of biological data, particularly with small samples.

PlPh 5-183w. PLANT PHYSIOLOGY

PlPh 5-184f. PLANT PHYSIOLOGY

PlPh 5-188f,w,s. RESEARCH PERSPECTIVES IN PLANT PHYSIOLOGY

PlPh 5-702w. GAS EXCHANGE BY PLANTS

PlPh 8-251f,w. SEMINAR: PLANT PHYSIOLOGY

Plant Breeding

5-020w.° INTRODUCTION TO PLANT BREEDING. (3 cr; prereq GCB 3-022 or equiv) Stuthman
Introductory course concerned with plant breeding methodology and general principles.

8-200w. PRINCIPLES OF PLANT BREEDING I. (3 cr; prereq 5-020, GCB 5-033 or ‡) Rasmusson
Examination of principles involved in breeding self-pollinated crops. Population concepts, selection schemes, host pathogen relationships, hybrid breeding, and new approaches.

8-210s. PRINCIPLES OF PLANT BREEDING II. (3 cr; prereq 8-200 or ‡) Stucker
Examination of principles involved in breeding cross-pollinated crops. Population concepts, alternative selection schemes, heterosis, and combining ability.

8-220w. APPLICATION OF QUANTITATIVE GENETICS TO PLANT BREEDING. (3 cr; prereq 8-210, GCB 5-042; offered 1973-74 and alt yrs) Stucker
Use of population and quantitative genetic principles in decision making in plant breeding.

8-230f. CYTOGENETICS. (4 cr; prereq GCB 5-031, Biol 5-601 or ‡; 3 lect and 2 lab hrs per wk) Phillips
Discussion of 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.

8-270f,w. SEMINAR: PLANT BREEDING. (1 cr) Staff

8-280s. CURRENT TOPICS IN PLANT BREEDING. (2 cr; prereq 8-210 or ‡; offered 1972-73 and alt yrs) Rasmusson

8-290s. CURRENT TOPICS IN PLANT GENETICS. (2 cr; prereq GCB 5-031 or ‡; offered 1973-74 and alt yrs) Staff

8-310f,su.° LABORATORY METHODS IN PLANT BREEDING. (1 cr; prereq 5-020 or ‡) Lambert
Field study of plant breeding programs and techniques.

8-320s. METHODS IN PLANT GENETICS. (2 cr; prereq GCB 5-031 or ‡; offered 1972-73 and alt yrs) Staff
Planning and analysis of genetic experiments. Special applications.

8-330f,w,s,su. RESEARCH IN PLANT GENETICS. (Cr ar) Staff

AMERICAN INDIAN STUDIES (AmIn)

Courses in Which Graduate Credit May be Earned When Program Related

5-112. INDIANS OF THE SOUTHWEST. (4 cr; prereq 3-061)
Power relationships between Indians and other ethnic groups in the southwestern United States and northwestern Mexico from a historical perspective.

5-121. URBAN INDIANS IN THE UNITED STATES. (4 cr; prereq 3-061 or Anth 1-002 or 3-211 or ‡) Buffalohead
Application of social science and historical analysis to a major and relatively recent phenomenon in Indian life: the rapid cityward migration taking place since World War II.

5-131. INDUSTRIALIZATION, EMPLOYMENT, AND THE AMERICAN INDIAN. (4 cr; prereq 3-061 or ‡)
Sources of unemployment on Indian reservations; efforts to promote industrialization and economic development; employment and economic problems of urban Indians.

5-211. ARTS OF THE AMERICAN INDIAN. (4 cr; prereq 3-061 or 3 cr art history or ‡) Morrison
Visual arts of North American Indians. Some attention to other arts and to Indians of Latin America.

5-212. AMERICAN INDIAN CRAFTS. (4 cr; prereq 5-211 or ‡)
Research into the traditional art of different tribes paralleled with a studio workshop where students will pursue their own projects—the actual making of American Indian crafts.

5-570. EDUCATION AND THE AMERICAN INDIAN. (Cr ar, §EdAd 8-239; prereq 3-061 or ‡)
Undergraduate seminar concerned with the education of Indian children and youth. Specific topics will be selected on a year-to-year basis.

5-960. TOPICS IN AMERICAN INDIAN STUDIES. (Cr ar; prereq 3-061 or ‡)
Special courses on various aspects of American Indian studies. Topics will be listed in the *Class Schedule.*

5-980. SEMINAR: AMERICAN INDIAN STUDIES. (Cr ar; prereq listed in *Class Schedule* when seminar topic is announced)
Undergraduate seminar concerned with American Indian history. Topics will be selected on a year-to-year basis.

AMERICAN STUDIES (AmSt)

Professor

Mary C. Turpie, *chairman, director of graduate study*
Chester Anderson
Robert H. Beck
Hyman Berman
Bernard R. Bowron, Jr.
Clarke A. Chambers
David Cooperman
Charles H. Foster
Donald M. Gillmor
George S. Hage
Chadwick C. Hansen
Arthur L. Johnson
Joseph J. Kwiat
Rodney C. Loehr
Paul L. Murphy
David W. Noble
Johannes Riedel
Mulford Q. Sibley
Francis J. Sorauf, Jr.
Robert F. Spencer
Gregory P. Stone
Donald R. Torbert
Rudolph J. Vecoli
Leonard G. Wilson

Associate Professor

Ayers L. Bagley
Kent Bales
Kinley J. Brauer
Peter Carroll
George Green
Edward Griffin
John R. Howe, Jr.
John Modell
Martin Roth
Allan H. Spear
Roger H. Stuewer

Assistant Professor

Roger Buffalohead
Arthur Geffen

The Program in American Studies is not a department but an interdepartmental degree program. Consequently, the graduate faculty members of all the participating departments actually constitute the graduate faculty of American studies.

Prerequisites—An undergraduate major in one of the participating departments (history, English, philosophy, art history, music, anthropology, economics, education, journalism and mass communication, political science, sociology), or a major in American studies, or other preparation acceptable to the Committee on American Studies.

American Studies as a Minor—Consult the chairman.

Language Requirement—For the Master's degree, reading knowledge of one foreign language. For the Ph.D. degree, consult the chairman.

Master's Degree—Only under Plan B; 45 hours of American subjects are required, distributed in four areas: (a) history, (b) literature, (c) philosophy and fine arts, (d) social sciences. All candidates must include AmSt 8-201, 8-202, 8-203 in their program and must pass a written and an oral examination in American studies.

Doctor's Degree—Candidates for the Doctor's degree enroll in courses on aspects of American civilization distributed in the four areas named above and in the fifth area of foreign civilization. All candidates must include AmSt 8-301 and 8-311, 8-312, 8-313 in their program, write an interdepartmental dissertation, and pass a series of written examinations, the preliminary oral examination, and the final oral examination.

For further details see the *Program in American Studies* departmental brochure.

8-201, 8-202, 8-203. INTRODUCTION TO AMERICAN STUDIES. (3 cr per qtr; prereq M.A. candidate) Turpie, Chambers, Kwiat, Hage
Exposition of interdisciplinary methods and of the concept of American studies; reading of classics in American civilization; extended exploration of a topic.

8-301. SEMINAR: INTRODUCTION TO AMERICAN STUDIES. (3 cr; prereq Ph.D. candidate) Turpie

8-311, 8-312, 8-313. SEMINAR: AMERICAN STUDIES. (3 cr per qtr; prereq Ph.D candidate) Sibley, Hansen
Problems and methods in the study of American culture.

8-401, 8-402, 8-403. MATERIALS FOR THE STUDY OF AMERICAN CIVILIZATION. (3 cr per qtr; prereq advanced degree candidate in American studies or ‡) Turpie

8-970. READINGS IN AMERICAN CIVILIZATION. (Cr ar; prereq consent of program chairman) Turpie and staff
Independent study of interdisciplinary aspects of American civilization under guidance of members of various departments.

Note—For approved courses in American history, literature, philosophy, and other departments concerned, see the annually revised course list available in the American Studies Office.

ANATOMY (Anat)

Professor

Arnold Lazarow, M.D., Ph.D., *head*
Morris Smithberg, Ph.D., *director of graduate study*
Anna-Mary Carpenter, Ph.D., M.D.
Padamakar K. Dixit, Ph.D.
Carl B. Heggestad, M.D., Ph.D.
R. Dorothy Sundberg, M.D., Ph.D.

Associate Professor

Wesley D. Anderson, D.V.M., Ph.D.
G. Eric Bauer, Ph.D.

Assistant Professor

H. David Coulter, Ph.D.
Orion Hegre, Ph.D.
Joseph L. Rigatuso, Ph.D.
Donald W. Robertson, Ph.D.
Robert L. Sorenson, Ph.D.

Lecturer

Lars Folke, L.D.S., Ph.D.
Robert J. Issacson, D.D.S., Ph.D.

Prerequisites—Prerequisite work for all majors or minors in the field of anatomy includes general zoology, 9 credits.

Major and Minor for the Ph.D.—Each major in anatomy must have had or must take the basic courses (8-000 level) in anatomy (embryology, gross anatomy, histology, and human neuroanatomy). For majors in hematology, Anat 5-765/5-766 is required. Majors in clinical subjects who desire a minor in anatomy must have had, as prerequisites, the courses in anatomy usually required of medical students, including Anat 5-100/5-101, 5-103/5-104, 5-106/5-107, and 5-111.

Language Requirement—For the Master's degree, none required. For the Ph.D. degree, reading knowledge of one foreign language—French, German, Italian, Spanish, or Russian. Other requirements, if any, will be at the discretion of the adviser.

Master's Degree—Limited number offered only under Plan A. (Consult director of graduate study prior to submitting application.)

Doctor's Degree—The department provides excellent facilities for work in anatomy leading to the Ph.D. degree.

Note—Graduate study in anatomy is also offered at the Mayo Graduate School of Medicine of the University of Minnesota. See the bulletin, *Graduate Programs in the Health Sciences.*

5-105. DENTAL MICROSCOPIC ANATOMY. (6 cr; prereq ‡) Bauer, Coulter
Minute structure of cells, tissues, and organs of the human body.

5-108. GROSS ANATOMY FOR DENTAL STUDENTS. (6 cr; enrollment limited; prereq ‡) Sorenson and staff
Lectures and dissection; thorax, extremities; abdomen and pelvis.

5-109. GROSS ANATOMY FOR DENTAL STUDENTS. (6 cr; enrollment limited; prereq ‡) Sorenson and staff
Lectures and dissection; head and neck.

5-110. DENTAL NEUROANATOMY. (3 cr; prereq 5-105 or ‡) Staff
Gross and microscopic structure of central nervous system; emphasis on structure related to function. Laboratory demonstrations include gross anatomy of the brain stem.

5-190. ADVANCED ANATOMY. (Cr ar; prereq regis med, 5-104) Staff
Teaching methods or supervision of student's original research or combination of both.

5-765/5-766. HEMATOLOGY. (4 cr per qtr; prereq 5-103 or Zool 5-066 or ‡) Sundberg
Blood and blood-forming organs; blood and bone marrow from standpoint of diagnosis and prognosis.

5-767. SEMINAR: HEMATOLOGY. (1 cr; prereq 5-766) Sundberg

8-100/8-101.† GROSS HUMAN ANATOMY. (16 cr for both qtrs; enrollment limited; prereq ‡) Heggestad, Lazarow, Smithberg, Robertson, Anderson
Dissection of the human body and discussion in small groups designed to enrich the experience of the graduate student in understanding anatomic relationships in preparation for teaching.

8-103/8-104.† HUMAN HISTOLOGY. (8 cr for both qtrs; enrollment limited; prereq ‡) Carpenter, Lazarow
Microscopic structure, cytochemical and functional aspects of cells, tissues, and organs. Current literature with emphasis on methodology applicable to morphologic research.

8-106/8-107. HUMAN EMBRYOLOGY. (6 cr for both qtrs; enrollment limited; prereq ‡) Heggestad, Rigatuso
Development of the human body. Microscope slides, series of embryo type specimens, and specimens demonstrating anomalies are available for individualized study.

8-111. HUMAN NEUROANATOMY. (4 cr; enrollment limited; prereq ‡) Smithberg, Coulter
Structure and function of the nervous system including organs of special sense.

8-115. ADVANCED DENTAL MICROSCOPIC ANATOMY. (3 cr; enrollment limited; prereq ‡) Bevis
Microscopic structure of oral-related cells, tissue, and organs. Demonstrations and laboratory exercises with electron microscope and associated technics.

8-135. BIOLOGICAL ELECTRON MICROSCOPY: TECHNICS. (Cr and hrs ar; prereq ‡; offered 1973-74 and alt yrs)

8-137. BIOLOGICAL ELECTRON MICROSCOPY: INTERPRETATION. (Cr and hrs ar; enrollment limited; prereq 5-103 or 5-104 or equiv, ‡) Coulter

8-153, 8-154, 8-155, 8-156. ADVANCED ANATOMY. (Cr and hrs ar; prereq ‡) Staff
Cytochemistry, embryology, gross anatomy, hematology, histology, neurology, or experimental morphology.

8-160. INTRODUCTION TO HISTOLOGIC AND MORPHOLOGIC-HISTOCHEMICAL TECHNICS. (2 cr; prereq 5-104, ‡; offered 1972-73 and alt yrs) Carpenter
Fixation, embedding, and staining of cytological components and enzymes.

8-161/8-162/8-163. METHODS IN ANATOMICAL RESEARCH. (2 cr per qtr; primarily for 1st-yr grad students; prereq 5-100 or ‡; offered 1972-73 and alt yrs) Bauer and staff
Introduction to instrumentation, technics, and experimental approaches in the fields of cell physiology, microchemistry, radioautography, quantitative histochemistry, tissue culture, etc.

8-168. SEMINAR: CYTOLOGICAL ASPECTS OF PROTEIN SYNTHESIS AND SECRETION. (3 cr; prereq 5-101 or ‡; hrs ar) Bauer
Protein synthesis, storage, and secretion in mammalian tissues, with emphasis on hormone production. Correlation of structure and function of subcellular organelles and current ideas on regulation of synthesis and secretion.

8-201, 8-202, 8-203, 8-204. RESEARCH IN ANATOMY. (Cr and hrs ar; prereq ‡) Abrahamson, Anderson, Bauer, Carpenter, Coulter, Dixit, Heggestad, Hegre, Lazarow, Rigatuso, Smithberg, Robertson, Sorenson, Sundberg
Cytochemistry, embryology, gross anatomy, histology, hematology, or neurology. Special facilities offered to graduate students in clinical departments for work on problems in applied anatomy.

8-205, 8-206, 8-207. SEMINAR: ANATOMY. (1 cr per qtr; prereq ‡) Lazarow and staff
Reviews of current literature and discussion of research work being carried on in the department.

8-211. NEUROCYTOLOGY. (1 cr; prereq ‡) Coulter
Ultrastructure, cytochemistry, and physiology.

ANESTHESIOLOGY (Anes)

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

ANIMAL PHYSIOLOGY

STEERING COMMITTEE

Alan G. Hunter, *chairman, director of graduate study*
Archie L. Good
Edmund F. Graham
Rodney B. Harvey
William D. Schmid
Clarence M. Stowe

STAFF

Professor

Harold E. Dziuk
Archie L. Good
Edmund F. Graham
Eugene Grim
Paul B. Hammond
Alan G. Hunter
Nathan Lifson
Richard E. Phillips
Clarence M. Stowe
Alvin F. Weber

Associate Professor

Bo G. Crabo
Thomas F. Fletcher
Grace W. Gray
Rodney B. Harvey
William S. Herman
Edward F. Jankus
Garth E. Miller
William D. Schmid

Assistant Professor

William H. Burke
Gary E. Duke
Donald E. Gilbertson
Judson D. Sheridan
John P. Sullivan

Prerequisites—For major work a Bachelor's degree in animal science, fisheries and wildlife, biology, veterinary medicine, zoology, or an equivalent degree, including course work in zoology, biology, chemistry, physics, mathematics. Deficiencies in previous training must be corrected before a student becomes a candidate for the degree.

Major—Animal physiology is a broad field which includes diverse aspects of physiology ranging from the cellular level to organ systems and whole organism physiology. The programs tend to be based on mammalian, avian, reproductive, cardiovascular, gastrointestinal, neural, and behavioral physiology with a species orientation toward domestic and wild animals. Students doing major work will be required to satisfy a basic core curriculum which includes courses in animal science, veterinary anatomy, animal and veterinary physiology, physical chemistry, and biochemistry, after which courses and research emphasizing various species or systems may be selected with the guidance of the adviser and the steering committee.

Minor—The minor area is taken in a field logically related to the student's major interest. In addition to the adviser's approval, the minor area selections must be approved by the Animal Physiology Steering Committee.

Master's Degree—Offered under both Plan A and Plan B.

Doctor's Degree—Work leading to the Ph.D. degree is offered.

Courses Offered—In general, courses from animal science, veterinary physiology and veterinary pharmacology, physiology, fisheries and wildlife, and zoology which stress the functional characteristics of cells, organs and organ systems, or the whole animal, fit in the animal physiology program. However, students are urged to consult with a faculty member and the steering committee before initiating their program.

ANIMAL SCIENCE (AnSc)

Professor

Robert W. Touchberry, *head*
Lester E. Hanson, *director of graduate study*
Charles E. Allen
William J. Boylan
Ralph E. Comstock
John D. Donker
Franklin D. Enfield
Richard D. Goodrich
Edmund F. Graham
Alan G. Hunter
Robert M. Jordan
Robert J. Meade
Jay C. Meiske
Donald E. Otterby
Richard E. Phillips
William E. Rempel
Robert N. Shoffner
Paul E. Waibel
Jesse B. Williams
Charles W. Young

Associate Professor

William H. Burke
Melvin L. Fahning
Eldon G. Hill
Garth E. Miller
John D. Smith
George M. Speers

Assistant Professor

James W. Nordstrom

Prerequisites—For major work, a baccalaureate degree in agriculture or biology with emphasis on the animal sciences and with substantial training in chemistry, physics, and mathematics. Deficiencies in previous training must be corrected, usually without credit, before students become candidates for a degree. For minor work students must satisfy the departmental graduate faculty that they have an adequate background.

Major—Students doing major work for the Doctor's degree may emphasize breeding, genetics, meats, nutrition, or physiology. With the approval of the adviser, graduate courses in several subject matter disciplines may be approved for major work.

Minor—The minor area of work is taken in a field logically related to students' major interest and, in addition to approval by their adviser, must meet the requirements established by the department offering the minor work. With the approval of their major adviser, students may substitute a supporting program of study for the minor.

Students in this department may obtain degrees in animal science, in genetics, in nutrition, or in animal physiology. See Index for requirements in genetics, nutrition, and in animal physiology.

Language Requirement—The department has no language requirement for M.S. or Ph.D. degrees. Individual faculty advisers may require some or all of their advisees to attain a prescribed level of proficiency in a foreign language(s). Students who wish to have proficiency in a language recorded on their transcripts must prove proficiency by passing either the Graduate School Foreign Language Test or a test administered by the appropriate language department.

Master's Degree—Offered under both Plan A and Plan B.

Doctor's Degree—Work leading to the Ph.D. degree is offered.

5-230. SYSTEMS AND METHODS OF ANIMAL BREEDING. (4 cr; prereq 3-220) Boylan, Young
Application of quantitative genetic principles to animal breeding; systems of breeding as related to beef and dairy cattle, poultry, sheep, and swine; industry-related problems and research in animal breeding.

5-240. ANIMAL CYTOGENETICS AND IMMUNOGENETICS. (4 cr; prereq GCB 3-022 or ‡) Shoffner
Application of cytogenetics and immunogenetics to problems in animal breeding, systemics, pathology, and animal biology.

5-310. GENERAL ENDOCRINOLOGY. (3 cr; prereq 1-300 or 6 cr systemic physiology or ‡) Sullivan
(Same as VPP 5-310) Physiological effects of endocrine organs and hormones.

5-314. BEHAVIORAL PHYSIOLOGY. (3 cr; prereq 1-300 or 6 cr systemic physiology, Biol 5-051 or ‡) Phillips
(Same as VPP 5-314) Current concepts of neurological and neurochemical bases of animal behavior, including reception, coding, transmission, and storage of information; level of integration; central control of input and output; spontaneity, development, and learning.

5-320. AVIAN PHYSIOLOGY. (3 cr; prereq 1-300 or equiv; offered 1973-74 and alt yrs) Duke
(Same as VPP 5-320) Physiology of various species of wild and domestic birds.

5-321. ADVANCED AVIAN PHYSIOLOGY. (1 cr; offered 1973-74 and alt yrs) Duke
(Same as VPP 5-321) Survey of physiology of some phenomena characteristic of nondomestic avian and mammalian species, such as physiology of flying, diving, migration, annual reproductive cycles, circadian rhythms, hibernation, and torpidity.

5-322f. PHYSIOLOGY OF REPRODUCTION. (5 cr; prereq 6 cr systemic physiology) Crabo
Principles of reproductive physiology with emphasis on endocrinological aspects.

5-323w. COMPARATIVE PATTERNS OF VERTEBRATE REPRODUCTION. (4 cr; prereq 5-322 or ‡, offered 1973-74 and alt yrs) Burke
Comparative patterns, endogenous and exogenous rhythms, and the control of estrus cycles.

5-324s. SEMEN PRESERVATION AND ARTIFICIAL INSEMINATION. (4 cr; prereq 5-322 or ‡; offered 1973-74 and alt yrs) Graham
Chemistry of gametes and reproductive secretions; preservation of spermatozoa, with emphasis on cryobiology; artificial insemination and factors influencing reproductive performance.

5-325w. PHYSIOLOGY OF FERTILIZATION AND GESTATION. (4 cr; prereq 5-322 or ‡; offered 1972-73 and alt yrs) Hunter
Physiological events occurring during gametogenesis; capacitation and fertilization, the period of the embryo; the period of the fetus; and parturition.

5-326s. IMMUNOREPRODUCTION. (4 cr; prereq 5-322 or ‡; offered 1972-73 and 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.

5-402. NONRUMINANT NUTRITION. (4 cr; prereq 1-401) Hanson, Waibel
Nutrient requirements of chickens, turkeys, and swine; feed supplies, their composition and utilization in formulation of adequate diets. Role of feed additives, their use and limitations. Nutritional interrelationships and feeding systems.

5-403. RUMINANT NUTRITION. (4 cr; prereq 1-401) Goodrich, Otterby
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. Nutrition of horses will be considered also.

5-510. MUSCLE CHEMISTRY AND PHYSIOLOGY. (4 cr; prereq 1-300, BioC 1-302 or equiv...AnSc 1-500 recommended; offered 1973-74 and alt yrs) Allen
(Same as FScI 5-510) Fundamental properties of muscle ultrastructure, chemistry and physiology as they relate to muscle proteins, growth, contraction, energy metabolism, adaptive responses, rigor mortis, and conversion of muscle to meat.

5-512. MEAT CHEMISTRY AND PROCESSING. (4 cr; prereq 1-500, BioC 1-302) Addis
(Same as FScI 5-512) 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.

5-601. SWINE PRODUCTION. (4 cr; prereq 1-401...3-220 recommended) Meade
Status and characteristics of the swine industry; application of principles of animal breeding, nutrition, physiology, and economics to swine production; considerations in development of a successful swine enterprise.

5-602. SHEEP PRODUCTION. (4 cr; prereq 1-401...3-220, 3-403 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.

5-603. BEEF CATTLE PRODUCTION. (4 cr; prereq 1-401...3-320, 3-403 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.

5-604. DAIRY FARM MANAGEMENT. (4 cr; prereq 3-403 or ‡...3-220 recommended) Miller, Young
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.

5-605. COMMERCIAL POULTRY PRODUCTION. (4 cr; prereq 1-401...3-320, 3-402 recommended) Speers
Current practices and production systems with emphasis on managerial aspects of egg, broiler, and turkey production. Technical and practical phases of production and marketing considered in relation to their underlying principles. Visits to appropriate commercial production units.

5-703. LITERATURE AND SEMINAR. (2-3 cr [3 cr for two seminar reports]) Donker, Hunter
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.

5-710. SPECIAL PROBLEMS. (Cr ar; open to students who have completed pertinent prereqs; prereq ‡)
Research in an area of animal science under supervision of a staff member. Written report of research is required.

5-715. TUTORIAL. (Cr ar; prereq ‡)
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.

8-220.* ADVANCED ANIMAL BREEDING. (3 cr; prereq GCB 3-022, Stat 5-021) Staff
Assigned readings and lectures on more recently proposed techniques and their likely application to farm animals.

8-221.* QUANTITATIVE INHERITANCE. (3 cr; prereq GCB 5-402) Boylan
Application of principles in quantitative genetics to improvement of economic species. Selection indexes and choice of breeding systems.

8-420.* ENERGY IN ANIMAL NUTRITION. (3 cr; prereq BioC 5-002 or equiv or ‡...BioC 5-743 recommended; offered 1972-73 and alt yrs) Donker
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.

8-421.* PROTEIN AND AMINO ACID NUTRITION. (3 cr; prereq BioC 5-002 or equiv or ‡...BioC 5-743 recommended; offered 1972-73 and alt yrs) Nordstrom
Role; sources, how determined; measurements of protein quality; fate and use of ingested protein and amino acids and interrelationships with other nutrients.

8-422.* VITAMIN NUTRITION. (3 cr; prereq BioC 5-742 or ‡; offered 1973-74 and alt yrs) Waibel
Principles of vitamin nutrition for rats, poultry, swine, cattle, and sheep, including vitamin characteristics, interrelationships, and requirements, and deficiency symptoms.

8-423.* MINERAL NUTRITION. (3 cr; prereq BioC 5-002 or ‡...BioC 5-742 recommended; offered 1973-74 and alt yrs) Smith
Principles of mineral nutrition for domestic and laboratory animals; mineral requirements, interrelationships, utilization, and metabolism.

8-440.* RUMINANT NUTRITION. (3 cr; prereq BioC 5-002 or ‡...MicB 5-321 recommended; offered 1972-73 and alt yrs) Meiske
Development, physiology, and function of the rumen, role of rumen-microflora in digestion and synthesis and factors influencing these phenomena.

8-740. CONCEPTS AND DEVELOPMENTS IN RUMINANT NUTRITION. (2 cr; prereq ‡)
Review and critical evaluation of recent research reports of relevance to ruminant nutrition.

8-741. CONCEPTS AND DEVELOPMENTS IN AVIAN NUTRITION. (2 cr; prereq ‡; offered fall 1972-73 and alt yrs)
Students will review and critically evaluate current research reports, concepts, and ongoing research in poultry nutrition.

8-742. CONCEPTS AND DEVELOPMENTS IN SWINE NUTRITION. (2 cr; prereq ‡; offered spring 1973-74 and alt yrs)
Review and evaluation of scientific literature pertinent to swine and small animal nutrition.

8-750x. CONCEPTS AND DEVELOPMENTS IN MEAT SCIENCE AND TECHNOLOGY. (1 cr [may be repeated once for cr]; prereq ‡)
Review and evaluation of pertinent scientific literature.

8-810x.* RESEARCH IN ANIMAL SCIENCE. (Cr ar; prereq ‡)
Research including experimental studies in disciplines associated with animal production and research with special emphasis on interdisciplinary studies embracing environmental and managerial considerations.

8-820x.* RESEARCH IN ANIMAL GENETICS. (Cr ar; prereq ‡)
Research in quantitative genetics, cytogenetics, and other areas related to animal breeding.

8-830s.* RESEARCH IN ANIMAL PHYSIOLOGY. (Cr ar; prereq ‡)
(Same as VPP 8-830) Individual research under faculty direction. Topics to be 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.

8-840x.* RESEARCH IN ANIMAL NUTRITION. (Cr ar; prereq ‡)
Research in selected areas of animal nutrition. Research topics and animal species determined by consultation.

8-850x.* **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
Elden Johnson, *chairman*
Luther P. Gerlach
E. Adamson Hoebel
Frank C. Miller
Rupert I. Murrill
William L. Rowe
Robert F. Spencer

Associate Professor
Robert C. Kiste
Eugene Ogan
Harvey B. Sarles

Assistant Professor
Stephen F. Gudeman
Dennis E. Puleston
Alan W. Rew

Language Requirement—For the Master's degree, one foreign language. For the Ph.D. degree, two foreign languages or one foreign language and special competence in a research technique.

Master's Degree—Offered under Plan A or Plan B.

Doctor's Degree—Work leading to the Ph.D. degree is offered. See departmental brochure for specific requirements.

5-112. SOCIAL ANTHROPOLOGY: KINSHIP AND MARRIAGE. (5 cr; prereq 1-502 or ‡) Gudeman, Ogan, Rew
Examination of 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.

5-114. STRUCTURAL ANTHROPOLOGY. (5 cr; prereq 1-502 or 5-112 or ‡) Gudeman
Assumptions, methods, and problems of structural anthropology; structural analysis of kinship, ritual, myth, and social organization.

5-115. ECONOMIC ANTHROPOLOGY. (5 cr; prereq 1-502...waived for majors in economics and business administration) Gerlach, Gudeman
Analysis and comparison of varied systems of production and distribution; special reference to nonindustrial societies. Relationship between economic and social, political, religious, psychological, and environmental factors.

5-116. CULTURAL ECOLOGY. (5 cr; prereq 1-002, 10 cr ethnology) Puleston
Survey of the literature on cultural ecology with emphasis on biological approach to ecosystems and population studies. Major monographs dealing with problems in cultural ecology will be covered in readings and lectures.

5-121. ANTHROPOLOGY OF LAW. (5 cr; prereq 1-502...waived for majors in other social sciences)
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.

5-131. ANTHROPOLOGY OF RELIGION AND FOLKLORE. (5 cr, §3-131; prereq 1-502 or ‡) Kiste, Spencer
Varieties and range of religious beliefs and practices. Relation of religion to other aspects of culture. Comparative analysis of folklore, myth, and oral literature.

5-132. SYMBOLIC ANTHROPOLOGY. (5 cr; prereq 1-502, 5-112 or ‡) Staff
Culture as a system of symbols.

5-141. CULTURE AND PERSONALITY. (5 cr; prereq 1-502 or ‡...waived for majors in public health, nursing, psychology, sociology, and social work) Ingham, Rowe, Sarles
Role of culture in formation of personality. Problems of individual adjustments to demands of culture. Psychological approach to culture.

5-145. ANTHROPOLOGY AND EDUCATION. (5 cr, §HEd 5-170; prereq 1-002) Holt
Cross-cultural perspectives in examining educational patterns, implicit and explicit cultural assumptions underlying them. Methods and approaches to cross-cultural studies in education.

5-146. INNOVATION IN HIGHER EDUCATION. (5 cr; prereq 5-145 or 5-151 or ‡) Miller
Social organization and cultural values of educational institutions. Role of decision making in the process of innovation. Analysis of specific changes in higher education.

5-151. CULTURAL CHANGE AND DEVELOPMENT. (5 cr; prereq 1-502) Kiste, Miller, Ogan
Processes of cultural change; invention, diffusion, and acculturation. Effects of colonialism, urbanization, and modernization. Analysis of developing societies. Applied anthropology.

5-152. ANTHROPOLOGY OF SOCIAL MOVEMENTS. (5 cr; prereq 1-002 or ‡) Gerlach
Cross-cultural comparative 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, U.S.A.

5-153. URBAN ANTHROPOLOGY. (5 cr; prereq 1-002 or ‡) Rew, Rowe
Structure and process in non-Western urban centers; emphasis on the role of rural migrants, relationship of urbanism to political and economic development, role of voluntary associations, adjustment of kinship groups to urban life.

5-154. ANTHROPOLOGY OF COLONIALISM. (5 cr; prereq 1-502 or ‡) Kiste, Ogan, Rowe
Social structural, symbolic, and psychological aspects of the societies of colonizers and the colonized; emphasis on South Asia, Oceania, and Puerto Rico.

5-158. ANTHROPOLOGICAL ANALYSIS OF AMERICAN CULTURE. (5 cr; prereq 1-502 or ‡) Rowe
Anthropological perspectives on contemporary American culture and society with emphasis on values, family organization, socialization and kinship, education, and community integration.

5-161. LANGUAGE AND CULTURE. (5 cr; prereq 1-002 or ‡) Sarles, Spencer
Relation of language to behavior; languages as systems of thought, logic, and orientation and their impacts on cultures; analysis of selected linguistic and cultural systems; glottochronology.

5-162/5-163†/5-164. KINESICS. (5 cr per qtr; prereq ‡ for 5-162 and 5-163, 5-163 for 5-164) Sarles
Human communication in micro and macro perspective; nonverbal aspects of interaction within and across cultures. Use of video and cinematic methods of observation; discussion of kinesiology, animal communication, the body as an information transmitting/handling device.

5-171. METHOD AND THEORY OF AMERICAN ARCHAEOLOGY. (5 cr; prereq 1-501) Johnson, Puleston
Examination of field methods systems of data recording, analytical methods, and their conceptual bases. Abstract theory is integrated with specific case material. Some laboratory exercises in application of artifact analysis.

5-181. PRIMATE AND HUMAN EVOLUTION. (5 cr; prereq 1-002) Murrill
Origins and relationships of extinct forms of nonhuman primates and man.

5-182. HUMAN BIOLOGY. (5 cr; prereq 1-002) Murrill
Evolutionary processes in differential development of races. Physical characteristics, distribution, and relationships of living races. Human genetics and blood types. Influence of various environments on man.

5-183. HUMAN PHYSICAL GROWTH AND DEVELOPMENT. (5 cr; prereq 1-002...waived for majors in child development) Murrill
Period of growth—prenatal, birth, infancy, childhood, and adolescence. Sex differences in growth, skeletal maturation. Development and growth of the head. Growth and eruption of teeth.

5-212. INDIANS OF THE GREAT PLAINS. (5 cr; prereq 1-002 or ‡)
Prehistoric origins of tribes. Cultures of Missouri River tribes and nomads of the Plains.

5-221. INDIANS OF SOUTH AMERICA. (5 cr; prereq 1-002) Gudeman, Ingham
Enthnographic survey. Prehistory of various areas. Spanish and Portuguese contact and adjustment of various tribes to modern conditions.

5-222. PEOPLES AND CULTURES OF MIDDLE AMERICA. (5 cr; prereq 1-502...waived for majors in Latin-American Area Studies) Gudeman, Ingham
Survey of both Indian- and Spanish-speaking people of Middle America. Analysis of processes of acculturation that have produced contemporary cultures of Mexico and Central America.

5-223. PEOPLES AND CULTURES OF THE CARIBBEAN. (5 cr; prereq 1-002 or ‡) Hendricks
Island and littoral cultures of Circum-Caribbean. Emphasis on social structure, cultural pluralism, continuity, and change.

5-241/5-242. PEOPLES AND CULTURES OF AFRICA. (5 cr per qtr; prereq 1-002 for 5-241, 5-241 or ‡ for 5-242) Gerlach
5-241: Survey of cultures of western and central Africa. Ecological adaptation, races, languages, social organization, economic systems, political systems, aesthetic expression. Review of significant theoretical issues and problems in African anthropology. Special focus on subjects of key interest, i.e., ecological adaptation, urbanization, migration, change. 5-242: Survey of cultures of eastern and southern Africa. Ecological adaptation, races, languages, social organization, economic systems, political systems, aesthetic expression. Review of significant theoretical issues and problems in African anthropology. Special focus on subjects of key interest, i.e., ecological adaption, urbanization, migration, change.

5-251. ISLAMIC CULTURE SPHERE. (5 cr; prereq 1-002 or ‡) Gerlach, Spencer
Mohammed and founding of Islam. Development and spread of Islamic religion, law, government, and other institutions in Middle East, Africa, and Asia. Culture and society in contemporary Middle East.

5-261. INDIAN CULTURE AND SOCIETY. (5 cr; prereq 1-502 or ‡) Rowe, Spencer
Survey of tribes, caste, and culture history in South Asia. Cultural influences from India in Southeast Asia.

5-263. MODERN INDIA: TOWNS AND CITIES. (5 cr; prereq 1-502 and 5-261 or ‡) Rowe
Development of Indian towns and cities from anthropological perspective; urban life, city growth, and urban migration.

5-281. CULTURE AND SOCIETY IN CHINA AND JAPAN. (5 cr; prereq 1-002 or ‡) Gerlach
Development of Chinese institutions and other cultural manifestations. Their influence on cultures of Japan, Korea, and Vietnam. Analysis of and comparison between contemporary Chinese and Japanese societies.

5-291/5-292. ETHNOLOGY OF OCEANIA. (5 cr per qtr; prereq 1-502) Kiste, Ogan, Rew
Survey of South Pacific cultures. Emphasis on comparative ethnology of Polynesia and Micronesia (5-291) and Melanesia (5-292). Impact of Western culture on island societies; significance of Oceanic ethnology to anthropological theory.

5-316. ETHNOLOGICAL FIELD TECHNIQUES. (5 cr; prereq sr or grad or ‡) Miller
Introduction to techniques of field observation, interviewing, and recording; training in field methods, presentation of data, and interpretation of results provided by laboratory exercises with informants.

5-366. METHOD AND THEORY IN ANTHROPOLOGICAL LINGUISTICS. (5 cr; prereq 1-002 or ‡) Sarles, Spencer
Linguistic theory and practice as tool in anthropological field work; analysis of phonological, morphological, and syntactic problems in world languages.

5-376su. FIELD RESEARCH IN ARCHAEOLOGY. (5-10 cr [may be taken for cr only once]; prereq 1-501) Johnson
Archaeological field excavation, survey, and research in prehistoric sites in Minnesota. Intensive training in excavation techniques, recordation, analysis, and interpretation of archaeological materials.

5-386. METHODS IN PHYSICAL ANTHROPOLOGY. (5 cr; prereq 1-002) Murrill
Comparative osteology of man and anthropoid apes. Variations related to sex, age, and race. Observations and measurements on the skeleton.

5-387. METHODS IN HUMAN BIOLOGY. (5 cr; prereq 1-002)
Anthropometric, dermatolyphic, radiographic, cephalometric, and other methods used in human biology. Specific methods used in any given class will depend on interest in the class.

5-521. ARCHAEOLOGY OF MIDDLE AMERICA. (5 cr) Puleston
Developmental stage survey of major features of prehistoric cultures of Mexico and Central America.

5-522. ARCHAEOLOGY OF SOUTH AMERICA. (5 cr) Adams
Developmental stage survey of major features of prehistoric cultures of South America. All major ecological zones will be covered.

5-531. PALEOANTHROPOLOGY. (5 cr) Johnson
Survey of archaeological record of human cultural origins and developments in Pleistocene and early recent periods in Africa, Europe, and Asia.

5-532. OLD WORLD PREHISTORY: EUROPE, NEAR EAST, AND EGYPT. (5 cr)
Recent period prehistory stressing the origins, development, and dispersion of systems of food production; the origins of urbanism.

5-533. ASIAN PREHISTORY. (5 cr) Johnson
Origins and developments of major Asian cultural traditions.

5-591. PREHISTORY OF OCEANIA. (5 cr) Puleston
Survey of prehistory of Oceania with major emphasis on archaeological evidence. Polynesia, Micronesia, Melanesia, Australia; insofar as they appear pertinent, Southeast Asia and the Americas.

5-910/5-920. TOPICS IN ANTHROPOLOGY. (Cr ar) Visiting professors
Special courses in all branches of anthropology. When course is offered, topic will be listed in *Class Schedule* and prerequisites stated at that time.

8-001. SEMINAR: BASIC ANTHROPOLOGY (CULTURAL). (3 cr) Staff

8-002. SEMINAR: BASIC ANTHROPOLOGY (SOCIAL). (3 cr) Staff

8-003. SEMINAR: BASIC ANTHROPOLOGY (BIOLOGICAL). (3 cr) Staff

8-004. SEMINAR: BASIC ANTHROPOLOGY (ARCHAEOLOGY). (3 cr) Staff

8-005. SEMINAR: BASIC ANTHROPOLOGY (SELECTED TOPICS). (3 cr) Staff

8-102. SEMINAR: PRINCIPLES OF SOCIAL AND CULTURAL ANTHROPOLOGY. (3 cr; for nonmajors only; prereq grad status) Staff

8-152. SEMINAR: RESEARCH METHODS IN SOCIAL AND CULTURAL ANTHROPOLOGY. (3 cr) Miller

8-153. SEMINAR: QUANTITATIVE AND CROSS-CULTURAL RESEARCH METHODS. (3 cr) Staff

8-161, 8-162, 8-163. SEMINAR: GENERAL ANTHROPOLOGY. (3 cr per qtr) Staff

8-171. SEMINAR: MUSEUMS AND ANTHROPOLOGY. (3 cr) Johnson

8-181, 8-182. ANTHROPOLOGY AND THE SCIENTIFIC METHOD. (3 cr per qtr) Staff

8-221, 8-222, 8-223. SEMINAR: ETHNOLOGY. (3 cr per qtr) Staff

8-311. SEMINAR: SOCIAL ANTHROPOLOGY. (3 cr) Gudeman, Ogan

8-316. SEMINAR: THE COMMUNITY IN ANTHROPOLOGICAL PERSPECTIVE. (3 cr) Miller, Rowe

8-318. SEMINAR: ADVANCED SOCIAL ANTHROPOLOGY. (3 cr) Gudeman, Ogan

8-325. SEMINAR: THEORIES AND PROBLEMS IN HUMAN ECOLOGY. (3 cr) Gerlach

8-331. SEMINAR: POLITICO-LEGAL INSTITUTIONS. (3 cr)

8-341. SEMINAR: PHILOSOPHICAL ANTHROPOLOGY. (3 cr) Spencer

8-361, 8-362, 8-363. SEMINAR: CULTURE AND PERSONALITY. (3 cr per qtr) Rowe, Sarles

8-381. SEMINAR: CULTURAL DYNAMICS. (3 cr) Kiste, Miller, Ogan

8-382. SEMINAR: APPLIED ANTHROPOLOGY. (3 cr) Kiste

8-383. SEMINAR: URBAN ANTHROPOLOGY. (3 cr; offered when feasible) Rowe

8-395. ETHNOLOGICAL FIELD SESSION. (Cr ar; offered when feasible)
Field research in social anthropology of American Indian or non-European communities.

8-411, 8-412, 8-413. SEMINAR: ANTHROPOLOGICAL LINGUISTICS AND COMMUNICATION. (3 cr per qtr) Sarles, Spencer

8-431. SEMINAR: COMPARATIVE ETHOLOGY. (3 cr) Sarles

8-501, 8-502, 8-503. SEMINAR: ARCHAEOLOGY. (3 cr per qtr) Johnson, Puleston

8-505. SEMINAR: PALEOECOLOGY AND ARCHAEOLOGY. (3 cr) Johnson, Puleston
Investigation of paleoecological techniques and their application to archaeological analysis.

8-508. ADVANCED FIELD TECHNIQUES IN ARCHAEOLOGY. (6 cr; prereq 5-376) Johnson

8-521. PROBLEMS IN MIDDLE AMERICAN ARCHAEOLOGY. (3 cr) Puleston

8-601, 8-602, 8-603. SEMINAR: BIOLOGICAL ANTHROPOLOGY. (3 cr per qtr) Murrill

8-950. ADVANCED RESEARCH IN ANTHROPOLOGY (NONTHESIS). (Cr ar)

ARCHITECTURE AND LANDSCAPE ARCHITECTURE

Professor

Ralph E. Rapson, *head*
Walter K. Vivrett, *director of graduate study*
Robert G. Cerny
Roger B. Martin
Valerius L. Michelson
John S. Myers
Leonard S. Parker
Hugh G. Peacock
James E. Stageberg
George C. Winterowd

Associate Professor

Roger D. Clemence
Thomas H. Hodne
Hosni N. Iskander

Assistant Professor

Dennis W. Grebner
Kay M. Lockhart
John G. Rauma
Alan D. Robinette
Milo W. Thompson

Instructor

Robert E. Diedrich
Richard B. Morrill

Prerequisites—Admission is usually limited to students of high academic standing, who show evidence of professional promise and who hold a bachelor of environmental design (B.E.D.) degree as awarded by the University of Minnesota. Admission may also be considered in the case of superior students who hold a degree other than B.E.D., such as bachelor of architecture or bachelor of arts (with a major in architecture). A minimum of 45 credits shall be accomplished in residence at the University of Minnesota, Minneapolis.

Applicants are required to submit examples of their original design work and/or reports or papers for review. These should be addressed to the School of Architecture, 110 Architecture Building, University of Minnesota, Minneapolis, Minnesota 55455.

Applicants may be required to do preparatory work as a condition for admission. Such preparatory work shall not be considered as credits earned toward the M.Arch. degree.

Language Requirement—None.

Master of Architecture Degree—Three programs leading to this degree are offered:

a. *Architecture*—Study in depth at the scale of the single building or group of buildings. Opportunities are provided to pursue one or more concentrations such as: housing; building systems analysis; design and construction; history and theory of architecture; and building functions such as education, recreation, and transportation. Core of this program is contained in Arch 8-251 through 8-256. Problems involving analysis, programming, and design are covered. This program requires completion of 90 graduate credits under Plan B, or a total of 54-72 credits under Plan A with thesis. At least 45 credits of the work offered shall be accomplished in residence at the University of Minnesota.

b. *City Design*—Study of the three-dimensional environment at the scale of the city and the metropolitan area. Emphasis is on breadth, bringing together several of the major disciplines in planning and design. The core of this program is contained in Arch 8-271 through 8-276. Problems involving environmental design, metropolitan and comprehensive planning are covered. This program requires completion of 90 graduate credits under Plan B. At least 45 credits of the work offered shall be accomplished in residence at the University of Minnesota.

c. *Health Care Facilities Design*—Study of emerging patterns of organization and delivery of health services and the facilities which these require. Offered in cooperation with the School of Public Health and its program in hospital and health care administration. This program requires 135 credits of graduate-level work, approximately 30 credits of which must be in public health. Candidates interested in this program should declare their intent as early as possible in their first graduate year.

Candidates will be expected to fulfill the general requirements of the Graduate School for a Master's degree with the following exceptions:

1. A program of study, including courses drawn from one or more departments, will be planned for each student in lieu of the *major* and *minor* requirements.
2. Programs usually will require a minimum of 90 academic credits under Plan B; 54 credits under Plan A.

Architecture (Arch)

5-051. ANCIENT ARCHITECTURE. (4 cr; prereq 1-021)
History of development of architecture and urban design in Egypt, Mesopotamia, Crete, Mycenae, and classic Greece and Rome until the advent of Christianity.

5-052. EARLY MEDIEVAL ARCHITECTURE. (4 cr; prereq 1-021)
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 A.D. 1150.

5-053. GOTHIC ARCHITECTURE. (4 cr; prereq 1-021)
History of development of architecture and urban design in western Europe from A.D. 1150 until A.D. 1400.

5-054. RENAISSANCE AND BAROQUE ARCHITECTURE. (4 cr; prereq 1-021)
History of development of architecture and urban design in Italy, Spain, France, Germany, and the low countries from 1400 until the French Revolution.

5-055. ENGLISH AND EARLY AMERICAN ARCHITECTURE. (4 cr; prereq 1-021)
Pre-Columbian civilizations and development of architecture and urban design in America and England from 1500 until 1865.

5-056. MODERN ARCHITECTURE. (4 cr; prereq 1-021)
History of development of architecture and urban design from early 19th-century sources in Europe and America until the present time.

5-101, 5-102, 5-103. TUTORIAL WORK IN HISTORY OF ARCHITECTURE. (2 cr per qtr; prereq 5-056 or ‡) Winterowd
Reading and written reports on special historical problems.

5-104. SEMINAR: EUROPEAN ARCHITECTURE. (3 cr; prereq 5-056 or ‡)
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 works of Mies van der Rohe.

5-105. SEMINAR: SCANDINAVIAN ARCHITECTURE. (3 cr; prereq 5-056 or ‡)
Survey of Scandinavian architectural history with emphasis upon the origin and development of modern architecture in Denmark, Finland, Norway, and Sweden.

5-106. SEMINAR: AMERICAN ARCHITECTURE. (3 cr; prereq 5-056 or ‡)
Contemporary architecture in the United States from the period of Henry Hobson Richardson until the present time and including the specific contributions of Louis H. Sullivan, Frank Lloyd Wright and his "Prairie School" contemporaries, Eliel and Eero Saarinen, and the later works of Walter Gropius and Mies van der Rohe. Field trip.

5-115/5-116. STRUCTURE AND FORM IN ARCHITECTURE. (4 cr per qtr; prereq AEM 3-092) Michelson
Form as interface between programmatic requirements for environmental change and physical means available to the architect; concentration on physical parameters of statics, mechanics of solids, and three-dimensional manipulation of material to arrive at

logical solutions for given problems of enclosing space; architectural morphology covered through contemporary and ancient examples and experimental work on models; modular and proportional relationships.

5-130. PLANNING: THE DEVELOPMENT OF URBAN FORM. (3 cr; prereq ‡; hrs ar) Iskander
Physical development of urban place from early Middle East urban revolution to the Industrial Revolution, as manifestation of changes in underlying social, political, and economic forces as well as planning theories, if any, to which they gave rise.

5-134, 5-135, 5-136. PLANNING. (3 cr per qtr; prereq ‡) Vivrett, Iskander
Tutorial work in community facilities and housing.

5-137. PLANNING: URBAN FORM AND STRUCTURE. (4 cr, §5-132; prereq ‡) Iskander
Exploration of economic, technological, and social factors which 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.

5-138. PLANNING: THEORY AND METHODOLOGY. (4 cr, §5-131; prereq 5-137 or ‡) Iskander
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.

5-139. PLANNING: HOUSING AND URBAN SERVICES. (4 cr, §5-133; prereq 5-138 or ‡) Iskander
Definition of problems of housing, transportation, and other subsystems of urban services. Evaluation of society's goals, private efforts, and public programs designed to meet the needs in these areas. The role of technology as it affects problems and solutions.

5-150. INSTITUTIONAL PLANNING. (2 cr; prereq 5-113, ‡) Vivrett

5-151, 5-152, 5-153. THEORY OF ARCHITECTURE. (2 cr per qtr; prereq ‡) Rapson and visiting lecturers
Architecture in philosophical and theoretical context.

5-170. CITYSCAPE. (3 cr; prereq 5-093 or ‡; hrs ar) Clemence
The city and its components as aesthetic elements; factors which have helped to generate urban form.

5-171/5-172. URBAN FORM. (3 cr per qtr; prereq 5-113, 5-138) Vivrett
Principles and techniques involved in city design.

5-970. DIRECTED STUDY. (Cr ar; prereq ‡)
Areas of study useful to individual program objectives not available in regular course offerings.

8-201, 8-202, 8-203. SPECIAL RESEARCH IN ARCHITECTURAL HISTORY. (Cr ar; prereq 3-056 or ‡) Winterowd

8-231, 8-232, 8-233. PLANNING. (Cr ar) Iskander, Rapson, Vivrett
Individual problems and research in planning.

8-251, 8-252, 8-253, 8-254, 8-255, 8-256. ARCHITECTURAL DESIGN. (9 cr) Cerny, Clemence, Iskander, Rapson, Vivrett
Problems involving analysis, program, and design; individual and collaborative effort.

8-261, 8-262, 8-263. SELECTED PROBLEMS IN ARCHITECTURE. (Cr ar; prereq minimum of 12 cr in 8-251, 8-252, 8-253, 8-271, 8-272, 8-273) Cerny, Rapson, Vivrett
Advanced architectural design problems; research and development of significant architural form. Individual and collaborative effort.

8-271, 8-272, 8-273, 8-274, 8-275, 8-276. PROBLEMS IN CITY AND COMMUNITY DESIGN. (9 cr per qtr) Clemence, Hodne, Iskander, Martin, Rapson, Thompson, Vivrett
Studies in the development of city spaces and urban character as they relate to changing socioeconomic needs and advancing technologies.

Landscape Architecture (LA)

5-010. PRINCIPLES OF OUTDOOR RECREATION DESIGN AND PLANNING. (4 cr; 4 lect hrs per wk)
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.

5-101/5-102. SITE PLANNING AND DESIGN I AND II. (6 cr per qtr; 2 lect and 12 lab hrs per wk)
Case study analysis and design of site organizational systems.

5-103/5-104. URBAN LANDSCAPE DESIGN I AND II. (6 cr per qtr; 2 lect and 12 lab hrs per wk)
Case study analysis and design of urban environments.

5-105/5-106. RECREATIONAL PLANNING AND DESIGN I AND II. (6 cr per qtr; prereq 5-010; 2 lect and 12 lab hrs per wk)
Analysis development and presentation of landscape design solutions for diverse recreational land use.

5-107/5-108. REGIONAL LANDSCAPE DESIGN. (6 cr per qtr; prereq 3-092; 3 lect and 12 lab hrs per wk)
Emphasis placed on the study of large-scale land areas. Analyzing development potential and evolving solutions for integration of divergent land use patterns such as agricultural, residential, commercial, industrial, and recreational.

5-110. ADVANCED LANDSCAPE PLANNING AND DESIGN. (6 cr; prereq terminal qtr; 2 lect and 12 lab hrs per wk)
Advanced studies in area of students' option.

5-115/5-116. THEORY OF LANDSCAPE FORM AND STRUCTURE. (2 cr per qtr; prereq 3-091 or ‡; 4 discussion hrs per wk)
Studies in landscape perception; lecturers, discussions, and exercises in application of abstract design principles to the assessment of land developments; review of psychological and social implications of land developments; exploration of design potential of landscape materials; investigation of contemporary problems in land development including all scales and types of land uses.

5-121/5-122. LANDSCAPE ARCHITECTURAL DESIGN. (6 cr per qtr; prereq ‡; 1 lect and 15 lab hrs per wk)
Research analysis and design of large-scale land development problems. Urban design and regional design collaboratives with fellow design professions and technical disciplines.

5-124. LANDSCAPE ARCHITECTURAL SEMINAR. (1 cr; prereq terminal yr of study)
Analysis of design principles and goals in modern society. Review of current site development projects. Investigation in depth into specific areas of land development.

5-131/5-132/5-133. SELECTED PROBLEMS IN LANDSCAPE ARCHITECTURE. (Cr ar; prereq ‡) Martin

5-175. LANDSCAPE TECHNOLOGY II. (4 cr; 2 lect and 6 lab hrs per wk)
Lectures, exercises, and projects in materials and construction techniques and working document preparation.

5-226. 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.

5-262. HISTORY AND LITERATURE OF LANDSCAPE ARCHITECTURE. (4 cr; 4 lect hrs per wk)
Search for design principles as expressed in landscape created by man from ancient times to contemporary period. Specific focus on analysis of the visual form of environments as outgrowths of geographical, cultural, and technological determinants.

ART HISTORY (ArtH)

Professor
Carl D. Sheppard, *chairman*
Melvin Waldfogel, *director of graduate study*
Norman W. Canedy
Marion J. Nelson
Sidney Simon
Donald R. Torbert

Associate Professor
Sheila McNally
Robert J. Poor

Assistant Professor
Frederick Asher
Frederick Cooper
M. Alison Stones
Michael Stoughton

Prerequisites—Undergraduate preparation of approximately 27 Upper Division credits in the history of art or their equivalent. In some cases prerequisites can be completed concurrently with graduate work.

Language Requirement—For the two Master's degrees, reading knowledge of one foreign language, French or German. For the Ph.D. degree, two foreign languages, preferably French and German.

Master of Arts Degree in Art History—Plan B only.

Requirements for the Major: 30 credits in art history, including one course in each of three of the following subfields: ancient, medieval, Renaissance/baroque, 19th and 20th centuries.

Methodology: Students who do not have course work in the methodology of art history on their entrance record must include one on their Master's program.

Related Fields: Of the 18 credits in related fields required by the Graduate School, 12 may be taken in courses in art history selected from any of the following subfields not included in the student's major: American, Scandinavian, East Asian, South Asian, methodology-bibliography. Recommended related fields outside the department are: anthropology, classics, English, foreign languages and literatures, history, studio arts. A minimum of 6 credits is required in each of two related fields or subfields.

Seminars: The art history courses on the program must include two seminars on different topics and from different instructors.

Starred Papers: The three starred papers will be for three different professors and from at least two subfields.

Master of Arts Degree in Museology—This program places special emphasis on professional preparation for work in art museums. The candidate must have the equivalent of an undergraduate major in art history (approximately 27 quarter credits of Upper Division courses). Students for this degree (offered under Plan B) are not admitted directly into the program in museology but as graduate students majoring in art history. The decision as to acceptance for candidacy for the degree in museology will be made at the end of the first year's work. A very limited number of candidates can be accepted.

To earn the degree a candidate must offer 50 credits of course work, of which 30 will be earned in art history, including one course of methodology, and 21 additional credits of museology courses, the first 6 of which are in an intensive introductory seminar and the remaining 15 of which comprise the internship program. This consists of supervised work and training for 4 hours a day over a 9-month period in one or more of the participating museums. The specific area or areas of emphasis in the internship is arrived at in consultation among the student, the director of the museology program, and representatives of the participating museums.

Doctor's Degree—*Prerequisites*: Before admission to Ph.D. candidacy, the student must have passed the departmental Master's examination. Students who have a Master's degree from another institution or from another department at the University of Minnesota are required to pass the equivalent of the departmental Master's examination.

Language Requirement: Both French and German, although substitutions of other languages may be made after consultation with the department and by petition to the Graduate School.

Subfields: Within the field of art history the subfields offered for the Ph.D. are: ancient, medieval (including Scandinavian), Renaissance/baroque, modern (including American and Scandinavian), and Oriental.

5-102. GREEK SCULPTURE. (4 cr, §Clas 5-102; prereq jr or ‡) Coulson
Styles and techniques of Greek sculpture from the archaic period down to the end of the fourth century B.C. Emphasis on sculptors and styles of the various schools throughout Greece, Sicily and southern Italy, and Asia Minor.

5-103. HELLENISTIC ART AND ARCHAEOLOGY. (4 cr, §Clas 5-103; prereq jr or ‡) Coulson
Greek architecture, sculpture, ceramics, painting, and minor arts from the beginning of the fourth century B.C. to the end of the Hellenistic period. Attention paid to city planning, public buildings, and topography of such sites as Athens, Olynthos, Corinth, Priene, Pergamon.

5-104. ROMAN ARCHITECTURE. (5 cr, §Clas 5-104; prereq 1-008 or 3-008 or 3-162) Cooper, McNally
Types and techniques of buildings in the city of Rome and throughout the Empire from the fifth century B.C. to the fourth century A.D. Includes discussion of major archaeological sites.

5-105. ROMAN PAINTING AND MOSAICS. (5 cr, §Clas 5-105; prereq 1-008 or 3-008 or 3-162) McNally
General introduction to Roman painting and mosaics followed by discussion of specific problems and of sites such as Pompeii and Antioch.

5-106. GREEK PAINTING. (5 cr, §Clas 5-106; prereq 5-102 or 5-103; offered every third year) McNally
Methods of research and analysis in classical art and applied to study of vases; investigation of original objects and of sources.

5-107. ROMAN SCULPTURE. (4 cr, §Clas 5-107; prereq 1-008 or 3-008 or 3-162) Cooper, McNally
Sculpture from Rome and its provinces from the first century B.C. to the fourth century A.D. with special emphasis on the role of sculpture in Roman politics and religion.

5-108. GREEK ARCHITECTURE. (4 cr, §Clas 5-108; prereq 1-008 or 3-008 or 3-152) Cooper, McNally
Archaic and classical examples of religious and secular architecture with special consideration of their setting in major archaeological sites.

5-109. INTRODUCTION TO ETRUSCAN ART AND ARCHITECTURE. (4 cr, §Clas 5-109; prereq jr or ‡) Coulson
Survey of the architecture, sculpture, painting, and minor arts of Etruscans. Attempt to place this art into its political, religious, and social setting. Brief attention paid to methods of Etruscan archaeology.

5-203. EARLY MEDIEVAL ART. (4 cr; prereq 3-009, grad or ‡) Sheppard
Survey of architecture, sculpture and painting, and selected minor arts of the Mediterranean world and of western Europe from Early Christian to Romanesque period.

5-213. INTERNATIONAL GOTHIC PAINTING AND SCULPTURE. (5 cr; prereq 4 cr medieval art history or ‡; offered alt yrs) Stones
Patronage in major centers of culture: Prague, London, Milan, Paris, and Burgundy in relation to the artistic production of the late 14th and early 15th centuries.

5-214. GOTHIC ARCHITECTURE. (5 cr; prereq 4 cr medieval art history or ‡; offered alt yrs) Sheppard, Stones
Gothic architecture from the mid-12th to the early 16th century in France, Germany, England, Italy, and Spain with special consideration of later regional variants produced.

5-215. ROMANESQUE AND GOTHIC PAINTING. (5 cr; prereq 4 cr medieval art history or ‡; offered alt yrs) Stones
Wall and panel painting, mosaics, and manuscript illumination in France, Germany, England, Italy, and Spain from the 11th to the 14th centuries.

5-234. EARLY AND HIGH GOTHIC SCULPTURE. (4 cr; prereq 3-009, grad or ‡) Steyaert
Developments in style and iconography of Gothic sculpture with emphasis on France and Germany.

5-252. BYZANTINE ART. (5 cr; prereq 5-203 or ‡) Sheppard
Architecture, sculpture, and painting in the Eastern Christian regions from the foundation to the fall of Constantinople in the 15th century, with reference to its impact on the West.

5-253. ROMANESQUE SCULPTURE. (4 cr; prereq 9 cr art history or ‡) Sheppard
Sculpture as developed in France and Italy in the 11th century and manifested throughout Europe in the 12th and early 13th centuries.

5-261. THE ILLUMINATED BOOK. (5 cr; prereq 4 cr medieval art history or ‡; offered alt yrs) Stones
Techniques involved in production of illuminated books in the Middle Ages and evolution in types of books, decorative schemes, and style.

5-306. 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.

5-307. FIFTEENTH-CENTURY ITALIAN ARCHITECTURE, SCULPTURE, AND PAINTING. (4 cr; prereq 3-011 or ‡) Canedy
Early Renaissance art from Brunelleschi to Bellini with emphasis on development of the "repertory" of monument types which survived to modern times.

5-313. ITALIAN HIGH RENAISSANCE ARCHITECTURE, SCULPTURE, AND PAINTING. (4 cr; prereq 3-011, grad 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.

5-314. LATER 16TH-CENTURY ITALIAN ARCHITECTURE, SCULPTURE, AND PAINTING. (4 cr; prereq 5-313, grad or ‡; offered alt yrs) Canedy
Mannerism and other trends from the High Renaissance to the baroque.

5-315. DRAWINGS AND GRAPHICS OF THE RENAISSANCE. (4 cr; prereq 5-307 or 5-313, grad or ‡; offered alt yrs) Canedy
History of drawings and graphics from the early Renaissance to the baroque. Original works will be utilized.

5-323. LATE GOTHIC AND RENAISSANCE SCULPTURE IN NORTHERN EUROPE. (4 cr; prereq 3-009, grad or ‡) Steyaert
Sculpture in Germany, France, and the Netherlands from the 14th to the 16th century.

5-324. FIFTEENTH-CENTURY PAINTING IN NORTHERN EUROPE. (4 cr; prereq 3-009, grad or ‡) Steyaert
Painting in the Netherlands, France, and Germany during the late Gothic period and its influences.

5-326. SIXTEENTH-CENTURY PAINTING IN NORTHERN EUROPE. (4 cr; prereq 3-011, grad or ‡) Steyaert
Northern Renaissance painting in Germany, the Netherlands, and France.

5-328. FLEMISH "PRIMITIVES." (4 cr; prereq 5-326 or ‡) Steyaert
In-depth consideration of Flemish 15th-century painting, with special emphasis on works of Van Eyck, Campin, Van der Weyden, and their followers (Christus, Bouts, Van der Goes, Memling, David).

5-346. BAROQUE ART IN ITALY AND SPAIN. (5 cr; prereq 3-011, grad or ‡; offered alt yrs) Stoughton
Italian sculpture, painting, and architecture and Spanish painting of the 17th century.

5-347. BAROQUE ART IN ENGLAND, FRANCE, AND LOWLANDS. (5 cr; prereq 3-011, grad 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.

5-357. EIGHTEENTH-CENTURY ART IN FRANCE. (4 cr, §3-303; prereq 3-011, grad or ‡; offered alt yrs) Stoughton
Rococo and neoclassical art and architecture in France. Emphasis on painting (Watteau, Boucher, Fragonard, Chardin, David) with some consideration of prints and decorative arts.

5-358. EIGHTEENTH-CENTURY ART IN ITALY, GERMANY, AUSTRIA. (4 cr; prereq 3-011, grad or ‡; offered alt yrs) Stoughton
Survey of architecture, sculpture, and painting with some consideration of prints.

5-441. EARLY 19TH-CENTURY EUROPEAN PAINTING. (5 cr, §5-431; prereq 3 cr art history, 19th-century history, literature or ‡; offered alt yrs) Waldfogel
Neoclassicism: the impact of the new understanding of the past, personality, and nature on art and the artist's response to technology and the new social and political structures.

5-442. TOPICAL STUDIES IN EARLY 19TH-CENTURY EUROPEAN PAINTING. (5 cr; prereq 5-441; offered alt yrs) Waldfogel
Selected themes from ArtH 5-441.

5-443. LATER 19TH-CENTURY EUROPEAN PAINTING. (5 cr, §5-432; prereq 3 cr art history, 19th-century history, literature or ‡; offered alt yrs) Waldfogel
Realism and aestheticism; Ruskinian and French realism, socialism, and urbanism; avant-garde and art for art's sake as a program; fin de siecle and escapism.

5-444. TOPICAL STUDIES IN LATER 19TH-CENTURY EUROPEAN PAINTING. (5 cr; prereq 5-443; offered alt yrs) Waldfogel
Selected themes from ArtH 5-443.

5-463. EARLY 20TH-CENTURY PAINTING. (5 cr, §5-433, §5-434; prereq 3-012, grad or ‡) Simon
Topics and/or movements in modern painting mainly prior to the mid-1920's. Material or subjects dealt with in class vary but course content, taken as a whole, remains constant. Extensive readings. Papers.

5-464. LATER 20TH-CENTURY PAINTING. (5 cr, §5-435; prereq 5-463 or ‡; offered alt yrs) Simon
Topics and/or movements in modern painting mainly after the mid-1920's. Material or subjects dealt with in class vary with each offering, but course content, taken as a whole, remains constant. Extensive readings. Papers.

5-465. MODERN SCULPTURE. (5 cr, §5-438; prereq 3-012 or two art history courses; offered when feasible) Simon
Introduction to modern sculpture from Rodin to the present. Major trends and monuments. Extensive readings. Papers.

5-466. THE AVANT GARDE. (5 cr; prereq 3-012 or 5-463 or ‡; offered alt yrs) Simon
History and theory of the "avant-garde" as applied to problems of contemporary art. Contributions of the thought of McLuhan, Buckminster Fuller, Cage, Greenberg, Sontag, as well as rock music. Influence of the "counter-culture."

5-467. MODERN ART CRITICISM. (5 cr; prereq 5-463 or 5-464 or ‡; offered alt yrs) Simon
Major critical approaches to modern art. Special emphasis on problems of contemporary critical writing. Criticism workshop. Analysis of works of most influential contemporary working critics.

5-535. ART IN THE UNITED STATES. (4 cr, §3-448; prereq 3 cr art history or ‡; offered alt yrs) Cooper, Torbert
Painting and sculpture in the United States. Selected key works and artists from early settlement through early 20th century.

5-536. TOPICAL STUDIES: ART IN THE UNITED STATES. (5 cr; prereq 5-535 or ‡; offered alt yrs) Cooper, Torbert
Proseminar dealing with selected problems in American painting and sculpture from their origins to early 20th century.

5-545. AMERICAN ARCHITECTURE. (5 cr; prereq sr, grad or ‡; offered alt yrs) Torbert
American building and European traditions that influenced it from earliest settlement through revivals to about 1890.

5-547. MODERN AND EUROPEAN ARCHITECTURE. (5 cr; prereq sr, grad or ‡; offered alt yrs) Torbert
Development of modern architecture on the international scene with particular reference to influence on work in United States (Sullivan, Wright, Behrens, Gropius, Mies, Le Corbusier, Perret, Saarinen, Brewer, Nervi, Torroja, Candela, etc.).

5-641. SCANDINAVIAN ART OF THE 19TH AND 20TH CENTURIES. (5 cr; prereq 3-012 or 3-467, grad or ‡) Nelson
Painting, sculpture, architecture, and decorative arts, with emphasis on the rise of expressionism in the fine arts and on "Scandinavian Modern" in design.

5-643. PREHISTORIC ART OF NORTHERN EUROPE. (4 cr; prereq 4 cr art history or ‡) Nelson
Art north of the Alps from the Ice Age through the Celtic period. Includes cave painting, sculpture, funerary architecture, ceramics, and metalwork.

5-644. MEDIEVAL ART OF SCANDINAVIA. (4 cr; prereq 3-009, grad or ‡) Nelson
Migration, Viking, and Christian art in Scandinavia from the 5th through the 15th centuries. Includes architecture, sculpture, painting, and metalwork.

5-645. FOLK ARTS OF SCANDINAVIA. (4 cr, §3-655; prereq 4 cr art history or ‡; offered alt yrs) Nelson
Wood carving, metalwork, decorative painting, weaving, stitchery, and domestic architecture of rural Scandinavia with emphasis on its origins in pagan and medieval art.

5-725. 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.

5-765. EARLY CHINESE ART. (5 cr; offered alt yrs) Poor
Development of ancient ceramics and ritual bronzes, early Buddhist sculpture, and early Chinese painting.

5-766. 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.

5-767. JAPANESE PAINTING. (4 cr; offered alt yrs) Poor
Japanese pictorial arts from earliest to modern times; works which best exemplify development of indigenous traditions.

5-769. CONNOISSEURSHIP IN ORIENTAL ART. (5 cr; prereq ‡; offered alt yrs) Poor
Direct examination of Oriental art objects in local collections.

5-775. EARLY INDIAN ART. (4 cr; prereq 4 cr art history or ‡) Asher
Sculpture and architecture of India from the Indus Valley Civilization through the Kushana Period.

5-776. LATER INDIAN ART. (4 cr) Asher
Sculpture and architecture of India from the Gupta period through the 12th century.

5-777. PAINTING OF INDIA. (4 cr) Asher
Entire history of Indian painting beginning with the early tradition of mural painting but concentrating primarily on miniature painting of the 12th century onward.

5-895. METHODOLOGY I. (4 cr; prereq art history major or ‡)
Problems concerned with the use of bibliographies of various art historical periods. Work with all types of reference and source materials. Proseminar.

5-911. ASPECTS OF ARCHITECTURE, SCULPTURE, AND PAINTING OF PRE-COLUMBIAN AMERICA. (5 cr; prereq sr, grad or ‡) Torbert
Aspects of architecture, sculpture, and painting, principally in Mexico and Guatemala with emphasis on Olmec and Maya cultures.

5-921, 5-922, 5-923. ART OF THE FILM. (4 cr per qtr; prereq ‡; offered when feasible)
Aesthetics of the film. Editing, montage, sound, use of the camera, etc.

5-959. SUMMER TRAVEL COURSE IN EUROPEAN ART. (6 cr, §3-059; prereq ‡) Torbert
See description for ArtH 3-059.

5-970. DIRECTED READINGS. (1-5 cr per qtr; prereq ‡) Staff

5-990. DIRECTED RESEARCH. (1-5 cr; prereq sr, ‡) Staff

8-114. SEMINAR: TOPOGRAPHY OF ATHENS. (3 cr, §Clas 8-114; prereq ‡) Coulson

8-151. TOPOGRAPHY OF ANCIENT ROME. (3 cr; prereq ‡) McNally

8-190. PROBLEMS IN CLASSICAL ART. (3 cr; prereq ‡) Cooper, McNally

8-191. SEMINAR: PROBLEMS IN CLASSICAL ART. (3 cr; prereq 8-190, ‡) Cooper, McNally

8-200. SEMINAR: PROBLEMS IN MEDIEVAL SCULPTURE. (3 cr; prereq ‡) Sheppard

8-201. SEMINAR: PROBLEMS IN MEDIEVAL SCULPTURE. (3 cr; prereq 8-201, ‡) Sheppard

8-220. MANUSCRIPT ILLUMINATION. (3 cr; prereq 5-213, 5-324 or ‡) Stones

8-221. SEMINAR: MANUSCRIPT ILLUMINATION. (3 cr; prereq 8-220, ‡) Stones

8-230. SEMINAR: PROBLEMS IN MEDIEVAL ART. (3 cr; prereq ‡) Sheppard

8-231. SEMINAR: PROBLEMS IN MEDIEVAL ART. (3 cr; prereq 8-230, ‡) Sheppard

8-320. PROBLEMS IN NORTHERN RENAISSANCE ART. (3 cr; prereq 9 cr art history or ‡) Staff

8-321. SEMINAR: PROBLEMS IN NORTHERN RENAISSANCE ART. (3 cr; prereq 8-320, ‡) Staff

8-330. SEMINAR: PROBLEMS IN ITALIAN RENAISSANCE ART. (3 cr; prereq one Renaissance art history course) Canedy

8-331. SEMINAR: PROBLEMS IN ITALIAN RENAISSANCE ART. (3 cr; prereq 8-330, ‡) Canedy

8-340. SEMINAR: PROBLEMS IN BAROQUE ART. (3 cr; prereq ‡) Staff

8-341. SEMINAR: PROBLEMS IN BAROQUE ART. (3 cr; prereq 8-340, ‡) Staff

8-400. NINETEENTH-CENTURY ART. (3 cr; prereq ‡) Waldfogel

8-401. SEMINAR: 19TH-CENTURY ART. (3 cr; prereq 8-400, ‡) Waldfogel

8-440. TWENTIETH-CENTURY ART. (3 cr; prereq ‡) Simon, Torbert

8-441. SEMINAR: 20th-CENTURY ART. (3 cr; prereq 8-440, ‡) Simon, Torbert

8-520. AMERICAN ART. (3 cr; prereq ‡) Torbert

8-521. SEMINAR: AMERICAN ART. (3 cr; prereq 8-520, ‡) Torbert

8-650. SEMINAR: STUDIES IN SCANDINAVIAN ART. (3 cr; prereq ‡) Nelson

8-651. SEMINAR: STUDIES IN SCANDINAVIAN ART. (3 cr; prereq 8-650, ‡) Nelson

8-660. SEMINAR: PREHISTORIC EUROPE. (3 cr; prereq 5-643, 5-655, or ‡) Nelson
Limited topics or problems in art of prehistoric Europe.

8-661. SEMINAR: PREHISTORIC EUROPE. (3 cr; prereq 8-660, ‡) Nelson

8-720. SEMINAR: ORIENTAL ART. (3 cr; prereq ‡) Poor

8-721. SEMINAR: ORIENTAL ART. (3 cr; prereq 8-720, ‡) Poor

8-770. SEMINAR: ART OF INDIA. (3 cr; prereq ‡) Asher

8-771. SEMINAR: ART OF INDIA. (3 cr; prereq 8-770, ‡) Asher

8-801. METHODOLOGY II. (3 cr; prereq 5-895 or ‡)
History of art history and study of contemporary philosophies of art history and criticism.

8-810. BIBLIOGRAPHY. (3 cr; prereq ‡) Staff

8-994. MUSEOLOGY I: INTRODUCTION TO MUSEUM PRINCIPLES AND PRACTICES. (6 cr; required for candidates for M.A. in museology; prereq △) Simon and staff
Intensive investigation of museum history, bibliography, organization, and current problems. Lectures and discussions supplemented by field trips to observe museum operations and to meet with museum personnel.

8-995/8-996/8-997. MUSEOLOGY II, III, IV. (5 cr per qtr; required of candidates for M.A. in museology; prereq △) Sheppard
Apprenticeship program in museum practices. Four hours a day internship activity in various departments of museums participating in the program—education, conservation, curatorial (painting, sculpture, decorative arts, design, prints, and drawings).

ASTRONOMY AND ASTROPHYSICS (Ast)

Professor
Neville J. Woolf, Ph.D., *director of the observatories*
Karlis Kaufmanis, Ph.D.
Edward P. Ney, Ph.D.

Associate Professor
Philip M. Solomon, Ph.D.
Wayne A. Stein, Ph.D.

The University of Minnesota operates three observatories. There is a student observatory with a 10½-inch refractor on campus. A 30-inch reflector is used for infrared observation at the O'Brien Observatory, Marine on St. Croix, Minnesota. A 60-inch telescope at 9,100 feet on Mt. Lemmon, Tucson, Arizona, is operated jointly with the University of California.

Prerequisites—For major work, Ast 3-051, differential and integral calculus, and 2 years of college physics. For minor work, Ast 3-051, differential and integral calculus, and 1 year of college physics.

Language Requirement—M.S. and Ph.D. candidates must demonstrate proficiency in one foreign language by:

a. Passing the Graduate School Foreign Language Test, *or*
b. Obtaining a certificate of proficiency from a University of Minnesota foreign language department, *or*
c. Presenting evidence of 1 year's college credit in the foreign language with an average grade of B or higher, *or*
d. Presenting evidence of college credit in the foreign language for the third quarter of a 3-quarter sequence, or the second semester of a 2-semester sequence, or in a more advanced course, in each case with a grade of B or higher.

Refer to the language requirement in the section on Physics for further details.

Master's Degree—Offered under Plans A and B in astronomy.

Doctor's Degree—Candidates for the Ph.D. degree in astrophysics will be expected to pass qualifying examinations as determined by the chairman of the School of Physics and Astronomy before admission to the preliminary examination. As part of the program for the Ph.D., Phys 5-051/5-052/5-053, 5-151/5-152/5-153 and one advanced seminar sequence are required.

Minor Requirement—An M.S. or Ph.D. candidate satisfies the minor requirement by taking courses in one or two fields outside the field of specialization. The M.S. Plan A program requires 9 minor credits. The M.S. Plan B and Ph.D. programs require 18 minor credits. For the Master's, these are distributed between at least two fields of no less than 6 credits each.

5-161.* ASTROPHYSICS OF DIFFUSE MATTER. (3 cr; prereq 3-051 and Phys 3-501 or ‡)
Diffuse matter in the solar system, interstellar and extragalactic space, and the radiation field in these environments. Gaseous nebulae, radio astronomy and nonthermal radio sources, cosmic rays, and some aspects of cosmology.

5-162.* ASTROPHYSICS OF CONDENSED MATTER. (3 cr; prereq 3-051, Phys 3-501, or ‡)

8-200.* SEMINAR. (1-3 cr per qtr)
For students who are prepared for advanced work along specific lines.

Phys 8-163/8-164.* PLASMA PHYSICS

Phys 8-400.* SEMINAR: COSMIC RAY AND SPACE PHYSICS

Phys 8-411/8-412.* COSMIC RAY AND SPACE PHYSICS

Phys 8-421/8-422.* SOLAR AND MAGNETOSPHERIC PHYSICS

Phys 8-481/8-482/8-483.* ASTROPHYSICS

Phys 8-990. RESEARCH IN PHYSICS

BIOCHEMISTRY

Graduate training leading to the M.S. and Ph.D. degrees in biochemistry is offered in each of two biochemistry departments, one in the College of Biological Sciences and the other in the Medical School. The two departmental programs, however, are closely coordinated through an interdepartmental committee, and, except for minor differences in detail, the graduate program in biochemistry can be considered to be a single entity.

Prerequisites—For major work candidates must offer courses in analytical, organic, and physical chemistry equivalent to those contained in an American Chemical Society approved curriculum. In addition the student is required to have at least 1 year of college physics, mathematics through integral calculus, and 1 year of biology (general, botany, zoology, microbiology, and genetics). Students may be permitted to make up deficiencies in these requirements in the course of completing their graduate program. Candidates for Master's degree in biochemistry and those seeking a Ph.D. degree with a minor in biochemistry may be admitted with less rigorous requirements.

Major—Both biochemistry departments require completion of the core curriculum (5-741/5-742/5-743 or their equivalent) accompanied by the laboratory program in the respective departments. Additional courses in physical and organic chemistry, advanced biochemistry, and biology are required as described below for each department. Students will also be expected to participate in the graduate seminar programs of their respective departments.

The Ph.D. degree also requires a minor field of study which may be chosen from biophysics, botany, chemistry, genetics, microbiology, physiology, zoology, or other suitable fields, or a "supporting program" generally made up by more than one discipline. Approximately 20 credits of course work are required; the actual number is determined by choice of minor or supporting program.

Minor—The requirements for a minor in biochemistry include the core curriculum plus advanced courses in biochemistry to give a total of approximately 20 credits. Two quarters of physical chemistry (5-501/5-502 or 5-520/5-521 or their equivalent) are a prerequisite for a minor. A student who has not had physical chemistry may take it concurrently with the other courses, but it will not be counted as part of the 20 credits.

Supporting Program—The supporting program is designed to allow maximum flexibility in satisfying individual interests and needs. Those desirous of a supporting program involving biochemistry should work out a suitable program through the graduate directors of the respective biochemistry departments.

Master's Degree—Offered only under Plan A.

Language Requirement—A reading knowledge of one foreign language is required for the Ph.D. degree; generally the language is selected from among French, German, or Russian. In special cases some other language in which a significant literature in biochemistry is published may be substituted by petition.

Preliminary Examinations—Written preliminary examinations for the Ph.D. degree are given once or twice a year.

Note—Graduate study in biochemistry is also offered at the Mayo Graduate School of Medicine of the University of Minnesota, Rochester, Minnesota. The requirements outlined above also apply to this program. Consult the *Graduate Programs in the Health Sciences Bulletin.*

Biochemistry (BioC)

(College of Biological Sciences)

Professor

LaVell M. Henderson, Ph.D. *head, director of graduate study*
Stanley Dagley, D.Sc.
John E. Gander, Ph.D.
Robert Jenness, Ph.D.
Samuel Kirkwood, Ph.D.
Irvin E. Liener, Ph.D.
Walter O. Lundberg, Ph.D.[1]
Palmer Rogers, Ph.D.[2]
Hermann Schlenk, Ph.D.[1]
Max O. Schultze, Ph.D.
Ulysses S. Seal, Ph.D.[3]

Associate Professor

Victor A. Bloomfield, Ph.D.
Peter J. Chapman, Ph.D.
Robert L. Glass, Ph.D.
Rex E. Lovrien, Ph.D.
Huber R. Warner, Ph.D.

Assistant Professor

John S. Anderson, Ph.D.
Ronald E. Barnett, Ph.D.[4]
Kenneth G. Mann, Ph.D.[5]

Proficiency Examinations—All students are required to take proficiency examinations in analytical, organic, and physical chemistry. These examinations are offered at the time of admission and are used as a guide in the selection of graduate courses.

Requirements for the Ph.D. Degree—Students working for the Ph.D. degree must satisfactorily complete 1 year of graduate biochemistry (BioC 5-741 to 5-747 or its equivalent), 1 quarter of graduate organic chemistry (e.g. Chem 8-301), 1 quarter of a graduate physical chemistry course, two further courses in any field of chemistry, and at least 6 credits in selected advanced courses in biochemistry (in either of the biochemistry departments of the University).

All students must have on their record 6 hours of credit in Upper Division and/or graduate level biology courses.

With the approval of the adviser, courses in various fields of mathematics, physics, chemistry, biology, agricultural, and medical sciences may be included as part of the major course of study.

Beginning graduate students are required to enroll in the orientation seminar (BioC 8-091) during their first quarter in residence. This seminar is designed to acquaint the student with the research program of each staff member so that an adviser can be selected early in the winter quarter for the first year. In subsequent quarters all graduate students are expected to participate continuously in the graduate student seminar (BioC 8-094) which deals with research and literature reports, and in the departmental seminar (BioC 8-194) which features staff, visitors, and students who are nearing completion of theses.

Registration for BioC 8-091 (1 credit), 8-094 (4 credits), and 8-194 (2 credits) is required for the Ph.D. degree and should be registered for during the first 2 years to complete the program of study before the preliminary examinations.

5-001w/5-002s. INTRODUCTION TO BIOCHEMISTRY. (4 cr per qtr; prereq Chem 3-302 or # [students with grade of A or B in Biol 3-021 may be exempted from 5-001]; 3 lect, 3 lab hrs per wk)

Introduction to fundamentals of composition, chemical properties, reactions, and interactions of biological materials; these are illustrated in part through laboratory exercises performed by student.

---

[1] Member of the Hormel Institute staff.

[2] Primary appointment in Department of Microbiology.

[3] Member of Veterans Administration Hospital staff.

[4] Primary appointment in Department of Chemistry.

[5] Primary appointment at Mayo Clinic, Rochester, Minnesota.

5-522f. BIOPHYSICAL CHEMISTRY: STRUCTURE. (4 cr, §Chem 5-522; prereq 2 qtrs physical chemistry...BioC 5-741 or 5-002 desirable)
Methods of structure determination of biological macromolecules. Molecular weight determination, hydrodynamics, scattering and diffraction, optical and magnetic resonance spectroscopy. Application to proteins, nucleic acids, and synthetic analogs.

5-523w. BIOPHYSICAL CHEMISTRY: ENERGETICS. (3 cr, §Chem 5-523; prereq 2 qtrs physical chemistry...BioC 5-741 or 5-002 desirable)
Energetics of biochemical reactions. Titration, binding, and folding stabilization in macromolecules. Conformational changes and cooperative behavior. Coupling and energy gradients in transport.

5-524s. BIOPHYSICAL CHEMISTRY: DYNAMICS. (4 cr, §Chem 5-524; prereq 2 qtrs physical chemistry...BioC 5-741 or 5-002 desirable)
Application of thermodynamics, statistical mechanics, and chemical kinetics to biological systems. Theoretical and experimental enzyme kinetics, solvent effect, structure-function relation.

5-741f/5-742w/5-743s. GENERAL BIOCHEMISTRY. (3 cr per qtr, §MdBc 5-741/5-742/5-743; prereq Chem 3-303 or equiv, Chem 5-501 or Chem 5-520 or equiv or ¶Chem 5-501 or ¶Chem 5-520, or ‡)
Introductory course for biochemistry majors and minors, offered jointly by the two departments of biochemistry (College of Biological Sciences and Medical School). Integrated lectures and readings on structure and function of biomolecules and on intermediate metabolism and regulation.

5-745f/5-746w. GENERAL BIOCHEMISTRY LABORATORY. (3 cr per qtr; prereq 5-741/5-742, cr in analytical chemistry and ‡)
Laboratory course to accompany BioC 5-741/5-742.

5-747s. ADVANCED BIOCHEMICAL TECHNIQUES. (3 cr; prereq 5-746, ¶5-743, ‡)
Laboratory in modern methods for study of enzymatic and metabolic reactions.

5-970. DIRECTED STUDIES. (1-3 cr; prereq ‡, △)
Offered to enable students to make up certain deficiencies in background course work.

8-091. GRADUATE STUDENT ORIENTATION. (1 cr)
To acquaint first-year graduate students with current areas of research in department.

8-094. RESEARCH AND LITERATURE REPORTS. (1 cr)
Consideration of current developments in biochemistry.

8-194. GRADUATE SEMINAR. (1 cr; prereq △)
Reports on recent developments in biochemistry and on research projects in department.

8-211s. ADVANCED CARBOHYDRATE CHEMISTRY. (2 cr, §MdBc 8-220; prereq 5-743; offered 1972-73 and alt yrs)
Lectures and assigned reading on composition, structure, chemical and physical properties, and biochemical functions of carbohydrates.

8-221s. ADVANCED ENZYME CHEMISTRY. (2 cr; prereq 5-743; offered 1972-73 and alt yrs)
Lectures and assigned reading on nature and function of enzymes.

8-225f. TRACER TECHNIQUES. (3 cr; prereq ‡, 5-743, 5-746)
Laboratory work on application of radioisotopes to study of metabolic processes.

8-231s. ADVANCED LIPID CHEMISTRY. (2 cr; prereq 5-743; offered 1973-74 and alt yrs)
Lectures and assigned readings on composition, structure, chemical and physical properties, and biochemical functions of fats and fat-like compounds.

8-241w. METABOLISM OF NUCLEIC ACIDS. (3 cr, §MdBc 8-211; prereq ¶5-743; offered 1972-73 and alt yrs)
Lectures on synthesis and metabolism of nucleotides and nucleic acids, and their role in protein synthesis and cellular metabolism.

8-250. SPECIAL TOPICS IN BIOCHEMISTRY. (1-3 cr; prereq 5-743)
Lectures and discussions varying from quarter to quarter according to staff availability and needs of department.

8-261w. ADVANCED PROTEIN CHEMISTRY. (3 cr, §MdBc 8-217; prereq 5-743; offered 1973-74 and alt yrs)
Lectures and assigned readings on composition, structure, chemical and physical properties, and biochemical functions of proteins and amino acids.

8-271f. VITAMINS. (3 cr; prereq 5-743 or ‡)
Lectures and assigned readings on biochemistry of vitamins and their physiological action.

8-990. GRADUATE RESEARCH. (2-5 cr; prereq ‡)
Research problems in various fields in biochemistry represented by staff interests.

Biochemistry (MdBc)

(Medical School)

Professor

Wallace D. Armstrong, Ph.D., M.D., *head*
Charles W. Carr, Ph.D., *director of graduate study*
Ellis S. Benson, M.D.[4]
Robert W. Bernlohr, Ph.D.[2]
Ivan D. Frantz, M.D.
Helmut R. Gutmann, M.D.[3]
Ralph T. Holman, Ph.D.[4]
Andreas Rosenberg, Ph.D.[1]
Leon Singer, Ph.D.
Frank Ungar, Ph.D.
John F. Van Pilsum, Ph.D.
Donald B. Wetlaufer, Ph.D.
Finn Wold, Ph.D.
Leslie Zieve, M.D., Ph.D.[5]

Associate Professor

James W. Bodley, Ph.D.
Mary E. Dempsey, Ph.D.
Ronald D. Edstrom, Ph.D.
Ernest D. Gray, Ph.D.
James F. Koerner, Ph.D.

Lecturer

Quenton T. Smith, Ph.D.[6]

The core curriculum includes, together with the specified entrance requirements MdBc 5-741, 5-742 and 5-743 or by permission MdBc 5-100/5-101 and laboratory 5-750 and graduate seminar. Majors are also required to present additional laboratory experiences and 1 year of MdBc 5-053 as part of their core program and to pass a written preliminary examination at the end of the first year. This examination covers the entrance requirements and the core material. The advanced courses making up the total major and minor (supporting) programs must include a minimum of three biochemistry courses, three chemistry courses, and two biology courses.

5-053f,w,s,su. PROBLEMS IN BIOCHEMISTRY. (Cr and hrs ar; may be taken 1 or more qtrs; prereq 5-743 or 5-101) Staff

5-100. BIOCHEMISTRY. (6 cr; primarily for medical students; prereq physics and organic chemistry) Armstrong, Wetlaufer, Wold, Koerner, Bodley

5-101. BIOCHEMISTRY. (4 cr; primarily for medical students; prereq 5-100) Koerner, Bodley, Ungar, Carr

5-741f/5-742w/5-743s. GENERAL BIOCHEMISTRY. (3 cr per qtr, §BioC 5-741/5-742/5-743; prereq Chem 3-303, 5-501, or 5-520 or ¶5-501 or 5-520, or ‡)
See BioC 5-741.

5-750s. BIOCHEMISTRY LABORATORY. (4 cr; biochemistry majors given priority; prereq 5-742) Staff
General experimental techniques, instrumental analyses, special individual projects with oral reports and examinations.

8-150f,w,s. SEMINAR: BIOCHEMISTRY. (1 cr) Staff

8-206f. ADVANCED ENDOCRINOLOGY AND STEROID CHEMISTRY. (3 cr; minimum of 8 students; prereq 5-743 or 5-101; offered 1973-74 and alt yrs) Ungar
Type and nature of enzyme systems which synthesize steroid hormones, control mechanisms for hormone production via the CNS-hypothalamus-pituitary-target pathway; hormone-regulated molecular events in metabolism and growth; comparison of mode of action of peptide and steroid hormones.

8-211s. NUCLEIC ACID STRUCTURE AND FUNCTION. (3 cr, §BioC 8-241; prereq 5-743 or 5-101; offered 1973-74 and alt yrs) Bodley, Koerner, Gray
Lectures and readings on current topics in DNA and RNA structure, synthesis, and function.

8-215su. TOPICS IN LIPID METABOLISM. (3 cr; minimum of 8 students; prereq 5-743 or 5-101 or ‡; offered 1973 and alt yrs) Frantz
General survey, with emphasis on pathways of formation and breakdown of various classes of lipids. Applications to human disease are discussed.

---

[1] Primary appointment in Department of Laboratory Medicine.
[2] Primary appointment in Department of Microbiology.
[3] Located at Minneapolis Veterans Hospital.
[4] Member of the Hormel Institute staff.
[5] Primary appointment in Department of Medicine, Minneapolis Veterans Hospital.
[6] Primary appointment in School of Dentistry.

8-217w. PROTEIN CHEMISTRY. (3 cr, §BioC 8-261; minimum of 8 students; prereq 5-743 or 5-101 or ‡, Chem 5-504 or ‡; offered 1972-73 and alt yrs) Wetlaufer
Structure of proteins as revealed by chemical and physical investigations; selected examples of correlation between protein structure and function.

8-219f. BIOCHEMISTRY OF SPECIALIZED TISSUES. (3 cr; minimum of 8 students; prereq 5-743 or 5-101; offered 1972-73 and alt yrs) Van Pilsum
Biochemical and physiological functions and metabolism of adipose, nervous, muscle, liver, kidney, and other tissues in mammals.

8-220w. CARBOHYDRATE METABOLISM. (3 cr; prereq 5-743 or 5-101; offered 1973-74 and alt yrs) Edstrom
Lectures and readings in carbohydrate metabolism in mammalian systems. Special emphasis on biosynthesis and degradation of polysaccharides, glycoproteins, and glycolipids. Discussion of metabolic diseases of carbohydrate metabolism involving storage of polymeric products.

8-236f,w,s. RADIOISOTOPE SEMINAR. (1 cr, §Rad 8-236) Loken, Armstrong and staff

BIOLOGY

The major in biology is designed to accommodate students in areas of biological specialization which are by their nature interdepartmental. Faculty are drawn from members of the graduate faculty in the areas of biological, agricultural, and medical sciences. Note that majors in the biological sciences are also offered by many departments of the University.

Students who wish to earn an advanced degree in biology must demonstrate competence in the field as a whole at approximately the level of the undergraduate biology major by passing a comprehensive examination. Students will ordinarily write this examination at the beginning of their graduate training so that the results may be used as a basis for evaluation and counsel. Those who perform well will not be required to retake the examination. Others will retake it when they have had the opportunity to correct earlier deficiencies.

Prerequisites—Students will be expected to have completed the equivalent of an undergraduate major in a biological science, organic chemistry, a year of college physics, and mathematics through calculus. Deficiences must be removed during the first year of graduate work.

Language Requirement—None.

Master's Degree—In addition to passing the comprehensive examination, students pursuing the master of science (Plan A) must take 18 credits of biological sciences, at least 9 of which must be within a single department or program. Nine credits are required for the minor which may be either outside the biological sciences or from a department or program within the biological sciences from which no courses are used for the major. A thesis and final oral examination complete the requirements for this plan.

The master of science (Plan B) requires 45 credits. Students can offer a minimum of 21 credits in the biological sciences and 18 credits in two related fields. Students must take at least 6 credits in a field to have it accepted as a related field. If students prefer, they may fulfill the requirements by taking 9 credits in each of four biological science departments or programs. Three papers representing the quality but not the range of a thesis shall be prepared. In the case of students choosing the 9-credit sequence, the papers must come from at least two departments or programs. A final oral examination completes the requirements.

Doctor's Degree—In addition to passing the comprehensive examination, each student must complete a program of specialization. Descriptions of the programs which have been formally established follow. If no suitable program has

been established, students may arrange (in consultation with their faculty adviser) for a unique program to be designed for them.

Programs of Specialization—The following specializations have been formally established.

Cell Biology—Frederick Forro, Jr., Director of Graduate Study. Robert K. Herman, Director of Admissions, Department of Genetics and Cell Biology, 227 Snyder Hall, University of Minnesota, St. Paul, Minnesota 55101. The program emphasizes the view that cell biology interfaces strongly with basic physical and chemical science on one side and with more complex multicellular biological systems on the other. In addition to core and elective courses offered in cell biology, a typical program would include study of biomathematics, biophysical chemistry, biochemistry, genetics, and developmental biology. Early laboratory experience is gained through rotating apprenticeships to program faculty.

Developmental Biology—Nelson Spratt, program chairman. Students will be expected to become proficient in areas of advanced genetics, cell biology, physical chemistry, and biochemistry in addition to developmental biology.

Evolutionary and Systematic Biology—Harrison Tordoff, program chairman. Students should have some preparation in the taxonomy of groups of organisms which hold special interest for them. In addition to basic requirements in biochemistry, genetics, biostatistics, and in the systematics of one or more of the major groups of organisms, students must develop a high level of competence in at least one of the following areas: (a) comparative biochemistry; (b) genetics of speciation, cytogenetics including cytotaxonomy, and experimental taxonomy; (c) phylogeny and taxonomy of living and extinct groups of organisms as seen from the viewpoint of comparative anatomy and morphology; (d) comparative physiology.

Biology (Biol)

5-052. GENERAL PHYSIOLOGY. (5 cr; prereq 3-011, 3-021, Phys 1-106 or 1-291/1-295) Goldstein, Sheridan
Quantitative approach to the study of cell function with emphasis on application of physical and chemical principles. Major topics include transport, electrical activity of cell membranes, and cell contractility. Lectures, discussions, laboratory.

5-061. DEVELOPMENTAL BIOLOGY. (3 cr; prereq 3-032) Spratt, McLaughlin
Developing systems and control mechanisms of development, from molecule to organism.

5-065. LABORATORY IN DEVELOPMENTAL BIOLOGY. (2 cr; prereq 5-061 or ¶5-061) Spratt, McLaughlin

5-501. BIOCHEMICAL EVOLUTION. (4 cr; prereq 5 cr biochemistry) Kirkwood, Jenness
Lectures and assigned reading on molecular evolution covering prebiotic evolution and the phylogeny of important functional molecules and biochemical systems in living organisms.

5-601. GENERAL CYTOLOGY. (3 cr, §3-032, §GCB 5-051; prereq 10 cr in biology, botany, or zoology, elementary genetics or ‡) Johnson, Cunningham
Introductory analysis of structure, growth, and function of cells and organelles.

5-605. GENERAL CYTOLOGY LABORATORY. (2 cr; prereq 5-601 or ¶5-601, or 3-031 or ¶3-032, or ‡) Johnson, Cunningham
Experimental approach to cell structure and function including specialized forms of light microscopy, autoradiography, cell fractionation. Introduction to electron microscopy.

5-951. THE BIOLOGIST AS SCIENTIST, EDUCATOR, AND CITIZEN. (3 cr; prereq 15 cr biological science) Hooper and staff
Role of the scientist in decision making and persuasion; teaching methods in biology; organizational structure of the academic and governmental world.

8-710. TUTORIAL IN DEVELOPMENTAL BIOLOGY. (3 cr; prereq ‡)

8-950. GRADUATE SEMINAR. (1-2 cr; prereq ‡)
Reports on recent developments in biology.

8-970. SPECIAL TOPICS IN BIOLOGY. (1-3 cr; prereq ‡)

8-990. GRADUATE RESEARCH. (2-5 cr; prereq ‡)

Cell Biology (GCB)

Graduate Faculty

John S. Anderson (biochemistry)
William P. Cunningham (genetics and cell biology)
David P. Fan (genetics and cell biology)
Frederick Forro, Jr. (genetics and cell biology)
Albert W. Frenkel (botany)
Robert K. Herman (genetics and cell biology)
Alan B. Hooper (genetics and cell biology)
Ross G. Johnson (zoology)
Douglass C. Pratt (botany)
Palmer Rogers (microbiology)
Murray D. Rosenberg (genetics and cell biology)
Irwin Rubenstein (genetics and cell biology)
L. E. Scriven (chemical engineering)
Judson D. Sheridan (zoology)
Leon A. Snyder (genetics and cell biology)
Huber R. Warner (biochemistry)
Val W. Woodward (genetics and cell biology)

Members of the graduate faculty for cell biology represent several departments and colleges within the University. Students wishing to earn the Master's or Ph.D. degree in biology with specialization in cell biology may choose a major adviser from among these members.

The following courses in cell biology are offered by the Department of Genetics and Cell Biology.

5-051. INTERMEDIATE CELL BIOLOGY. (3 cr, §Biol 5-601; prereq ‡...introductory biochemistry and molecular genetics recommended) Cunningham, Hooper, Johnson
Introductory analysis of structure, replication, and function of general and specialized cell types at the microscopic and molecular level. Topics include cell membranes, organelles and macromolecular aggregates; cell division, secretion, regulation of macromolecule synthesis, and cellular differentiation.

5-052. QUANTITATIVE TECHNIQUES, CELL BIOLOGY. (3 cr; prereq ‡...introductory cell or molecular biology and biochemistry recommended) Hooper, Rosenberg, and staff
Methods used to study the structure, growth, and function of cells. Techniques include tissue culture, cell synchronization, isolation of subcellular organelles, assessment of purity of fractions, compartmental analysis in eucaryotic systems, single cell electrophoresis, examples of some basic biological problems, and the design of pertinent experimental methods.

5-062. CELLULAR REGULATION. (3 cr; prereq ‡)
See description under Genetics.

5-082. MEMBRANES AND INTERFACES. (3 cr; prereq ‡) Rosenberg
Thermodynamics and statistical mechanics of interfaces; the electrical properties of interfaces; experimental methods for the study of gas/liquid and liquid/liquid interfaces; interfaces in biological systems; cell membranes; the plasma membrane; mitochondrial membranes; special membranous systems within cells; methods for isolation of membranes; chemical reaction at interfaces; the dynamic properties of interfaces; model membrane systems; the cell surface region and cell-contact relations.

8-060. CURRENT TOPICS IN GENETICS AND CELL BIOLOGY. (2 cr [may be repeated for cr])

8-900. SEMINAR: GENETICS AND CELL BIOLOGY. (1 cr [may be repeated for cr])

8-990. RESEARCH IN GENETICS AND CELL BIOLOGY. (Cr ar [may be repeated for cr])

BIOMEDICAL ENGINEERING

Professor

Kenneth H. Keller (Chemical Engineering & Materials Science), *chairman, director of graduate study*
Perry L. Blackshear, Jr. (Mechanical Engineering)
William E. Bradley (Neurology)
Richard L. Varco (Surgery)

Associate Professor

Victor A. Bloomfield (Biochemistry)
Richard Moore (Laboratory Medicine)
Frederick M. Waltz (Electrical Engineering)

This group, together with other members of the graduate faculty approved by the Biomedical Engineering Unit Committee may serve as graduate advisers for this area.

Degrees—The program in biomedical engineering leads to the Ph.D. degree only. However, work in biomedical engineering can be taken as a minor in either a Master's or Ph.D. program.

Prerequisites—Candidates for the Ph.D. degree should have completed undergraduate work in an engineering, physical, or biological science field. They must have sufficient breadth of training to allow them to undertake graduate level courses in the several fields that comprise the Ph.D. program. Where specific deficiencies exist, candidates may be accepted into the program contingent upon the successful completion of certain preliminary courses designed to correct those deficiencies. In most cases, such preliminary courses would not be part of the Ph.D. program.

Approval of Program—The candidate's tentative program will be planned with the aid of an adviser selected from the above list or otherwise approved by the Biomedical Engineering Unit Committee. The unit committee will consider the suitability of the program and thesis topic and will take appropriate action. The unit committee will also be responsible for the appointment of an examination committee.

Major Program—The purpose of the major program is to provide a student with comprehensive training in both the engineering and biomedical aspects of at least one area of biomedical engineering. To accomplish this, the student will normally take a broad, but cohesive program consisting of at least nine credits in each of three departments. Two of these departments should be in a college other than that of the minor. In addition, the student will normally register in one of the ongoing biomedical engineering seminar series for at least six quarters.

Minor Program—The minor program is intended to insure that the emphasis on breadth in the major is complemented by the development of specialized proficiency in at least one sub-discipline of this inherently interdisciplinary field. To accomplish this, the student will be required to complete at least eighteen credits in the department designated as his minor with at least nine of these credits in 8-000 series courses. The minor department will normally be the one most closely related to undergraduate training or the one in which the adviser holds an appointment.

Language Requirement—The student will be required to demonstrate proficiency in French, German, or Russian or to complete an alternative program subject to the approval of the unit committee.

BIOMETRY (PubH)

Professor

Marcus O. Kjelsberg, Ph.D., *head*
Eugene A. Johnson, Ph.D., *director of graduate study*
Eugene Ackerman, Ph.D.
Jacob E. Bearman, Ph.D.
Arnold G. Fredrickson, Ph.D.
Richard B. McHugh, Ph.D.
Andreas Rosenberg, Ph.D.

Associate Professor

Dean E. Abrahamson, M.D., Ph.D.
Glenn E. Bartsch, Sc.D.
James R. Boen, Ph.D.
Kathleen M. Keenan, Ph.D.
Ruth B. Loewenson, Ph.D.
Richard Moore, Ph.D., D.Sc.

Assistant Professor

Prithwis DasGupta, Ph.D.
Läel C. Gatewood, Ph.D.
Anne I. Goldman, Ph.D.

Prerequisites—Mathematics through calculus with an undergraduate major in one of the social, biological, mathematical, or physical sciences.

Program of Study—Biometry is the study of analytical and quantitative aspects of biology, medicine, public health, and health care systems. Possible areas of emphasis include measurement problems, model building, evaluation of health programs, experimental design and analysis, systems monitoring and control, health computer sciences, demography and health statistics. Students may elect courses from one or more of such fields as computer and information control sciences, hospital and health care administration, epidemiology, mathematics or statistics to complement biometry course offerings. Advanced work in the social, biological, or medical sciences is usually taken as part of a minor or supporting program but, with special justification, may be taken as part of the major.

Language Requirement—None.

Master's Degree—Plan A and Plan B programs leading to the M.S. degree are available. Most students would be expected to enroll in the Plan B program. The Plan A program is usually restricted to those with an undergraduate major in biometry or those with a D.D.S., D.V.M., or M.D. degree, or a Ph.D. degree in a bioscience.

Doctor's Degree—Work for the Ph.D. degree is offered in accordance with the general requirements of the Graduate School.

Note—Graduate study in biometry is also offered at the Mayo Graduate School of Medicine of the University of Minnesota. Consult the *Graduate Programs in the Health Sciences Bulletin.*

Courses listed with no description are described in the Public Health section of this bulletin.

5-403. COMPUTER APPLICATIONS IN HOSPITAL AND HEALTH CARE ADMINISTRATION. (3 cr; prereq hospital and health care administration students only, others ‡) Johnson

5-404. INTRODUCTION TO BIOSTATISTICS AND STATISTICAL DECISION. (3 cr; prereq ‡) Weckwerth

5-405. BIOMETRIC METHODS IN ENVIRONMENTAL HEALTH I. (3 cr; prereq environmental health students only, others ‡) DasGupta

5-406. BIOMETRIC METHODS IN ENVIRONMENTAL HEALTH II. (3 cr; prereq 5-405) Bearman

5-407. VITAL STATISTICS I. (3 cr) Bearman, Kjelsberg

5-408. VITAL STATISTICS II. (3 cr; prereq 5-407 with grade of B)

5-409/5-410. BIOMETRY IN CLINICAL STUDIES I, II. (3 cr per qtr; prereq D.D.S., M.D. or D.V.M., or ‡) Bearman

Introduction to numerical and graphical treatment of data from dental, medical, and veterinary research. Examples taken from recent literature. Design, conduct, and analysis of clinical studies. Prophylactic and therapeutic trials. Validity and reliability of measurements and calibration studies for clinical setting. Sensitivity and specificity of tests and their application in clinical research and diagnosis. Special problems of cooperative studies.

5-411. INTRODUCTION TO MATHEMATICAL DEMOGRAPHY. (3 cr, §Soc 5-561; prereq ‡) DasGupta

Basic demographic measures and concepts of fertility, mortality, and migration. Introduction to stable population methods and to demographic estimates from incomplete data.

5-412. SURVEY SAMPLING IN SOCIAL AND HEALTH SCIENCE RESEARCH. (3 cr, §Soc 5-970; prereq ‡) DasGupta

Introduction to methodology of probability sampling in social and health science surveys. Analysis and application of simple random, stratified, systematic, multistage, and cluster sampling.

5-430/5-431/5-432. BIOMEDICAL COMPUTING I, II, III. (3 cr per qtr; prereq Math 1-111) Johnson and staff
Introduction to digital computers and FORTRAN programming, with applications in biology and medicine; information capture, storage, retrieval, and display; statistical analysis packages; simulation; analog signal processing; nonlinear models; hospital information systems.

5-433/5-434/5-435. COMPUTER METHODOLOGY IN THE DELIVERY OF HEALTH CARE I, II, III. (3 cr per qtr; prereq 5-432 or ‡) Ackerman, Gatewood
Records and files, file maintenance, report generation, hospital administrative information, and accounting systems. Medical records, abstracting the medical record, medical information systems based on the medical record for hospitals, surveys, physicians, outpatient clinics, and research. Monitoring of clinical laboratory equipment, physiological monitoring of acutely ill patients, total hospital information systems.

5-436. ANALYTICAL TECHNIQUES FOR HEALTH DELIVERY SYSTEMS. (3 cr; prereq calculus, 5-450, 5-451 or ‡) Johnson
Operations research and systems analysis techniques applied to medical service systems. Special emphasis on applications of linear programming, theory of queues, and inventory models in health care systems.

5-440/5-441. QUANTITATIVE MAMMALIAN BIOLOGY I, II. (3 cr per qtr, §Phsl 3-052/3-053; prereq 1-yr sequences in mathematics, physics, chemistry, biology or ‡)
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.

5-450. BIOMETRY I. (3 cr; prereq familiarity with basic concepts of calculus desirable and ¶5-451) Bartsch, Jeffries
Basic concepts in probability; binomial, Poisson and normal probability models; estimation and testing statistical hypothesis of parameters of probability models.

5-451. BIOMETRY LABORATORY I. (2 cr; prereq ¶5-450) Jeffries
Application of concepts of probability to development of probability models for random phenomena in biological and medical sciences.

5-452. BIOMETRY II. (3 cr; prereq 5-450, ¶5-453) Bartsch, Jeffries
Further consideration of testing statistical hypotheses and interval estimation; chi square applied to frequency data; regression analysis; correlation; analysis of variance; contrasts and multiple comparison techniques.

5-453. BIOMETRY LABORATORY II. (2 cr; prereq ¶5-452) Jeffries
Application of concepts of testing and estimation of parameters of the basic probability models; application of chi square to goodness of fit and heterogeneity tests; application of regression to bioassay; application of analysis of variance to bioassay.

5-454. BIOMETRY III. (3 cr; prereq 5-452, ¶5-455) Bartsch, Jeffries
Analysis of nested, randomized block, factorial, and split plot designs.

5-455. BIOMETRY LABORATORY III. (2 cr; prereq ¶5-454) Jeffries
Basic designs will be illustrated with numerous examples from the biological sciences.

5-456. BIOMETRY CONSULTING SEMINAR. (3 cr; prereq biometry major) Boen, Goldman
Consultant and consultee interaction; communication and formulation of the biometric problem. Role and responsibility of biometrician. Robustness and relevance of frequently used analytical techniques. Biometry student internship experiences.

5-457. STOCHASTIC MODELS IN BIOLOGY AND MEDICINE. (3 cr; prereq 5-451, theoretical statistics, biometry major...others ‡) Boen
Applications of stochastic processes to health care systems, and to such varied biologic phenomena as epidemics, urinary tract infection, and carcinogenesis.

5-459. INTRODUCTION TO MATHEMATICAL THEORY IN BIOMETRY. (3 cr; prereq 2 qtrs calculus, 5-455, or ‡) 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.

5-460. DEMOGRAPHY AND HEALTH. (3 cr, §5-408; prereq biometry major, others ‡) Kjelsberg

5-461. BIOMETRIC TOPICS IN EPIDEMIOLOGY. (3 cr; prereq biometry major, others ‡) Kjelsberg
Relative risk; summarization of rates; misclassification; matching designs; incidence as a function of several variables; selection; clustering; familial aggregation.

5-462. LIFE TABLE TECHNIQUES. (3 cr; prereq biometry major, others ‡) Kjelsberg
Mathematical development of life table techniques and application to follow-up studies in medicine and public health.

5-463. MATHEMATICAL DEMOGRAPHY. (3 cr; prereq calculus, 5-450, 5-451 or ‡) Das-Gupta
Deterministic and stochastic one- and two-sex models of population growth. Integral equation and matrix approaches to stable population theory. Stochastic models of reproduction.

5-465/5-466/5-467. ADVANCED BIOMETRIC METHODS I, II, III. (3 cr per qtr; prereq 5-455 or ‡) Staff
Propagation of random error; elements of bioassay; compartment analysis; nonlinear estimation; categorical and nonparametric data analysis; diagnostic models; classification and clustering techniques; clinical trial methodology; Bayesian inference.

5-470. TOPICS IN BIOMETRY. (Cr ar) Staff
Selected readings with discussion based on these readings.

8-400. SEMINAR: BIOMETRY. (Cr ar) Staff

8-405/8-406/8-407. ADVANCED TOPICS IN HEALTH COMPUTER SCIENCE I, II, III. (3 cr per qtr; prereq 5-432, knowledge of COBOL, BASIC) Ackerman and staff
Peak detection and resolution, nonlinear optimization graphic displays. Small computer operation and programming including hardware concepts, data transmission, and programming. Computer systems design for the health sciences, using University of Minnesota Health Science Center as a case history, including medical goals and proposed alternate computer systems to achieve these.

8-415/8-416/8-417. MATHEMATICAL BIOLOGY I, II, III. (3 cr per qtr; prereq mathematics through differential equations and 1 yr sequence in physics, chemistry, and a basic biological science, with lab work in one or more, or ‡) Ackerman and staff
Physico-, chemico-, mathematical biology; statics and dynamics of tissues and fluids; biological reaction and compartment analysis, ion diffusions, and colloids; analog and digital computer used in biomedicine.

8-430/8-431/8-432. ADVANCED BIOMETRIC ANALYSIS I, II, III. (3 cr per qtr; prereq 5-467, advanced calculus, theoretical statistics) McHugh and staff
Biomedical measurement models; quantal, quantitative, direct, indirect. Tolerance distributions and dose-response functions. Parallel line and slope ratio assays. Radioactivity measurement and radiotracer experiments. Multifactorial and multistage designs in medical surveys and clinical trials. Sampling and randomization theory. Validity, reliability, sensitivity, and efficiency in design and analysis of clinical and laboratory research.

8-449. TOPICS IN BIOMETRY. (Cr ar; prereq 5-450 and ‡) Staff
Studies in special topics for advanced students.

8-450. RESEARCH IN BIOMETRY. (Cr ar) Staff
Opportunities will be offered for qualified students to pursue research work.

BIOPHYSICS (BPhy)

COMMITTEE

Professor

Otto H. Schmitt, Ph.D., *chairman*
Eugene Ackerman, Ph.D.
James Bassingthwaite, M.D., Ph.D.
Merle K. Loken, Ph.D., M.D.
A. Glenn Richards, Ph.D.

STAFF

Professor

Otto H. Schmitt, Ph.D., *director of graduate study*
Eugene Ackerman, Ph.D.
James Bassingthwaite, M.D., Ph.D.
Merle K. Loken, Ph.D., M.D.
Rufus W. Lumry, Ph.D.
A. Glenn Richards, Ph.D.
Murray D. Rosenberg, M.D., Ph.D.
Carlo A. Terzuolo, M.D.

Associate Professor

Richard Moore, Ph.D.
Alan L. Orvis, Ph.D. (Mayo Graduate School, Rochester)
Andreas Rosenberg, Ph.D.

Assistant Professor

Dean E. Abrahamson, Ph.D.

Instructor

George W. Beeler, Jr., Ph.D. (Mayo Graduate School, Rochester)

Additional course work in biophysical science areas, needed to strengthen individual student programs in biophysics, and co-advisory staff may be drawn

from related departments such as cell biology, physiology, physical chemistry, zoology, electrical engineering, mechanical engineering, chemical engineering, health computer sciences, or control sciences. There is opportunity for thesis research in a wide variety of topical areas such as biocomputer development, simulation, modeling, programming and displays, biological systems theory and pattern recognition, neural and sensory physiology, electrocardiography, automated diagnosis and health care systems, chronobiology, membrane structure and function, computer-aided therapeutic and tracer radiology, hemodynamics, and physical chemistry of proteins. There are additional opportunities for research in diversified biophysical areas at the Mayo Graduate School of Medicine in Rochester, Minnesota. Courses leading to the biophysics Master's degree are available in the program at Rochester as well as at Minneapolis, but biophysics candidates for the Ph.D. degree usually complete a major portion of their course work on the Minneapolis Campus.

Prerequisites—Students are ordinarily admitted to the graduate biophysics degree programs only if they have had good basic training in a biological, medical, or appropriate physical science area at a level equivalent to an undergraduate major and have had at least introductory courses in biology, physics, chemistry, mathematics, and computing. Some remedial study to fill undergraduate level gaps is often combined with regular graduate work.

Language Requirements—For the Master's degree a reading knowledge of one foreign language, preferably German or Russian, is required, although another language or additional course work can be substituted upon approval of an adviser's recommendation. For the Ph.D., a reading knowledge of Russian or German is required. A second foreign language, German, Russian, or French, is required unless another language or collateral field of study is accepted as a substitute.

Master's Degree—Offered under Plan A and Plan B.

Doctor's Degree—Work leading to the Ph.D. is offered.

Since biophysical science is a broad field including diverse biological and physical disciplines, credit in biophysics is regularly granted for courses drawn from many different departments. A wide diversity of appropriate courses is available in addition to those listed. The student's program should include courses from the following list supplemented by other courses listed under their respective departmental headings. In consultation with their adviser, students should plan a balanced program tailored to their individual needs. Because biophysics is highly interdisciplinary, a minor field is not identified as such on the student's program.

Note—Graduate study in biophysics is also offered at the Mayo Graduate School of Medicine of the University of Minnesota. See the physiology and biophysics section of the bulletin, *Graduate Programs in the Health Sciences.*

5-138. SEMINAR: BIOPHYSICAL SCIENCES. (Cr ar) Staff

5-155, 5-156, 5-157.* BIOPHYSICS. (3 cr per qtr; prereq basic preparation in biological sciences, physical sciences, mathematics, ‡) Schmitt

Selected representative topics in theoretical, experimental, and technical areas of biophysical science where quantitative methods of the physical sciences are especially applicable. 5-155: 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. 5-156: Biophysical function; dynamics of biophysical systems, excitatory state in nerve and muscle, contractility, secretion, synthesis, sensory and motor transducers. 5-157: Organization of biological systems for communication and control; stability of feedback and feed-ahead systems; biocommunication theory, computer aspects of living systems, biomimetics.

5-170, 5-171, 5-172. RADIATION BIOPHYSICS. (3 cr per qtr; prereq ‡) Loken
Theoretical and experimental aspects of radiological physics, medical physics, and radiobiology. Physical properties of various ionizing radiations; interaction of ionizing radiations with biological systems; use of radioactive isotopes as tracer elements.

8-204x.* RESEARCH IN BIOPHYSICS AND RADIATION BIOLOGY. (Cr ar) Loken

8-218x. SEMINAR: RADIOBIOLOGY. (1 cr; prereq ‡)
Biological effects of ionizing radiations. Discussion of research problems and current literature.

8-221, 8-222, 8-223x.* RESEARCH IN BIOPHYSICS. (Cr ar) Staff

8-296, 8-297, 8-298.* SEMINAR: BIOPHYSICS. (Cr ar) Schmitt

Rad 8-236. SEMINAR: RADIOISOTOPE. (1 cr; prereq ‡) Loken

BOTANY (Bot)

Professor
Albert W. Frenkel, *head*
Douglas C. Pratt, *director of graduate study*
Ernst C. Abbe
Alan J. Brook
Eville Gorham
John W. Hall
Herbert Jonas
Donald B. Lawrence
Albert J. Linck
Thomas Morley
Gerald B. Ownbey
Conrad J. Weiser
Herbert E. Wright, Jr.

Associate Professor
William P. Cunningham
Edward J. Cushing
Willard L. Koukkari
Thomas K. Soulen
Eduard J. Stadelmann
Clifford M. Wetmore

Assistant Professor
David J. McLaughlin

Prerequisites—For major work, general biology and at least 15 credits in botany or related subjects approved by the department. Students should also have completed a year of college physics and 2 quarters of organic chemistry. One quarter of calculus or statistics is prerequisite for the M.S. degree, and 2 quarters of calculus or statistics for the Ph.D. Deficiencies can be removed during the course of study. Special programs can also be arranged for students with unusual backgrounds, for example, in the physical sciences.

For minor work, general biology is required.

Language Requirement—For the Master's and Ph.D. degrees, no foreign language requirement is specified by the department. However, a foreign language requirement may be set by the student's faculty adviser after consultation with the student. Students who wish to have on their Graduate School transcript a record of proficiency in a foreign language must declare the language on their degree program and fulfill the requirement in the usual way (see the section on language requirements).

Master's Degree—Offered under both Plan A and Plan B.

Doctor's Degree—Work leading to the Ph.D. is offered.

5-103f. BIOLOGY OF NONVASCULAR PLANTS. (5 cr; prereq Biol 1-103 or 3-012) McLaughlin, Wetmore
Algae, fungi, lichens, and bryophytes. Characteristics, evolutionary relationships, life cycles, comparative morphology (including ultrastructure), and comparative nutrition. Living materials emphasized in the laboratory.

5-105w.* MORPHOLOGY OF VASCULAR PLANTS. (5 cr; prereq Biol 1-103 or 3-012 or ‡) Abbe, Hall
Vegetative and reproductive structure of living and fossil vascular plants. Their evolutionary relationships based on phylogenetic principles.

5-111w.* DEVELOPMENTAL PLANT ANATOMY. (5 cr; prereq Biol 1-002 or 1-103 or 3-012) Abbe
Microscopic structure of vascular plants with particular attention to development in the root, stem, and leaf.

5-141w. SURVEY OF PLANT PHYSIOLOGY. (3 cr, §PlPh 5-141; prereq Biol 1-002 or 1-103 or 3-012, 1 yr physics, course in organic chemistry or biochemistry) Frenkel
Physiological processes which occur in living plants with emphasis on higher plants. Growth and development, energy relations, mineral nutrition, water relations, respiration, photosynthesis, and nitrogen metabolism.

5-142w. PLANT PHYSIOLOGY LABORATORY. (2 cr; prereq 5-141 or ¶5-141)
Laboratory course to accompany Bot 5-141.

5-182s. PLANT METABOLISM. (3 cr, §PlPh 5-182; prereq course in biochemistry) 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.

5-183w. WATER, MINERALS, AND TRANSLOCATION. (4 cr, §PlPh 5-183; prereq course in biology, physics, and in organic chemistry or biochemistry) Stadelmann, Smith
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.

5-184f. PLANT GROWTH AND DEVELOPMENT. (3 cr, §PlPh 5-184; prereq course in biology and course in organic chemistry) Brun, Haissig
Growth of higher plants including division and differentiation of cells, development of plant organs, the effects of external factors on plant growth, photosynthesis and respiration in relation to plant development, and the nature and action of plant growth substances.

5-205s.* FLORA OF MINNESOTA. (4 cr; prereq 3-201 or ‡) Ownbey
Vascular plants of Minnesota; taxonomic and floristic relationships; geographical distribution and variation; collecting and identification; field trips.

5-231f. INTRODUCTION TO THE STUDY OF ALGAE. (5 cr; prereq 10 cr in botany or biology or ‡; offered 1972-73 and alt yrs) Brook
Structure, reproduction, and life histories of major algal divisions.

5-801su. SUMMER FLORA OF MINNESOTA. (5 cr; prereq 3-201 or equiv or ‡; offered in Lake Itasca Biology Session)
Survey of the summer flowering plants and ferns of the state with particular reference to the local flora. Collection and identification of species; distribution in Minnesota; literature and taxonomic methods.

5-805su.* AQUATIC FLOWERING PLANTS. (5 cr; prereq 3-201 or ‡; offered in Lake Itasca Biology Session)
Higher plants of aquatic and marsh habitats. Identification and collection; adaptive morphology and food value to wildlife; association of species; relation to the habitat.

5-811su. FRESHWATER ALGAE. (5 cr; prereq 10 cr in biology or ‡; offered in Lake Itasca Biology Session)
Morphology and taxonomy of freshwater algae with particular attention to the collection and identification of local algae.

5-815su. BRYOPHYTES. (5 cr; prereq 10 cr in biology or ‡; offered 1973 in Lake Itasca Biology Session)
Field and laboratory study of mosses and liverworts of Minnesota.

5-821su. LICHENS. (5 cr; prereq 10 cr in botany or zoology or ‡; offered 1974 in Lake Itasca Biology Session)
Taxonomy, ecology, and floristics of the lichens of northern Minnesota; identification, sampling methods, microchemistry as a taxonomic tool.

5-970f,w,s. BASIC BOTANY. (Cr ar; prereq Biol 1-002 or 1-103 or 3-012, ‡) Staff
Individual work in some special discipline.

8-950f,w,s. SEMINAR. (1 cr per qtr; prereq ‡) Staff

8-970f,w,s.* SPECIAL TOPICS. (Cr ar; prereq ‡) Staff
Treatment in depth of a specialized botanical topic, usually selected from the following: physiology of photosynthetic microorganisms, photosynthesis, advanced plant metabolism, pteridophytes, gymnosperms, survey of angiosperm families, principles of angiosperm phylogeny, pollen morphology and taxonomy, Quaternary phytogeography and palynology, paleobotany, biosystematics. A current schedule of when each topic is to be offered is available in the botany office.

8-990f,w,s.* RESEARCH PROBLEMS. (Cr ar; prereq ‡) Staff

All courses designated plant physiology elsewhere in this bulletin are acceptable as part of a major in botany, as are certain courses from other departments and colleges in the University. The following courses are examples:

Agro 8-230. CYTOGENETICS
Biol 5-601. GENERAL CYTOLOGY
Ecol 5-014. ECOLOGY OF PLANT COMMUNITIES
PlPa 5-104. BIOLOGY OF THE FUNGI

BUSINESS ADMINISTRATION

Professor

C. Arthur Williams, Jr., *dean*
Donald V. Harper, *director of graduate study*
R. Glen Berryman
Richard N. Cardozo
Gordon B. Davis
Gary W. Dickson
George W. England
John J. Flagler
Richard K Gaumnitz
Paul V. Grambsch
Jack C. Gray
Delbert C. Hastings
Herbert G. Heneman, Jr.
Thomas R. Hoffmann
Robert J. Holloway
Edwin H. Lewis
Thomas A. Mahoney
John Neter
William Rudelius
George Seltzer
Allen R. Solem
Albert K. Wickesberg
Mahmood A. Zaidi

Associate Professor

Carl R. Adams
Frederick J. Beier
Mario F. Bognanno
Norman L. Chervany
W. Bruce Erickson
Paul F. Jessup
John J. Mauriel
George T. Milkovich
Charles R. Purdy
Peter Rosko
Ivan Ross
John C. Schreiner
Roger G. Schroeder
John K. Simmons
Cyrus F. Smythe
Emil Starr
Roger B. Upson
William F. Weitzel
Andrew F. Whitman
Raymond E. Willis
Robert K. Zimmer

Assistant Professor

Michael Barrett
Gavin L. Collins
Patrick R. Pinto
Kenneth L. Rich
Donald E. Ricketts
Richard F. Sauter
Orville C. Walker, Jr.
Bruce D. Wonder

Lecturer

Wells J. Wright

Eligibility Examination—Applicants for work in business administration are required to present a report of their performance on the Admission Test for Graduate Study in Business (ATGSB) as part of the application for admission to graduate work in that field. Applications cannot be processed without the report. Since this test is given at limited times and places during the year, students would be well advised to make early arrangements for registration for the examination. For information concerning registration for the examination, students should write to the Educational Testing Service, P.O. Box 966, Princeton, N.J. 08540. Effective with applications for admission to fall quarter 1971, *all* applicants for admission to graduate programs in business administration *must* have taken the Admission Test for Graduate Study in Business. (*Note*—This rule supersedes the exceptions formerly granted to military personnel with overseas addresses and applicants whose native language is not English.)

*Master of Business Administration (M.B.A.)***

Purpose—This degree is offered under the auspices of the Graduate School of Business Administration and the University Graduate School and is designed

for individuals who desire to build upon a general competence in business administration the ability to analyze and solve problems faced by business managers. Specifically, the degree is designed to provide students with general knowledge of major business institutions and their principal functions, to develop perspective relative to the relationship between business administration and other disciplines and the relationship between the business system and other social systems, to develop skill in identifying, describing, and solving problems in administrative situations, and skill in written and oral expression and in handling interpersonal relationships and doing research.

Degree Requirements—Participants must complete the requirements of Parts I and II as set forth in the sections below.

1. Part I Requirements—Prerequisites

Requirements in Part I of the degree program consist of the "Tool Areas and Underlying Disciplines" and "Basic Business Core" (items a and b below). These requirements may be met through appropriate courses taken in the student's undergraduate program. Students lacking any of these courses or their equivalents must take courses necessary to meet the requirements of these two items. Any deficiencies may be removed during regular enrollment in the M.B.A. program but graduate credit on the student's formal program cannot be received for these prerequisite courses.

a. *Tool Areas and Underlying Disciplines*—All students must complete one introductory course in microeconomics, macroeconomics, elementary differential and integral calculus, statistics, accounting, and behavioral science (psychology or sociology).

b. *Basic Business Core*—All students must also complete a course in business (managerial) economics, business and society, introduction to management science, organization and management, introductory business finance, and introductory marketing.

2. Part II Requirements

Part II of the M.B.A. degree program consists of a minimum of 45 quarter credits of graduate courses as set forth in items a-e below.

a. *Required Courses*—As part of the 45 quarter credits of graduate courses, all participants in the M.B.A. program are required to complete Government and Business Enterprise (Mgmt 8-008) and Quantitative Approaches to Administrative Problems (OAM 8-159).

b. *Options*—Participants must select one of the two options available to M.B.A. students—the generalist option or the specialist option.

(1) Generalist Option—The generalist option is for students who wish to take a broad spectrum of courses without concentrating in any one area in business administration. Students selecting the generalist option must complete:

(a) At least five courses in business administration in at least three different subject areas with a minimum of at least two courses in two of the subject areas. The courses may be selected from among the following areas:

Accounting
Finance
Industrial Relations
Management
Management Information Systems
Marketing
Operations Analysis and Management
Quantitative Analysis
Risk Management and Insurance
Transportation and Business Logistics

(b) Corporate Strategy: Design and Implementation (Mgmt 8-010)

(c) Electives necessary to complete the 45 quarter-credit program. Electives may be taken either inside or outside the Graduate School of Business Administration with a maximum of three courses taken outside the School. A total of at least six courses in addition to Mgmt 8-008 and OAM 8-159 must be taken inside the Graduate School of Business Administration. Electives in business administration may be selected from the areas in (1) (a) above. Courses in business law may be used as electives.

(2) Specialist Option—The specialist option is for students who wish to concentrate their studies in a particular area in business administration. Students selecting the specialist option must complete:

** This degree program is effective in the fall quarter of 1972. Students in the old master of business administration degree program or in the old master of science degree program should consult the *Graduate School Bulletin* for 1970-1972 for degree requirements.

(a) Approximately five courses in business administration selected with the guidance of the adviser.

(b) A research course in the Graduate School of Business Administration.

(c) Electives necessary to complete the 45 quarter-credit program. Electives may be taken either inside or outside the Graduate School of Business Administration with a maximum of three courses taken outside the school. A total of at least six courses in addition to Mgmt 8-008 and OAM 8-159 must be taken inside the Graduate School of Business Administration. Electives in business administration may be selected from the areas in (1) (a) above. Courses in business law may be used as electives.

c. *Written Reports* (All M.B.A. Students)—At least 9 quarter credits must be earned in courses requiring the preparation of written reports which represent the quality but not the range of a Master's thesis. These "Plan B papers" are to be written in OAM 8-159 (5 credits) and in one other course with at least 4 credits but not in Mgmt 8-010. Specialists are encouraged to write the second paper in the research course. Students receiving less than a B grade in OAM 8-159 cannot receive Plan B paper credit for that course and must write a Plan B paper in connection with another course.

d. *Examinations* (All M.B.A. Students)—All candidates are required to take a final oral or written examination, or both, at the discretion of the faculty examining committee.

e. *Foreign Language* (All M.B.A. Students)—A foreign language is not required.

Executive (Evening) Master of Business Administration (E.M.B.A.)

An evening program intended for and limited to persons who are full-time employees of business and other organizations in the Twin Cities metropolitan area leading to the master of business administration degree is offered under the auspices of the Graduate School of Business Administration and the University Graduate School. The generalist option only is available in the evening program.

Doctor of Philosophy

Candidates for the doctor of philosophy degree are required to complete the following:

1. **General Competence**—For admission to the doctoral program, prospective candidates must demonstrate competence in tool areas, underlying disciplines, and the basic business core as outlined under the requirements for the master of business administration degree. The level of competence is that to be obtained from introductory courses in microeconomics, macroeconomics, elementary differential and integral calculus, statistics, accounting, and behavioral science (psychology or sociology), and one course in business (managerial) economics, business and society, introduction to management science, organization and management, introductory business finance, and introductory marketing.

2. **Major Field of Concentration in Business**—Prospective candidates must pass a comprehensive written proficiency (preliminary) examination in their major field of concentration to be selected from the following:

Accounting	Marketing
Finance	Operations Analysis and Management
Industrial Relations	Quantitative Analysis
Management	Risk Management and Insurance
Management Information Systems	Transportation and Business Logistics

3. **Related Field of Concentration in Business**—Prospective candidates must also demonstrate basic competence by passing a written proficiency examination in a related field within business administration to be selected from the fields listed in item 2 above.

4. **Research Methodology and/or Technique**—A minimum of 9 credits in research methodology and/or technique courses numbered 5-000 or higher must be completed with grades of C or better to give students technical research competence in their area of specialization. The courses selected to meet this requirement must provide for an integrated development of this research competence, and must be approved by the advisor and by the Program Review Committee of the graduate faculty in business administration.

5. **Underlying Discipline**—The following fields are identified as underlying disciplines for business administration: economics, mathematics, psychology, and sociology. Prospective candi-

dates must achieve basic competency in one or two of the underlying disciplines by completing either:

a. One of the above underlying disciplines as a minor field; in this case, all of the minor field requirements as set forth by the University Graduate School must be met; *or*

b. Twelve graduate credits in one underlying discipline selected from the four listed above plus 12 graduate credits in a related field also outside the area of business administration (this latter related field may be a second underlying discipline from the four listed above). A grade average of B or better must be earned in the courses in each discipline used to meet the requirements of this subsection.

6. Foreign Language—A foreign language is not required.

7. Oral Examination—Within 1 month after the start of the quarter following the successful completion of the written preliminary examinations in the major and related fields in business, students will take a comprehensive (preliminary) oral examination. This examination may cover any work in the student's approved program with the exception of the thesis. Successful completion of this examination formally admits students to candidacy for the degree.

8. Thesis and Final Oral—Candidates will complete a doctoral dissertation and final oral examination as prescribed by the University Graduate School and the Graduate School of Business Administration.

9. Ph.D. Minor—Business administration may be selected as a minor, or as part of a supporting program, for the Ph.D. Persons planning to take a Ph.D. minor in business must first consult with the director of graduate study who will sign all programs under item 9a (below), or will designate the graduate faculty member(s) to be consulted under the provisions of item 9b (below). A Ph.D. minor in business administration shall consist of either:

a. A cohesive program of 24 credits of graduate work in business administration developed in consultation with an adviser who is a full member of the graduate faculty in business administration; *or*

b. Passing a written Ph.D. preliminary examination in one of the fields in business administration. (See list of fields in item 2 above. Persons wishing to minor in industrial relations should consult the director of graduate study in the Department of Industrial Relations.)

Accounting (Acct)

5-085. ACCOUNTING FOR LAW STUDENTS. (4 cr; prereq Upper Division pre-law or law student)
Accounting concepts and practices and their relation to economics and law.

5-125. AUDITING PRINCIPLES AND PROCEDURES. (4 cr; prereq 3-102, 3-201)
The external and internal auditor's roles and function. Includes audit standards, ethics, procedures, legal responsibilities.

5-135. INCOME TAX ACCOUNTING. (4 cr; prereq 1-051)
Individual, partnership, and corporation taxation, emphasizing income tax planning.

5-180. ADVANCED ACCOUNTING. (4 cr; prereq 3-102)
Consolidated statements, partnerships, fiduciary, international, and fund accounting.

5-270. REPORTING FOR MANAGEMENT CONTROL. (4 cr; prereq 3-201)
Responsibility accounting; transfer pricing problems, capital budgeting; management control systems.

5-285. BUDGETING—DETERMINISTIC PLANNING MODELS. (4 cr; prereq 3-201)
Capital planning models, cash budgets, simulation. Emphasis placed on computerized models.

5-286. BUDGETING—PROBABILISTIC PLANNING MODELS. (4 cr; prereq 5-285)
Applications of probabilistic models and other quantitative techniques to accounting problems.

5-300. CURRENT TOPICS IN MANAGERIAL ACCOUNTING. (4 cr [may be repeated for cr]; prereq 3-201, ‡)
Selected topic(s). Coverage varies from quarter to quarter.

5-310. CURRENT TOPICS IN FINANCIAL ACCOUNTING. (4 cr [may be repeated for cr]; prereq 3-102, ‡)
Selected topic(s). Coverage varies from quarter to quarter.

8-050. PRINCIPLES OF ACCOUNTING I. (4 cr, §1-050)
Basic financial accounting concepts.

8-051. PRINCIPLES OF ACCOUNTING II. (4 cr, §1-051; prereq 8-050)
Accounting analysis for management and investor decision making.

8-101. ACCOUNTING THEORY AND PRACTICE I. (4 cr, §3-101; prereq 8-051)
Accounting principles and concepts of income. Measurement and valuation problems. Funds flow.

8-102. ACCOUNTING THEORY AND PRACTICE II. (4 cr, §3-102; prereq 8-101)
Application of principles and concepts to assets and equities accounting.

8-135. INCOME TAX ACCOUNTING. (4 cr; prereq 8-051)
Taxation of individuals, partnerships, and corporations with emphasis upon the effect of income taxation on business planning.

8-160. FINANCIAL STATEMENT ANALYSIS. (4 cr, §3-160; not open to accounting majors; prereq 8-051)
Interpretation and analysis of financial statements for investment and credit purposes.

8-201. MANAGERIAL ACCOUNTING. (4 cr, §3-201; prereq 8-051, MIS 8-208)
Relevant accounting data for managerial planning and control. Includes behavioral aspects.

8-215. BEHAVIORAL ACCOUNTING. (4 cr; prereq 8-201)
Consideration of behavioral aspects of accountant's work.

8-255. MANAGERIAL COST ACCOUNTING. (4 cr, §3-255; not open to accounting majors; prereq 8-051)
Use of cost accounting and analysis by management in setting policies, making decisions, and maintaining controls.

8-805. FINANCIAL ACCOUNTING: SEMINAR I. (4 cr; prereq ‡)
Valuation and measurement.

8-810. FINANCIAL ACCOUNTING: SEMINAR II. (4 cr; prereq ‡)
Income determination.

8-815. FINANCIAL ACCOUNTING: SEMINAR III. (4 cr; prereq ‡)
Financial statements.

8-820. MANAGERIAL COST ACCOUNTING: SEMINAR. (4 cr; prereq ‡)
Cost structures, analysis for planning and control.

8-825. AUDITING: SEMINAR. (4 cr; prereq ‡)

8-845. ADVANCED ACCOUNTING PROBLEMS. (4 cr [may be repeated for cr]; prereq ‡)
Discussion and reports on selected topics in accounting; subject matter varies from quarter to quarter.

8-990. READINGS IN ACCOUNTING. (Cr ar; prereq ‡)
Readings useful to individual students but not available in regular courses.

8-995. RESEARCH IN ACCOUNTING. (Cr ar; prereq ‡)

Business Law (BLaw)

8-158. INTRODUCTION TO LAW, AND THE LAW OF CONTRACTS AND AGENCY. (4 cr, §3-058)
Origin of law, its place in and effect upon society; history and development of law; systems of courts; legal procedure. Extensive study of the law of contracts as the basic law affecting business transactions. Law affecting the relationship between principal and agent, master and servant, and employer and employee.

8-278. PARTNERSHIPS, CORPORATIONS, AND LAW OF REAL PROPERTY. (4 cr, §3-078; prereq 8-158 or equiv)
Partnership and corporate forms of business entities, including methods of creating these relationships, and law developed to regulate and control these organizations and their members. Basic concepts and principles of real property law; transfers of ownership, control of and encumbering such interests.

8-288. LAW OF PERSONAL PROPERTY, SALES CONTRACTS, COMMERCIAL PAPER, AND WILLS AND ESTATES. (4 cr, §3-088; prereq 8-158 or equiv)
Basic concepts of personal property, including rights of possessors, bailee, finders and holders of security interests. Extensive study of the law affecting sales of goods contracts and contracts referred to as commercial papers (negotiable instruments), with emphasis on effect of the Uniform Commercial Code. Law of wills and estates in passing rights to property in event of death.

Finance (BFin)

8-000. FOUNDATIONS OF FINANCE. (4 cr, §3-000; prereq Acct 8-050 or ‡)
Comprehensive introduction to principal concepts in finance, with selected applications to administrative problems confronting both business and nonprofit organizations.

8-100. FINANCIAL MANAGEMENT. (4 cr, §3-100; prereq 8-000)
Rigorous case-oriented course which simulates executive-level discussion of corporate financial policy. The student is challenged to apply basic principles of finance on his own initiative. Effective verbal and written communication stressed. Case discussions augmented by written assignments, lectures, readings, and occasional guest presentations by financial executives.

8-200. FINANCIAL POLICY AND INTERNATIONAL BUSINESS. (4 cr; prereq 8-000)
Development of a framework for analysis of financial policy and international business from the viewpoint of a financial manager. Topics include financial policy of corporations, international investment, foreign exchange, exchange rate changes, international financial cooperation, capital markets, and government policies, all analyzed in terms of relevance to a business corporation.

8-300. INVESTMENT ANALYSIS AND MANAGEMENT. (4 cr, §3-300; prereq 3-000 or 8-000)
Introduction to investment decision making from the viewpoints of individual and institutional investors. Analytical techniques of security selection and portfolio management in the context of the nation's changing securities markets. Focus on risk-return relationships of various marketable securities and portfolio strategies.

8-301. PORTFOLIO THEORY AND MANAGEMENT. (4 cr; prereq 8-300)
Both theoretical and practical aspects of management of investment portfolios. The mean-variance approach and the resulting advantage of diversification. Practical aspects of portfolio management. Special emphasis on the opportunities and problems of computer-oriented methods for investment research and portfolio management.

8-400. MANAGEMENT OF FINANCIAL INSTITUTIONS. (4 cr; prereq 3-000 or 8-000)
Modern techniques of financial management applicable to a broad spectrum of financial institutions. Emphasis on analytical and computer skills, as applied through cases, problems, and class discussion.

8-800. FINANCE SEMINAR. (Cr ar [may be repeated for cr]; prereq 8-000 and ‡)
Forum for advanced research in finance. Periodic offerings focus on contemporary research in selected subareas of finance, e.g., analytics of financial management; computerized financial research; financial management of nonprofit institutions; financial markets; research and public policy; and portfolio theory and valuation models. Since sections of this seminar will differ, students should inquire about planned content of each year's offerings.

8-990. READINGS AND RESEARCH IN FINANCE. (Cr ar [may be repeated for cr]; prereq consent of adviser and ‡)
Advanced readings in finance. Experimental subject areas and materials for seminar discussion. Opportunities for individualized readings and research programs developed under faculty supervision.

Management (Mgmt)

5-101. ADVANCED TOPICS IN MANAGEMENT. (Cr ar [may be repeated for cr]; prereq sr or grad and ‡)
Specialized topics; coverage changes from quarter to quarter.

5-175. BUSINESS FORECASTING. (4 cr; prereq OAM 3-055, Mgmt 3-001 or 8-001, or ‡)
Methods of economic, social, and technological forecasting and applications to problems of managerial decision making and planning.

8-001. FUNDAMENTALS OF MANAGEMENT. (4 cr, §3-001)
Evolving study of concepts, theory, research, and operational problems of management. Examines necessary factors and relationships 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.

8-004. ADVANCED TOPICS IN MANAGEMENT. (4 cr [may be repeated for cr]; prereq 8-001)
Topics of special interest; coverage changes from quarter to quarter.

8-006. PSYCHOLOGY IN MANAGEMENT. (4 cr, §3-002)
Development and application of behavior principles, methods, and skills which underlie managerial competence in preventing and solving problems within and between individuals and groups and aid in effective utilization of human resources. Various laboratory procedures used to highlight concepts, methods and skills and furnish practice in applying them to management problems.

8-008. GOVERNMENT AND BUSINESS ENTERPRISE I. (4 cr)
Nature and objectives of economic systems; their roles in securing fundamental economic and social goals. Development of the free enterprise system; its current relevance. Contrasting views of proper and actual roles of government and business as institutions and their implications for business behavior.

8-009. GOVERNMENT AND BUSINESS ENTERPRISE II. (4 cr; prereq 8-008 or ‡)
American industrial structure, conduct, and performance. Problems of business and labor concentration and their implications. The antitrust laws and their applications to the individual business enterprise. Alternatives to antitrust. The antitrust laws as a form of business-government interaction and the implications of this experience for other areas of interaction.

8-010. CORPORATE STRATEGY: DESIGN AND IMPLEMENTATION. (5 cr; prereq to be taken in either of the last 2 qtrs of Master's program or ‡)
Designed to develop skill in (a) identifying problems, (b) analyzing them, (c) devising realistic solutions to the problems, and (d) making oral and written presentations of results of such investigations and decisions reached. Taught by case method, covering a wide range of situations, usually involving more than one functional area of the enterprise. Typical primary problems relate to goals, organization, control information, style of leadership and occur in one or more functional areas of the business as well as the top management level.

8-011. EVOLUTION AND DEVELOPMENT OF MANAGERIAL THOUGHT. (4 cr; prereq 8-001)
Intensive study of outstanding writers and practitioners in building a theory and philosophy of management. Case to be made for management as a distinct functional activity. Movement to apply methods of science to the area of management. Contributions made by various disciplines to the concept of management (e.g., engineering, sociology, psychology, economics). Projection of role of executive into the firm and society of the future.

8-012. ORGANIZATIONAL BEHAVIOR AND MANAGEMENT ANALYSIS. (4 cr; prereq 8-011)
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 will prepare papers based on their own research or on secondary analysis of existing literature.

8-251. BUSINESS RESEARCH METHODS AND TECHNIQUES. (4 cr; prereq QA 1-050 or equiv)
Examination and evaluation of research techniques; scientific method and philosophy; project design; data sources and analysis. Place of research in business administration. Student projects.

8-801. SEMINAR: INTERPERSONAL RELATIONS. (4 cr; prereq 3-002 or 8-006)

8-802. SEMINAR: MANAGEMENT. (4 cr; prereq 3-001 or 8-001)

8-990. READINGS IN MANAGEMENT THEORY AND ADMINISTRATION. (Cr ar; prereq consent of adviser, ‡, 2nd-yr grad, requisite introductory courses)
Intensive research into a particular subject; preparation of a major term paper normally required.

8-995. GRADUATE RESEARCH IN MANAGEMENT THEORY AND ADMINISTRATION. (Cr ar; prereq consent of adviser, ‡, 2nd-yr grad, requisite introductory courses)
Special research projects in cooperation with a specific problem in a business firm.

Management Information Systems (MIS)

5-096. SYMBOLIC ASSEMBLY LANGUAGES. (1 cr)
Use of symbolic assembly language in programming of computers. Self-paced instruction involving programming, using the Basic Assembly Language for the IBM System/360 and 370 of a structured set of problems, taking short quizzes, and participating in a programming laboratory.

5-097. SIMULATION LANGUAGES. (1 cr; prereq 3-099 or equiv)
Use of a simulation language such as GPSS of SIMSCRIPT to program a simulation on a digital computer. Self-paced instruction involving programming in a simulation language of a structured set of problems, taking short quizzes, and participating in a programming laboratory.

5-098. INTERMEDIATE COBOL. (1 cr; prereq 3-098 or equiv)
Intermediate and advanced features of the COBOL programming language. Self-paced instruction involving programming in COBOL of a structured set of problems, taking short quizzes, and participating in a programming laboratory.

5-099. INTERMEDIATE FORTRAN. (1 cr; prereq 3-099 or equiv)
Intermediate and advanced features of the FORTRAN language such as subprograms, advanced I/O, type declarations, and efficient programming. Self-paced instruction involving programming in FORTRAN of a structured set of problems, taking short quizzes, and participating in a programming laboratory.

5-101. INTRODUCTION TO MANAGEMENT INFORMATION SYSTEMS. (4 cr)
An overview of the field of management information systems. Topics include: relationship of information, management, and systems; what the manager should know about the computer; information systems for operational, tactical, and strategic decision making; administration and control of MIS development; and behavioral aspects of information processing.

5-102. INTRODUCTION TO SYSTEMS ANALYSIS. (4 cr; prereq 3-100, 5-101)
Feasibility studies, functional analysis, systems prototypes, specification, run definition implementation and operation. Particular attention to management systems concepts for imbedding a computer-based system into the organization. Concentration on the development of standards for systems work.

5-103. DATA STRUCTURES AND FILE PROCESSING. (4 cr; prereq 3-100, 5-101)
Sequential file processing, sorting techniques, and the standard random-access techniques, such as index sequential and randomizing. Introduction to the concepts of data management storage structures by studying list, multilists, rings, and inverted file structures.

8-208. INTRODUCTION TO COMPUTER SYSTEMS. (4 cr; prereq 3-098 or 3-099 or ¶)
Basic elements of computer hardware, software, and programming. Introduction to management information systems. Application of computers to problems in organizations.

8-209. DESIGN AND APPLICATION OF MANAGEMENT INFORMATION SYSTEMS. (5 cr; prereq 8-208, 3-098, 3-099, and 5-098 or ¶)
Principles of systems analysis and design of management information systems. Tools for performing systems analysis and design. Introduction to file structures and data management. Modeling and evaluation of information systems. Building a management information system—a case-oriented application of systems analysis and design.

8-210. ANALYSIS OF INFORMATION SYSTEMS. (5 cr; prereq 8-209 and 5-099 or ¶)
Theoretical approaches to systems analysis. Fundamental principles of system and subsystem structures, parts, and boundaries. Use of systems algebra and graphs for describing systems functions. Characteristics of information systems requirements, hardware, data, and performance criteria. Relation between a data process and its files. Introduction to information structures, lists, programming systems, and operating systems. Hardware and programming implication of grouping data, files, and processes.

8-229. SOFTWARE SYSTEMS. (4 cr; prereq 5-099 and 8-208)
Concepts underlying software systems, elements of design, and use in complex, computer-based systems. Assemblers, compilers, operating systems, and utility packages.

8-239. ONLINE REALTIME SYSTEMS AND DATA COMMUNICATIONS. (4 cr; prereq 8-209)
Concepts and design methods for interactive, realtime systems. Data communications in advanced systems. Hardware, software, and systems problems in design and operation of online realtime systems. Analysis of cost/value of realtime processing.

8-249. DATA MANAGEMENT AND RETRIEVAL. (4 cr; prereq 8-209)
Concepts and methods in design, establishment, and maintenance of the data base for a management information system. Approaches to information retrieval.

8-269. CONTROL AND ADMINISTRATION OF MANAGEMENT INFORMATION SYSTEMS. (4 cr; prereq 8-208)
Theory and practice of planning, control and administration applied to management information systems. Control elements in system design. Management of the information system.

8-839. SEMINAR: MANAGEMENT INFORMATION SYSTEMS. (Cr ar)

8-990. READINGS IN MANAGEMENT INFORMATION SYSTEMS. (Cr ar; prereq consent of adviser and ‡, 2nd year grad and requisite introductory courses)

8-995. GRADUATE RESEARCH IN MANAGEMENT INFORMATION SYSTEMS. (Cr ar; prereq consent of adviser and ‡, 2nd-yr grad and requisite introductory courses)

Manpower Economics and Industrial Relations (IR)

For description of the following courses see Industrial Relations.

IR 8-000. GRADUATE TOPICS IN INDUSTRIAL RELATIONS

IR 8-002. INDUSTRIAL RELATIONS SYSTEMS: LABOR MARKETS AND THE MANAGEMENT OF HUMAN RESOURCES

IR 8-003. ORGANIZATION AND STAFFING

IR 8-004. ORGANIZATION THEORY AND ANALYSIS

IR 8-005. EMPLOYEE COMPENSATION AND REWARD

IR 8-006. LABOR MARKETS: PROCESSES AND DYNAMICS

IR 8-007. COLLECTIVE BARGAINING NEGOTIATIONS: PROCESSES IN THE PUBLIC AND PRIVATE SECTORS

IR 8-010. INTERMEDIATE MANPOWER MANAGEMENT

IR 8-011. QUANTITATIVE METHODS IN INDUSTRIAL RELATIONS

IR 8-015. COMPENSATION, REWARD, MOTIVATION, AND PERFORMANCE

IR 8-016. INTERNATIONAL MANPOWER DEVELOPMENT AND UTILIZATION

IR 8-017. UNION GOVERNMENT AND POLICIES

IR 8-023. TRAINING AND DEVELOPMENT

IR 8-026. LABOR MARKETS: THEORETICAL AND EMPIRICAL CONSIDERATIONS

IR 8-027. COLLECTIVE BARGAINING NEGOTIATIONS: INDUSTRIAL CONFLICT

IR 8-033. MANAGEMENT DEVELOPMENT

IR 8-801. SEMINAR: INDUSTRIAL RELATIONS RESEARCH METHODOLOGY

IR 8-802. SEMINAR: INDUSTRIAL RELATIONS SYSTEMS

IR 8-803. SEMINAR: STAFFING, TRAINING, AND DEVELOPMENT

IR 8-804. SEMINAR: ORGANIZATIONS THEORY

IR 8-805. COMPENSATION AND REWARD SEMINAR

IR 8-806. SEMINAR: ADVANCED TOPICS ON LABOR MARKET THEORY AND RESEARCH

IR 8-807. SEMINAR: ADVANCED TOPICS IN COLLECTIVE BARGAINING

IR 8-990. INDEPENDENT STUDY IN INDUSTRIAL RELATIONS

Marketing (Mktg)

8-000. PRINCIPLES OF MARKETING. (4 cr, §3-000; prereq Econ 1-002 or equiv)
Basic policy and strategy issues in marketing and environmental factors that affect these issues. Legal, behavioral, ethical, competitive, economic, and technological factors as they affect product, pricing, promotion, and marketing channel decisions.

8-040. INTERNATIONAL MARKETING. (4 cr, §3-040; prereq 3-000 or 8-000)
Environmental factors impinging on international trade, such as culture and business customs, political factors and constraints, economic development, and multinational market groups; management of international trade including market potentials, marketing research, international organization, channels of distribution, sales promotion, pricing, credit, and financing; comparative marketing systems; case materials.

8-047. MARKETING MANAGEMENT. (4 cr; prereq 3-000 or 8-000)
Managing the marketing function; marketing planning, marketing strategy, marketing management concepts. Managing the marketing system; analysis of market structure. Extensive use of cases with a marketing decision orientation.

8-065. RETAIL MANAGEMENT. (4 cr, §3-065; prereq 3-000 or 8-000)
Principles and methods of retail management. Lectures and case materials focus on major decision areas, such as site selection, layout, merchandising, budgeting, and control. Social issues, trends, and future retailing systems also discussed.

8-075. SALES MANAGEMENT. (4 cr, §3-075; prereq 3-000 or 8-000)
Management of the personal selling function including sales organization; selection, training, compensation, motivation, supervision, and control of the field sales force; sales forecasting; sales budgets; sales and cost analysis. Case materials used extensively.

8-077. ADVERTISING AND SALES PROMOTION. (4 cr, §3-077; prereq 3-000 or 8-000)
The promotion function in marketing: media, audience, message, and communication theory. Establishing objectives for advertising and sales promotion, budget and media allocation decisions, sales promotion mix components, advertiser-agency structure and relationships, techniques for assessing advertising and sales promotion effectiveness, and socioeconomic considerations.

8-080. INDUSTRIAL AND GOVERNMENTAL PROCUREMENT. (4 cr, §3-080; prereq 3-000 or 8-000)
Procurement of supplies, equipment, and complete systems by industrial firms and governmental agencies. Quantity and quality decisions, forward buying, pricing decisions, and vendor selection decisions common to both industrial and governmental purchases. Unique problems of the acquisition of technological systems by government agencies; national and regional impact of these procurements.

8-085. PRICE AND PRODUCT POLICY. (4 cr, §3-085; prereq 3-000 or 8-000)
Managerial aspects of pricing and product policies and strategies. Methods used and factors considered in developing and updating product line and pricing decisions in both industrial and consumer markets. Topics covered include: pricing and product line objectives, product planning and evaluation, managing the product line, environmental factors affecting product and pricing strategies, and quantitative aspects of product line and pricing decisions.

8-090. MARKETING TOPICS. (Cr ar, §3-090; prereq 3-000 or 8-000)
Various selected topics and problems of current interest considered in depth. Class discussion and course projects.

8-095. MARKETING RESEARCH. (4 cr, §3-095; prereq 3-000 or 8-000, OAM 3-055 or equiv)
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.

8-098. INTRODUCTION TO CONSUMER BEHAVIOR. (4 cr, §3-098; prereq 3-000 or 8-000)
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."

8-800. SEMINAR: MARKETING THEORY. (4 cr; prereq 3-000 or 8-000 or equiv, ‡)

8-810. SEMINAR: CONSUMER BEHAVIOR. (4 cr; prereq 3-098 or 8-098, ‡)

8-820. SEMINAR: SOCIAL AND ECONOMIC ASPECTS OF MARKETING. (4 cr; prereq 3-000 or 8-000 or equiv, ‡)

8-990. READINGS IN MARKETING. (Cr ar; prereq 3-000 or 8-000, consent of adviser, ‡ in field covered)
Readings useful to student's program and objectives but not available in regular course offerings.

8-995. GRADUATE RESEARCH IN MARKETING. (Cr ar; prereq 3-000 or 8-000, consent of adviser, ‡ in field covered)
Individual research on an approved topic appropriate to the student's program and objectives.

Operations Analysis and Management (OAM)

5-056. APPLICATIONS OF ANALYTICAL METHODS AND COMPUTERS IN OPERATIONS MANAGEMENT AND ANALYSIS. (5 cr; prereq 3-055 or ‡)
Application of forecasting methods, optimization techniques; simulation, product and project management methods; inventory models, quality control techniques and computer technology problems encountered in organizational management. Specific laboratory sessions include problem solving and case analysis.

8-100. PROBLEMS IN OPERATIONS ANALYSIS AND MANAGEMENT. (4 cr; prereq 5-056)
Case study of current problems and techniques in the area of operations analysis and management. Builds upon and extends the concepts and techniques developed in basic courses. Problem areas cover the broad spectrum of business operations. Course serves as good preparation for OAM 8-159.

8-159. QUANTITATIVE APPROACHES TO ADMINISTRATIVE PROBLEMS. (5 cr; prereq 3-055, to be taken in terminal quarter of Master's program and ‡)
Field study of current problems and quantitative techniques in administration. Practical application of concepts and techniques developed in basic courses. Interest areas cover the broad spectrum of business administration problems. Students must contact department secretary prior to end of fourth week of classes in quarter prior to the quarter in which they plan to register for this course.

8-215. OPERATIONAL FORECASTING. (4 cr; prereq 5-056)
Forecasting models for discrete time series; measurement and analysis of error measurements; applications in decision making and design of dynamic control sytsems.

8-220. APPLICATIONS IN OPERATIONS ANALYSIS I (GENERAL). (4 cr; prereq 5-056)
Designed to increase students' ability to formulate problems and construct models for profit and nonprofit organizations. Introduction to existing models and to long-range planning.

8-221. APPLICATIONS IN OPERATIONS ANALYSIS II (SPECIFIC). (4 cr; prereq 8-220)
Introduction to applications for management of operations. Emphasis on analysis of scheduling and control problems.

8-850. SEMINAR: OPERATIONS ANALYSIS AND MANAGEMENT. (Cr ar; prereq 8-100 or equiv)

8-990. READINGS IN OPERATIONS ANALYSIS AND MANAGEMENT. (Cr ar; prereq consent of adviser and ‡, 2nd-yr grad and requisite introductory courses)

8-995. GRADUATE RESEARCH IN OPERATIONS ANALYSIS AND MANAGEMENT. (Cr ar; prereq consent of adviser and ‡, 2nd-yr grad and requisite introductory courses)
Research projects in cooperation with a specific problem in a business firm.

Quantitative Analysis (QA)

5-161. ADVANCED TOPICS IN MANAGEMENT SCIENCES. (4 cr; prereq OAM 3-055)
Special emphasis on current applications.

5-171. STATISTICAL METHODS FOR SAMPLE SURVEYS. (4 cr; prereq 1-050 or equiv)
Introduction to commonly used sampling methods and their application, including stratified, multistage and cluster sampling; methods of estimation including ratio and regression estimates; design of surveys taking into account costs; statistical measurement and control of nonsampling errors. Case analysis.

8-191. STATISTICAL METHODS IN BUSINESS ADMINISTRATION. (5 cr; prereq 1-050 and Math 1-142)
Tests on nature of population and population characteristics. Normal, t, chi square, and F distributions, nonparametric estimation and tests. Multiple regression and correlation. Other measures and tests of association. Applications to business problems.

8-193. ANALYSIS OF VARIANCE AND EXPERIMENTAL DESIGN IN BUSINESS. (4 cr; prereq 8-191 or equiv)
Analysis of variance for one-way, two-way data. Basic concepts of statistical design and analysis of results. Randomized block, latin square, crossover, factorial designs; confounding; estimation and comparison of effects; response surfaces; applications in business administration.

8-219. SIMULATION TECHNIQUES. (4 cr; prereq 8-191 and OAM 5-056)
Introduction to simulation; models, rationale, and analysis. Principles of Monte Carlo simulation. Survey of types of simulation. Experimental design for simulation.

8-231. LINEAR PROGRAMMING. (4 cr; prereq OAM 5-056)
Introduction to the linear programming area. Development of linear programming, mathematical content of algorithms and methods discussed as well as applications which illustrate the techniques. Problem formulation, simplex methods and variants, network problems, probabilistic linear programs, and decomposition.

8-232. NONLINEAR AND DYNAMIC PROGRAMMING. (4 cr; prereq 8-231)
Advanced methods for solving nonlinear and dynamic programs. Primarily technique oriented although applications discussed to illustrate main ideas. Classical optimization methods, gradient techniques, projection methods, and both problem formulation and solution methods in dynamic programs.

8-236. STOCHASTIC PROCESSES. (4 cr; prereq 8-191 or ‡)
Development of models of discrete state probabilistic processes, Markov chains, birth and death processes, and queuing models. For graduate students interested in applying these models to operational problems.

8-237. TIME SERIES ANALYSIS. (4 cr; prereq 8-236 or ‡)
Use of stationary and nonstationary linear stochastic processes in forecasting. Statistical analysis of discrete, univariate stationary time series; correlograms and periodograms. Transfer functions and introduction to multivariate time series analysis.

8-271. STATISTICAL DECISION THEORY. (4 cr; prereq 8-191 or equiv)
Decision making under certainty and uncertainty; utility theory; statistical decision theory; risk and risk function; decision functions; admissibility, sufficiency; Bayes decision rules; relation of classical statistics to statistical decision theory; applications to business.

8-351. SEMINAR: MANAGEMENT SCIENCES. (Cr ar; prereq OAM 3-055)
Forum for a broad range of state-of-the-art topics. Purpose is to develop an understanding and awareness of a variety of management sciences topics.

8-361. SEMINAR: MATHEMATICAL PROGRAMMING. (Cr ar; prereq 8-231)
Formulation of large-scale linear systems. Structure of problems from production scheduling, allocation, transportation, capital budgeting, network flows, input-output analysis, etc. Solution by decomposition and column generation. Formulation of integer and 0-1 constraints. Cutting plane and branch and bound methods.

8-371. SEMINAR: DECISION THEORY. (Cr ar; prereq 8-191)

8-381. SEMINAR: STOCHASTIC MODELS. (Cr ar; prereq 8-236)

8-990. READINGS IN QUANTITATIVE ANALYSIS. (Cr ar; prereq ‡)

8-995. GRADUATE RESEARCH IN QUANTITATIVE ANALYSIS. (Cr ar; prereq ‡)

Risk Management and Insurance (Ins)

8-100. RISK MANAGEMENT AND INSURANCE I. (4 cr, §3-100)
Recognizing and evaluating the property, liability, and personnel risks facing a business firm, a family, or other economic unit. Tools of risk management—retention, loss prevention, and insurance—and conditions under which they should be used. Selecting and dealing with an insurer. Public policy issues—government regulation, social insurance, and automobile insurance problems.

8-101. RISK MANAGEMENT AND INSURANCE II. (4 cr; prereq 8-100)
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.

8-200. LIFE AND HEALTH INSURANCE. (4 cr, §3-200; prereq 3-100 or 8-100)
Types of individual life and health insurance contracts, their uses, and their major provisions. Insurance and pension components of employee-benefit plans—their characteristics and regulation. Programming and estate planning. Business uses of individual life and health insurance. Selection of a life and health insurer.

8-210. ECONOMIC AND SOCIAL SECURITY. (4 cr, §3-210, §Econ 5-534)
Public and private approaches to problems of economic insecurity and poverty. Nature and causes of economic insecurity and poverty. Details and economic and social implications of private and public programs with emphasis on public programs such as social insurance and public assistance, and proposals such as guaranteed minimum income.

8-220. PROPERTY AND LIABILITY INSURANCE. (4 cr, §3-220; prereq 3-100 or 8-100)
Types and 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 and no-fault automobile insurance.

8-230. ACTUARIAL SCIENCE PRINCIPLES. (4 cr, §3-230; prereq Math 1-142 or ‡)
Calculation of net premiums, gross premiums, reserves, and nonforfeiture values for major life insurance contracts. Impact of assumed mortality, interest, and expense assumptions upon these items.

8-231. LIFE CONTINGENCIES. (4 cr, §3-231; prereq 8-230 or ‡)
Advanced topics on compound interest and annuities certain, the measurement of mortality, life insurance, and annuity premiums and reserves. Multilife functions. Population problems and multiple-decrement theory.

8-800. SEMINAR: RISK MANAGEMENT AND INSURANCE. (4 cr; prereq 3-100 or 8-100 and ‡)
Selected topics in risk management and insurance.

8-990. READINGS IN RISK MANAGEMENT AND INSURANCE. (Cr ar; prereq consent of adviser, ‡ in field covered)
Readings useful to student's individual program and objectives but not available in regular course offerings.

8-995. GRADUATE RESEARCH IN RISK MANAGEMENT AND INSURANCE. (Cr ar)
Research topics tailored to student needs.

Transportation and Business Logistics (Tran)

5-134. TRANSPORTATION AND BUSINESS LOGISTICS TOPICS. (Cr ar [may be repeated for cr]; prereq 3-054 or 8-154 and ‡)
Specialized topics. Coverage changes from quarter to quarter.

5-194. GOVERNMENT PROMOTION OF TRANSPORTATION. (4 cr; prereq 3-054 or 8-154)
The need for, form of, administration of, and impact of government promotion and subsidy of rail, highway, air, pipeline, and water transportation in the United States.

5-195. GOVERNMENT ECONOMIC REGULATION OF TRANSPORTATION. (4 cr; prereq 3-054 or 8-154)
The need for, form of, administration of, and impact of government economic regulation of rail, highway, air, pipeline, and water transportation in the United States.

8-154. FUNDAMENTALS OF TRANSPORTATION. (4 cr, §3-054; prereq Econ 1-002 or equiv)
Organization and economic aspects of the transportation system of the United States including rail, highway, air, pipeline, and water transportation. Administration of transportation by users of transportation, providers of transportation (carriers), and government.

8-264. BUSINESS LOGISTICS. (5 cr, §3-064; prereq 3-054 or 8-154)
Control of the flow of physical product by the firm. Topics include rate negotiation, transportation alternatives, logistics information systems, inventory control, warehouse operations and location, and logistics system design.

8-284. CARRIER MANAGEMENT. (5 cr, §3-084; prereq 3-054 or 8-154)
Managerial problems of carriers by rail, highway, air, and water. Topics include problems associated with carrier organization, operations, traffic and sales, finance and control, labor relations, public policy issues, and shipper-carrier interface.

8-804. SEMINAR: TRANSPORTATION AND BUSINESS LOGISTICS. (4 cr; prereq 3-054 or 8-154 or ‡)

8-990. READINGS IN TRANSPORTATION AND BUSINESS LOGISTICS. (Cr ar; prereq consent of adviser, ‡ in field covered)
Readings useful to student's individual program and objectives but not available in regular course offerings.

8-995. GRADUATE RESEARCH IN TRANSPORTATION AND BUSINESS LOGISTICS. (Cr ar; prereq consent of adviser, ‡ in field covered)

CHEMICAL ENGINEERING AND MATERIALS SCIENCE

Neal R. Amundson, *professor and head*

CHEMICAL ENGINEERING**

Professor

Herbert S. Isbin, *director of graduate study*
Rutherford Aris
Norman H. Ceaglske
John S. Dahler
H. Ted Davis
Arnold G. Fredrickson
Kenneth H. Keller
William E. Ranz
L. Edward Scriven II
Henry M. Tsuchiya

Associate Professor

Robert W. Carr, Jr.
Lanny D. Schmidt

Assistant Professor

Chris Macosko
Charles H. Swanson

METALLURGY/MATERIALS SCIENCE**

Professor

Louis E. Toth, *director of graduate study*
Morris E. Nicholson
Richard A. Swalin

Associate Professor

William W. Gerberich
Thomas E. Hutchinson
John M. Sivertsen

Assistant Professor

Chris Macosko

Prerequisites—For major work, the Bachelor's degree in chemical engineering, metallurgy, materials science, polymer engineering, chemistry, or physics. If they have not met this requirement, students may be required to pursue such additional preparatory studies as may be prescribed by their adviser.

For minor work, mathematics, physics, mechanics, chemistry, or supporting programs are generally chosen.

Major candidates for the Master's or Doctor's degree must have completed, as undergraduate or graduate, a year's work in physical chemistry.

Language Requirement—Students seeking the Ph.D. degree must demonstrate reading proficiency in one language other than their native language. Reading proficiency shall be demonstrated when students have:

1. Passed an intermediate level reading examination provided by the language department in question, and
2. Obtained the certification of their adviser that they are proficient.

With the approval of their adviser, students may petition the graduate committee of the department for permission to replace the foregoing requirement with an alternative program representing an equivalent amount of effort.

Examinations—The proficiency examinations for all entering graduate students will be given once each year, normally prior to the start of the fall quarter.

Master's Degree—Offered only under Plan A for chemical engineering, and both Plans A and B for metallurgy and materials science.

Doctor's Degree—Work leading to the Ph.D. degree is offered with flexible course programs in major and minor or supporting fields.

Chemical Engineering (ChEn)

5-001. MATHEMATICAL METHODS IN CHEMICAL ENGINEERING AND MATERIALS SCIENCE. (2 cr)
Computer programming with applications to chemical, physical, and engineering problems.

5-101. PRINCIPLES OF CHEMICAL ENGINEERING. (4 cr)
Energy and material balances applied to chemical engineering systems.

5-102. PRINCIPLES OF CHEMICAL ENGINEERING. (4 cr; prereq 5-101)
Fluid dynamics and its application to chemical engineering unit operations.

** Staff members participate in both undergraduate and graduate courses in combined programs.

5-103. PRINCIPLES OF CHEMICAL ENGINEERING. (4 cr; prereq 5-101)
Heat and mass transfer and its application to chemical engineering unit operations.

5-104. UNIT OPERATIONS AND SEPARATION PROCESSES. (4 cr; prereq 5-101)
Absorption, extraction, distillation, stagewise and continuous separations.

5-201. THERMODYNAMICS AND MATERIAL STATES. (4 cr)
Principles of thermodynamics applied to closed and open and to equilibrium states of homogeneous and heterogeneous substances, gases, liquids, and solids.

5-202. CHEMICAL ENGINEERING THERMODYNAMICS AND KINETICS. (4 cr; prereq 5-201)
Chemical equilibrium and chemical kinetics applied to chemical engineering systems.

5-301. CHEMICAL REACTOR ANALYSIS. (4 cr; prereq 5-202)
Principles of reactor design for homogeneous and heterogeneous reactions. Analysis of reactors from a kinetic and thermodynamic point of view.

5-401. CHEMICAL ENGINEERING LABORATORY. (2 cr)
Applications of unit operations; principles in fluid flow, heat and mass transfer; experiments with reports.

5-402. CHEMICAL ENGINEERING LABORATORY. (2 cr)
Continuation of ChEn 5-401.

5-403. CHEMICAL ENGINEERING LABORATORY. (2 cr)
Continuation of ChEn 5-401.

5-501. PROCESS EVALUATION AND DESIGN. (4 cr; prereq 4th yr or ‡)
Dynamics of chemical engineering industries, economics of process evaluation, bases for cost estimations. Applications of unit operations, reaction kinetics, and thermodynamics. Initiation of group projects.

5-502. PROCESS EVALUATION AND DESIGN. (2 cr; prereq 5-501)
(See ChEn 5-501) Process design project.

5-601. PROCESS CONTROL. (4 cr; prereq 4th yr or ‡)
Theory and application of instrumentation and control with particular emphasis on application to the chemical industry, including analytical methods.

5-603. ADVANCED PROCESS CONTROL. (4 cr; prereq 5-601)
(Continuation of 5-601) Additional methods for analysis and design of process control systems.

5-701/5-702/5-703. NUCLEAR REACTOR DESIGN. (3 cr per qtr; prereq ‡)
Engineering approach to development and application of nuclear reactor theory, including basic nuclear chemistry and physics, mathematical developments and special techniques, design, operation, and control of homogeneous and heterogeneous reactors, and nuclear reactor safety and economics. Laboratory credit available.

5-751/5-752/5-753. BIOLOGICAL ENGINEERING ANALYSIS. (3 cr per qtr; prereq ‡)
Modeling and analysis of biosystems. Thermodynamics, transport and transfer, biochemical reactions, growth and death processes discussed from both deterministic and probabilistic viewpoints.

5-901. CHEMICAL PROCESS LABORATORY. (2 cr; prereq 5-301)
Applications of principles covered in ChEn 5-301 in pilot or semiplant laboratory.

5-902, 5-903, 5-904, 5-905. SPECIAL PROBLEMS. (Cr ar)
Investigations in chemical engineering. Library or laboratory research.

8-001, 8-002, 8-003. PHYSICAL RATE PROCESSES AND TRANSFER OPERATIONS. (3 cr per qtr; prereq 5-103, ‡)
Advanced unit operations principles developed in terms of equilibrium and physical rate processes. Transport theories and important mass transfer and separation operations; distillation, absorption, extraction, leaching, etc. Typical problems solved for design of ideal stage and transport-controlled multistage of columnar contacting equipment.

8-004. PHYSICAL RATE PROCESSES. (3 cr; prereq 5-103, ‡)
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 ionic diffusion.

8-101. INTERMEDIATE FLUID MECHANICS. (3 cr; prereq 5-103, ‡)
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.

8-102. PROBLEMS IN FLUID MECHANICS. (3 cr; prereq 8-101)
Application of principles to prototypal cases of flow and transfer: problem solving and critical analysis of literature of physicochemical fluid mechanics.

8-103. TENSORS AND FIELD THEORY WITH APPLICATIONS TO CONTINUUM MECHANICS. (3 cr; prereq 8-201)
Tensor analysis as a basis for classical field theory. Continuum mechanics—equations of balance and constitutive relations. Applications in fluid mechanics, rheology, and statistical mechanics.

8-104. BOUNDARY AND INTERFACE MECHANICS. (3 cr; prereq 8-103; offered 1972-73 and alt yrs)
Theory of boundary conditions. Equilibrium and dynamics of fluid interfaces. Analysis of surface tension-driven motions and other interfacial phenomena.

8-105. PRINCIPLES AND APPLICATIONS OF RHEOLOGY. (3 cr; prereq 8-101, 8-103 or ‡; offered 1973-74 and 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.

8-106. ADVANCED TOPICS IN FLUID MECHANICS AND TRANSPORT PROCESSES. (3 cr; prereq 8-101, 8-103)
Topics in ideal, viscous, and turbulent flow and transport, interphase transfer.

8-201/8-202/8-203. ADVANCED MATHEMATICS FOR CHEMICAL ENGINEERS. (3 cr; prereq ‡)
Elements of linear algebra with applications. Tensors and vectors. Advanced treatment of ordinary and partial differential equations. Calculus of variations, dynamic programming, optimization. Problems.

8-301/8-302. ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS. (3 cr per qtr; prereq 5-202 or ‡)
Recent advances in theory and applications, particularly to flow systems. Topics; equations of state and generalizations, solution equilibriums, irreversible thermodynamics, etc., with problems.

8-401. CHEMICAL REACTION KINETICS—KINETICS OF HOMOGENEOUS REACTIONS. (3 cr; prereq ‡)
Descriptions 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.

8-402. CHEMICAL REACTION KINETICS—SURFACE CHEMISTRY. (3 cr; prereq ‡)
Kinetics of interfacial processes. Heterogeneous catalysis. Thermodynamics and statistical mechanics of interfaces.

8-403. CHEMICAL REACTION KINETICS—ADVANCED TOPICS. (3 cr; prereq ‡)

8-500. 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.

8-501/8-502/8-503. 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.

8-601/8-602/8-603. MOLECULAR THEORY OF TRANSPORT PROCESSES. (3 cr per qtr; prereq ‡)
Theory and interpretation of fluid transport phenomena in terms of molecular-scale processes.

8-701. ANALYSIS OF CHEMICAL ENGINEERING PROBLEMS. (3 cr; prereq 8-203)
Critical analysis of current chemical engineering literature.

8-702. ADVANCED TOPICS IN CHEMICAL ENGINEERING. (3 cr)

8-801, 8-802, 8-803. SEMINAR. (1 cr per qtr)
Presentation and discussion of papers concerning the newer developments in chemical engineering.

8-850. GENERAL SURVEY OF CHEMICAL ENGINEERING. (1 cr; prereq ‡; 8-850 is prereq to candidacy for Ph.D. degree with major or minor in chemical engineering, and an exam must be taken by end of fall qtr of 2nd yr in residence)
Independent reading under the guidance of the staff.

8-901, 8-902, 8-903. RESEARCH IN CHEMICAL ENGINEERING. (Cr ar)
Heat and mass transfer, fluid dynamics, chemical kinetics, chemical reactor theory, thermodynamics, process control, bioengineering, applied mathematics.

Metallurgy/Materials Science (MatS)

5-011/5-012/5-013. INTRODUCTION TO SCIENCE OF MATERIALS. (4 cr; prereq 3rd-yr IT student)
Introduction to relation between atomic and electronic structure of metals, semiconductors, insulators, and polymers and important properties of materials.

5-101. THERMODYNAMICS AND MATERIALS STATES. (4 cr; 3 lect and 2 rec hrs per wk)
(Same as ChEn 5-201) Principles of thermodynamics applied to closed and open systems and to equilibrium states of homogeneous and heterogeneous substances, gases, liquids, and solids.

5-102. THERMODYNAMICS AND KINETICS OF THE SOLID STATE. (4 cr; prereq course in chemical thermodynamics)
Theory of solids, heterogeneous equilibria, free energy composition diagrams, diffusion and reaction kinetics.

5-111. MATHEMATICAL METHODS IN CHEMICAL ENGINEERING AND MATERIALS SCIENCE. (2 cr)
(Same as ChEn 5-001) Computer programming with applications to chemical, physical, and engineering problems.

5-301. CONTROL OF MECHANICAL PROPERTIES IN METALS AND ALLOYS. (4 cr; 3 lect, 2 lab hrs per wk)
Mechanical properties of metals and alloys are discussed in terms of dislocation behavior, creep, fatigue, fracture toughness. Attention to control of mechanical properties through manipulation of microstructure by metal processing.

5-303. ANALYSIS OF METALLURGICAL PROBLEMS. (4 cr; 2 lect, 4 lab hrs per wk)
Specialized metallurgical subjects such as embrittlement of steels, residual stresses, wear, and fatigue in metals with primary emphasis on failure analysis.

5-401/5-402/5-403. PRINCIPLES OF PHYSICAL METALLURGY. (4 cr per qtr; prereq 5-012 or ‡)
Fundamentals of solidification, transformations; strength, deformation, and fracture of solids, casting hardenability, heat treatment of alloys; surface treatment, joining, working of metals.

5-450. CORROSION OF METALS. (3 cr; background in materials science and thermodynamics desirable)
Electrochemical theory, mechanisms of corrosion, theories of passivity, influence of environmental factors on corrosion. High temperature oxidation, corrosion control, organic coatings, alloying, inhibitors.

5-481, 5-482, 5-483. SPECIAL PROBLEMS IN PHYSICAL METALLURGY AND MATERIALS SCIENCE. (Cr and hrs ar; prereq sr standing)
Library or laboratory studies of scientific or engineering problems in physical metallurgy and materials science.

5-500. QUANTITATIVE METALLOGRAPHY AND ELECTRON MICROSCOPY. (3 cr; 2 lab hrs per wk)
Microstructure of materials, temperature measurement and control, equilibrium diagrams, quantitative metallography, electron microscopy.

5-521. X-RAY METALLOGRAPHY. (3 cr; 2 lab hrs per wk)
Physics of X-ray diffraction, powder patterns, crystal orientation, microradiography, application to metallurgy and materials science, solvus determination, phase equilibria, structure of cold worked metals.

5-610. POLYMERIC MATERIALS. (4 cr; prereq Chem 5-501 or ‡; 3 lab hrs per wk)
Introduction to structure of synthetic and biopolymers; polymerization and subsequent effect of structure on crystallinity, physical properties and viscoelastic behavior. Fabrication processes, applications of polymers and their environmental degradation.

8-110. THERMODYNAMIC PROPERTIES OF SOLIDS: CLASSICAL AND STATISTICAL MECHANICS APPLIED TO STUDY OF THE PROPERTIES OF SOLIDS. (3 cr; prereq ‡)
Consideration of electronic and ionic defect structure of compounds as a function of degree of nonstoichiometry and relation of defect properties to transport processes such as electrical conductivity and atomic diffusion. Interaction between defects and methods of calculating energetics of defect formation are presented.

8-111. TRANSPORT PROCESSES IN SOLIDS. (3 cr; prereq ‡)
Coupled processes such as thermoelectric power, thermotransport, and electrotransport are analyzed within the framework of the Thermodynamics of Irreversible Processes. Atomic diffusion in condensed phases considered in terms of many body interactions.

8-112. SOLID STATE REACTIONS. (3 cr; prereq ‡)
The kinetics of phase transformations and processes such as oxidation, epitaxial layer formation are considered in the framework of modern concepts of nucleation and growth theory such as the theory of spinodal decomposition.

8-210. CRYSTALLINE PROPERTIES OF METALS. (3 cr)
Geometry and properties of metal crystals, X-ray diffraction, electrical and thermal conductivity, Hall effect optical properties, and elastic and plastic behavior of metals.

8-211. MODERN THEORY OF METALS AND ALLOYS. (3 cr; prereq 8-210 or ‡)
Free electron theory of metals and application. Imperfection in crystals.

8-212. IMPERFECTIONS IN METALS. (3 cr; prereq 8-211 or ‡)
Theory of imperfections and their effects on properties of metals.

8-213, 8-214. STRUCTURE AND COHESION OF METALS AND SEMICONDUCTORS. (3 cr per qtr; prereq 8-212)
Basic physical theory of bonding in metals, alloys, and semiconductors; stability of phases and elastic constants of these materials. Crystal structures of the various systems discussed and related to fundamental parameters such as sizes of atoms and electronic structure of the crystal. Topics include applications of tight bonding approximation, Wigner-Seitz method, etc., to problems of calculating equilibrium structures, heats of solution, and energies of formation of defects.

8-220. TOPICS IN LOW TEMPERATURE METAL PHYSICS. (3 cr)
Temperature dependence of resistivity, thermal conductivity, and specific heats, general equations for electron scattering by photon-electron interactions and imperfections, experimental low temperature techniques, classical and quantum theories of superconductivity, type II superconductors, applications of superconductors, low temperature X-ray work, and low temperature magnetic measurements.

8-301. ELECTRON INTERACTION WITH SOLIDS. (3 cr; prereq ‡)
Physical principles involved in the process on interactions on electrons with solids are treated with particular emphasis placed on coherent interactions such as Bragg diffraction from crystalline materials. The radial distribution function resulting from interaction of electrons with atoms is calculated and used as a beginning point for development of dynamical and kinematical theories of electron diffraction. These theories are applied to the problem of image interpretation from the electron microscope and in the interpretation of electron diffraction patterns from low-energy diffraction systems. Consideration is also given to high-energy interaction producing radiation damage.

8-310/8-311. 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.

8-320. HIGH TEMPERATURE PROPERTIES OF MATERIALS. (3 cr)
Fundamental studies of refractory metals and ceramics. Phase diagrams, crystal chemistry, thermodynamics, mechanical, and electrical properties.

8-401, 8-402. TRANSFORMATIONS IN ALLOYS AND ORIGINS OF MICROSTRUCTURE. (3 cr per qtr; prereq 5-403 or ‡)
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.

8-470, 8-471, 8-472. SEMINAR: MATERIALS SCIENCE AND ENGINEERING. (Cr ar)

8-480, 8-481, 8-482. SELECTED TOPICS IN MATERIALS SCIENCE AND ENGINEERING. (Cr ar)

8-520. ELECTRON DIFFRACTION AND ELECTRON MICROSCOPY. (3 cr; prereq 8-301 or ‡)
Embodies an extended treatment of scattering and diffraction of electrons by solids with emphasis on the kinematical and dynamical theories of diffraction. Application of these theories to both low energy electron diffraction analysis of surfaces and interpretation of electron microscopic images are considered.

8-522. ADVANCED X-RAY DIFFRACTION OF METALS. (3 cr; prereq 5-403 or ‡)
Reciprocal lattice, structure factor, Fourier analysis, diffuse scattering and low angle scattering.

CHEMICAL PHYSICS

Professor

John E. Wertz, *head, director of graduate study*
Bryce Crawford, Jr.
John S. Dahler
H. Ted Davis
Morton Hamermesh
Robert M. Hexter
Sanford Lipsky
Rufus W. Lumry
C. Alden Mead
Wilmer G. Miller
Albert J. Moscowitz
Alfred O. C. Nier
Lewis H. Nosanow
John Overend
Stephen Prager

Associate Professor

Robert G. Bryant
Clayton F. Giese
Lanny D. Schmidt
Donald G. Truhlar
Walter Weyhmann

Assistant Professor

Sidney E. Buttrill, Jr.
W. Ronald Gentry
Michael R. Moldover

Doctor's Degree—The Ph.D. program in chemical physics will include that combination of physics, chemistry, and mathematics which will provide an adequate general background and allow for development of the student's particular interests. Thesis research will be directed by a member of the chemical physics faculty. Candidates will enjoy the facilities of both schools and will be eligible for fellowships available in either. Candidates are expected to attend and participate in appropriate seminars in both physics and chemistry.

Prerequisites—(a) Adequate preparation in mathematics, intermediate physics, and physical chemistry; (b) acceptance by the Graduate School; (c) willingness of either the physics or the chemistry departments to provide support.

Requirements for Candidacy—Candidates shall (a) demonstrate proficiency in elementary physical and inorganic chemistry by passing a proficiency examination in each; (b) pass the final examination in a course in chemical thermodynamics; (c) pass final examinations (with or without taking the courses) in a 1-year sequence at the graduate level in both physics and chemistry; an example of each is Phys 5-051, 5-052, 5-053 and Chem 8-520, 8-521, 8-511; (d) pass final examinations in either Phys 5-151, 5-152, 5-153 or Chem 8-510, 8-511, 8-512.

Language Requirement—Reading proficiency in one of the following: German, French, Russian.

Preliminary Examinations—The candidate may elect either of the two following types of examination:

1. The written examination in physics. The preliminary oral examination may be taken when the language requirement is satisfied.
2. Four cumulative examinations in the physical chemistry areas. A grade of A in 1 quarter of Chem 8-520/8-521, 8-510/8-511 will reduce the requirement to three cumulative examinations. The preliminary oral examination may be taken after passing three cumulative examinations, two quantum mechanics course examinations, and satisfying the language requirement.

CHEMISTRY (Chem)

Professor

Robert M. Hexter, *chairman*
C. Alden Mead, *director of graduate study*
Robert C. Brasted
Doyle Britton
Bryce L. Crawford
John S. Dahler
H. Ted Davis
Raymond M. Dodson
Stuart W. Fenton
C. Frederick Koelsch
Maurice M. Kreevoy
Edward Leete
Sanford Lipsky
Rufus W. Lumry
Edward J. Meehan
Wilmer G. Miller
Albert J. Moscowitz
Wayland E. Noland
Paul R. O'Connor
John Overend
Stephen Prager
Warren L. Reynolds
Ernest B. Sandell
John E. Wertz

Associate Professor

Victor A. Bloomfield
Richard F. Borch
Lawrence E. Conroy
Jack Z. Gougoutas
Victor G. Mossotti, Jr.
Harold S. Swofford

Assistant Professor

Ronald E. Barnett
Robert G. Bryant
Sidney E. Buttrill
John E. Ellis
W. Ronald Gentry
Louis H. Pignolet
Donald G. Truhlar
Frederick A. Van Catledge

Graduate work in the Department of Chemistry is organized in seven "specialty areas"—bio-organic and biophysical chemistry; chemical dynamics; chemical instrumentation and analysis; inorganic chemistry; organic chemistry; physical chemistry; spectroscopy and molecular structure.

The candidate for a higher degree is expected to show, in addition to the completion of the prescribed work, a maturity acquired by intensive personal study of the literature and of the methods of chemistry.

Prerequisites—For a major in chemistry, all candidates must offer the substantial equivalent of the courses in analytical chemistry, inorganic chemistry, organic chemistry, and physical chemistry required of undergraduate students in the chemistry curriculum, at least 1 year of college physics, and college mathematics through calculus.

A minor in chemistry can be arranged by consultation with the director of graduate study.

Proficiency Examinations—Students working toward any graduate degree in chemistry are required to take a set of four proficiency examinations, one in each of the fields of analytical, inorganic, organic, and physical chemistry. These examinations are taken on entrance and are offered in the fall during the week preceding the first day of classes and again during the week following the close of the winter quarter. The results of these examinations are used for orientation and guidance. Candidates for the Ph.D. degree are expected to satisfy the proficiency requirements in all four fields during the first year in residence. Candidates for the M.S. degree are expected to pass the proficiency examination in their major field during their first year in residence. Further information, including recommended texts for study purposes, may be obtained on request from the department.

Language Requirement—Candidates for the M.S. or Ph.D. degree must present evidence of a reading knowledge of some foreign language. This may be German, or another language approved by the Graduate Operations Committee. The requirements may be met by satisfying the Graduate School language requirement or by passing a reading test given by the Department of Chemistry. If the Graduate School requirement is satisfied by presenting undergraduate cred-

it, there must be further certification that the student has made use of the language while in Graduate School.

Course Requirements—Although no specific set of courses is required, Ph.D. candidates typically complete 36 quarter credits of work in approved graduate courses. In addition, they generally register for at least 6 credits of seminar and 4 credits of general survey courses (proficiency examinations). Typically, half of the course work is in the students' specialty area with the remainder outside the specialty area and of such nature as to make a logical unit. Students in consultation with their adviser design a program which meets their needs and interests.

Courses for the M.S. degree are chosen in accordance with Graduate School requirements for number and distribution of credits for the M.S. degree.

Procedures are available to obtain credit for a course by special examination, rather than by taking the course.

Preliminary Examinations—Written preliminary examinations are given twice each year in the areas of organic chemistry and bio-organic and biophysical chemistry. The other five areas use the cumulative system of written examinations. When these and other departmental requirements have been satisfied, the student may proceed to the preliminary oral examination.

M.S. Degree—Plan A and Plan B offered in all specialty areas.

Ph.D. Degree—Work for the Ph.D. is offered in all specialty areas.

5-120. PHYSICAL-CHEMICAL METHODS OF ANALYSIS. (4 cr; prereq elem analytical chemistry, 5-501)
(Lecture) Optical and electrochemical methods and methods of separation.

5-121. PHYSICAL-CHEMICAL METHODS OF ANALYSIS. (4 cr; prereq 5-120)
(Laboratory) Quantitative application of electrochemical, optical, and other physical techniques.

5-122. ADVANCED ANALYTICAL CHEMISTRY. (4 cr; prereq elem course in analytical chemistry, 5-501)
Equilibria in aqueous and nonaqueous systems.

5-123. ELECTROCHEMICAL METHODS OF ANALYSIS. (4 cr; prereq 5-120 or 8-101)
(Lecture) Potentiometric, coulometric, polarographic, and other electrical methods.

5-124. ELECTROCHEMICAL METHODS OF ANALYSIS. (3 cr; prereq 5-123)
Laboratory.

5-125. CHEMICAL INSTRUMENTATION. (4 cr; prereq 5-121 or equiv)
Chemical application of operational amplifiers. Instrumental techniques for detection and measurement.

5-126. MODERN ANALYTICAL CHEMISTRY. (5 cr; prereq 3-034; 2 lect, two 3-hr labs, and 1 lab discussion per wk)
Strategies and techniques for solving modern analytical problems. The use of modern instruments in analysis.

5-127. ANALOG INSTRUMENTATION. (5 cr; prereq Phys 1-291, Math 3-211; 3 lect and two 4-hr labs per wk)
Basic principles of electronic design and circuitry, servo systems, operational amplifiers, feed-back control, oscillators.

5-128. DIGITAL INSTRUMENTATION. (5 cr; prereq Phys 1-291, Math 3-211; 3 lect and two 4-hr labs per wk)
Simple switching devices such as semiconductor diodes and transistors; high-speed integrated circuits; binary, decimal, and modulo-M counters.

5-301. SPECTRAL METHODS OF ORGANIC QUALITATIVE ANALYSIS. (4 cr, §8-302; prereq 3-303)
Practical application of nuclear magnetic resonance and infrared spectral analysis to solution of organic problems.

5-302. ADVANCED ORGANIC CHEMISTRY LABORATORY WORK. (2-5 cr; prereq 3-304; 6-15 hrs lab work ar)
Selected laboratory synthetic problems which may include original work. Individual instruction.

5-309. INTERMEDIATE ORGANIC CHEMISTRY. (4 cr; prereq 3-303, 5-502)
Introduction to various aspects of physical organic chemistry.

5-342. CHEMISTRY OF NATURAL PRODUCTS. (3 cr; prereq 3-303; offered 1972-73 and alt yrs)
Biosynthesis of secondary natural products with emphasis on alkaloids, terpenes, and acetogenins.

5-343. CHEMISTRY OF NATURAL PRODUCTS. (3 cr; prereq 3-303; offered 1973-74 and alt yrs)
Steroidal hormones, their isolation, proof of structure, synthesis, and action.

5-344. HETEROCYCLIC COMPOUNDS. (3 cr; prereq 3-303; offered 1973-74 and alt yrs)
Typical classes of heterocyclic compounds, their chemical and physical properties and uses, synthesis.

5-365. ORGANIC QUALITATIVE ANALYSIS. (4 cr, §3-304; prereq 3-303)
Reactions of typical functional groups and introduction to methods of organic qualitative analysis.

5-501. PHYSICAL CHEMISTRY. (4 cr; prereq 1 yr college chemistry, Phys 1-291 or ¶Phys 1-291 or Phys 1-106 with ‡, Math 3-211)
Basic thermodynamics.

5-502. PHYSICAL CHEMISTRY. (4 cr; prereq 1 yr college chemistry, Phys 1-291 or ¶Phys 1-291 or Phys 1-106 with ‡, Math 3-211)
Atomic and molecular structure.

5-503. PHYSICAL CHEMISTRY. (4 cr; prereq 5-501, 5-502)
Statistical mechanics and reaction kinetics.

5-504. PHYSICAL CHEMISTRY. (4 cr; prereq 5-503)
Electrolytic solutions, electrochemistry, theory of liquid and solid states.

5-505. STATISTICAL THERMODYNAMICS. (4 cr; prereq 1 yr college chemistry, Phys 1-291 or ¶1-291 or Phys 1-106 with ‡, Math 3-211)
Classical statistical mechanics as applied to lattice model treatments of liquids and solutions.

5-510. ANALYSIS OF DATA. (1 cr; prereq 5-501 or 5-502 or 5-521)
Statistical and numerical treatment of physicochemical measurements.

5-511, 5-512. PHYSICAL CHEMISTRY LABORATORY. (1-3 cr per qtr; prereq 5-510)
Measurement and interpretation of physicochemical properties.

5-520/5-521. ELEMENTARY PHYSICAL CHEMISTRY. (3 cr per qtr; prereq 1 yr college chemistry, Phys 1-291 or ¶Phys 1-291 or Phys 1-106 or ‡, Math 3-211)
Brief general survey. 5-520: Chemical thermodynamics. 5-521: Kinetics, statistical mechanics, and molecular structure.

5-522. BIOPHYSICAL CHEMISTRY: STRUCTURE. (4 cr, §BioC 5-522; prereq 2 qtrs physical chemistry...BioC 5-741, 5-002 or equiv desirable)
Methods of structure determination of biological macromolecules. Molecular weight determination, hydrodynamics, scattering and diffraction, optical and magnetic resonance spectroscopy. Application to proteins, nucleic acids, polysaccharides, synthetic analogs, and membrane transport.

5-523. BIOPHYSICAL CHEMISTRY: ENERGETICS. (3 cr, §BioC 5-523; prereq 2 qtrs physical chemistry...BioC 5-741, 5-002 or equiv desirable)
Energetics of biochemical reactions. Titration, binding, and folding stabilization in macromolecules. Conformational changes and cooperative behavior. Coupling and energy gradients in transport.

5-524. BIOPHYSICAL CHEMISTRY: DYNAMICS. (4 cr, §BioC 5-524; prereq 2 qtrs physical chemistry...BioC 5-741, 5-002 or equiv desirable)
Application of thermodynamics, statistical mechanics, and chemical kinetics to biological systems. Theoretical and experimental enzyme kinetics, solvent effect, structure-function relation.

5-530. THERMODYNAMICS. (4 cr; prereq minimum of 2 qtrs physical chemistry)
Application to gases, chemical reactions, solutions, phase equilibria.

5-531. ATOMIC AND MOLECULAR STRUCTURE. (4 cr; prereq minimum of 2 qtrs physical chemistry)
Introduction to quantum mechanics with application to structure and bonding.

5-571/5-572. MOLECULAR SPECTROSCOPY. (4 cr per qtr; prereq 5-502 or 5-531 or equiv for 5-571)
Examination of various types of molecular spectroscopy from the standpoint of how structure information is obtained from spectra.

5-574. MOLECULAR STRUCTURE AND SCATTERING. (3 cr; prereq 5-571, 5-572)
Discussion of the determination of geometrical structure of molecules by x-ray, electron and neutron scattering. The effect of internal molecular motions on the structural determination. Inelastic scattering and molecular energies.

5-580. PHYSICAL CHEMISTRY OF POLYMERS. (3 cr; prereq 5-503 or ‡; offered spring 1974 and alt yrs)
Molecular weight distribution, statistical mechanics of polymer solutions, network polymers, viscosity, light scattering, viscoelastic behavior.

5-610. POLYMERIC MATERIALS. (4 cr; prereq 5-501 or ‡; 3 lect and one 3-hr lab per wk) (Same as MatS 5-610 in IT bulletin) Polymerization and structure of synthetic and biopolymers. Crystallinity, physical properties, and viscoelastic behavior. Application of polymers and their environmental degradation.

5-701. INORGANIC CHEMISTRY I. (4 cr; prereq 5-501, 5-502)
Atomic structure, structure and bonding in covalent molecules and ionic crystals, thermochemistry of chemical bonding. Applications to chemistry of nontransition elements.

5-702. INORGANIC CHEMISTRY II. (4 cr; prereq 5-701)
Chemistry of transition metal and rare earth compounds; nomenclature and stereochemistry; thermodynamics and kinetics of complex ion reactions; crystal field, ligand field, molecular orbital, and valence bond descriptions of bonding; solution chemistry of transition elements.

5-703. ADVANCED INORGANIC CHEMISTRY. (5 cr; prereq 3-201 and 5-502)
Modern treatment of transition and nontransition metal chemistry. Structure, bonding, and stereochemistry of inorganic and organometallic compounds. Selected current topics.

5-791, 5-792, 5-793‡. SELECTED TOPICS IN INORGANIC CHEMISTRY. (2 cr per qtr; prereq 5-702, △)
Topics of current interest in inorganic chemistry. Consult department for details of any particular quarter.

8-100. GENERAL SURVEY OF ANALYTICAL CHEMISTRY. (1 cr)
Independent reading which is prerequisite to candidacy for the Ph.D. degree.

8-101. PHYSICOCHEMICAL METHODS OF ANALYSIS. (4 cr; prereq 5-120 or ‡)
(Lecture) Optical and electrochemical methods and methods of separation.

8-102. PHYSICOCHEMICAL METHODS OF ANALYSIS. (4 cr; prereq 8-101)
(Laboratory) Quantitative application of electrochemical, optical, and other physical techniques.

8-104. OPTICAL METHODS OF ANALYSIS. (2 cr; prereq 8-101; offered 1973-74 and alt yrs)
Lecture.

8-190.* SEMINAR: MODERN PROBLEMS IN CHEMICAL INSTRUMENTATION AND ANALYSIS. (1 cr per qtr; prereq 5-120)

8-198. RESEARCH SEMINAR: CHEMICAL INSTRUMENTATION AND ANALYSIS. (Cr ar)
Current research, especially that carried on in the department.

8-211w. FUNDAMENTALS OF CHEMICAL DYNAMICS. (4 cr; prereq 5-503 or equiv)
Phenomenological kinetics; transition state theory (statistical, mechanical, and thermodynamic approaches); unimolecular, bimolecular, and termolecular reactions in the gas phase and in solution; relaxation processes; catalysis.

8-212s. CHEMICAL DYNAMICS IN SOLUTION. (4 cr; prereq 8-211)
Substitution reactions; electron-transfer reactions; electrode reactions; linear free energy relationships; structure of intermediates; ion pairing, solvent effects, ionic strength; diffusion-controlled processes; cage effects.

8-213s. CHEMICAL DYNAMICS IN THE GAS PHASE. (4 cr; prereq 8-211, 8-520, 5-531 or 8-510, 8-511)
Advanced theoretical and experimental topics such as differential cross sections, potential energy surfaces, classical trajectory studies, molecular beams, ion cyclotron resonance spectroscopy, chemiluminescence, photochemistry, hot atom studies, and theories of unimolecular reactions and recombination reactions.

8-290. SEMINAR: CHEMICAL DYNAMICS. (1 cr)

8-300. GENERAL SURVEY OF ORGANIC CHEMISTRY. (1 cr)
Independent reading which is prerequisite to candidacy for the Ph.D. degree. See proficiency examination section.

8-301. ADVANCED ORGANIC CHEMISTRY. (4 cr; prereq 3-303 or ‡)
Synthetic methods, chemistry of functional groups.

8-302. INTRODUCTION TO RESEARCH. (4 cr; prereq 3-303, 3-304, or equiv)
Practical application of nuclear magnetic resonance and infrared spectral analysis to solution of organic problems.

8-303. PHYSICAL ORGANIC CHEMISTRY. (4 cr; prereq 8-300, 8-500, or ‡)
Theory and mechanism.

8-304. ADVANCED ORGANIC CHEMISTRY. (4 cr; prereq 8-301 or ‡)
Synthetic methods.

8-305. THEORETICAL ORGANIC CHEMISTRY. (3 cr; prereq 5-502 or ‡)
Application of quantum mechanics to organic reactions and photochemistry.

8-341.* STEREOCHEMISTRY. (3 cr; prereq 8-301 or ‡; offered 1973-74 and alt yrs)
Stereochemistry of carbon compounds and of organic reactions.

8-342. INTRODUCTION TO RESEARCH. (4 cr; prereq 3-304, 8-302, or ‡)
Advanced laboratory problems, including original work.

8-343. THEORETICAL ORGANIC CHEMISTRY. (3 cr; prereq 8-303 or ‡, 5-503)
Application of chemical kinetics, thermodynamics, and simple quantum mechanics to problems of organic chemistry.

8-344. THEORETICAL ORGANIC CHEMISTRY. (3 cr; prereq 8-302 or ‡)
Empirical and theoretical correlations of nuclear magnetic resonance.

8-390.* SEMINAR: ORGANIC CHEMISTRY. (1 cr per qtr; required for all grad students taking major work in organic chemistry)

8-500. GENERAL SURVEY OF PHYSICAL CHEMISTRY. (1 cr)
Independent reading which is prerequisite to Ph.D. candidacy. See proficiency examination section.

8-510/8-511. QUANTUM MECHANICS. (4 cr; prereq 5-502, a course in differential equations)
Fundamental principles of quantum mechanics and their applications to atomic and molecular structure and spectra.

8-512. SCATTERING THEORY. (2 cr; prereq 8-511; offered 1973-74 and alt yrs)
Quantum theory of atomic and molecular collision phenomena.

8-513. GROUP THEORETICAL METHODS IN CHEMISTRY. (2 cr; prereq 8-511; offered 1973-74 and alt yrs)
Theory of groups and their representations. Applications to quantum mechanical problems of chemical interest.

8-514. MOLECULAR QUANTUM MECHANICS. (2 cr; prereq 8-511; offered 1972-73 and alt yrs)
Molecular orbital theory and other techniques used in the quantum theory of molecules.

8-515. INTERACTION OF RADIATION WITH MATTER. (2 cr; prereq 8-511; offered 1972-73 and alt yrs)
Classical and quantum theory of the electromagnetic field and its interaction with atoms and molecules.

8-520/8-521. STATISTICAL MECHANICS. (4 cr per qtr; prereq 5-501 plus 1 addtl qtr physical chemistry)
Statistical thermodynamics, irreversible processes, kinetic theory, chemical kinetics.

8-560. SEMINAR: PHYSICAL CHEMISTRY OF BIOLOGICAL SYSTEMS. (Cr ar)

8-565. SEMINAR: POLYMER PHYSICAL CHEMISTRY. (Cr ar)

8-570. SEMINAR: MOLECULAR SPECTROSCOPY. (Cr ar)

8-575. SEMINAR: MAGNETOCHEMISTRY. (Cr ar)

8-580. SEMINAR: PHOTOCHEMISTRY. (Cr ar)

8-585. SEMINAR: THEORETICAL CHEMISTRY. (Cr ar)

8-589. SEPARATION THEORY. (4 cr; prereq Math 1-250 or equiv, 1 yr physical chemistry)
Mathematical treatment of separation processes.

8-590. PHYSICAL CHEMISTRY SEMINAR. (1 cr; required of all grad students majoring in physical chemistry)

8-700. GENERAL SURVEY OF INORGANIC CHEMISTRY. (1 cr)
Independent reading which is prerequisite to candidacy for the Ph.D. degree. See proficiency examination section.

8-703. ADVANCED INORGANIC CHEMISTRY I: SURVEY OF THE TRANSITION METALS. (4 cr; prereq 1 yr each of undergrad organic and physical chemistry)
Reactions and properties of the transition metals, including the rare earths, and their compounds. Survey of coordination chemistry using elementary ideas of ligand field theory.

8-704. ADVANCED INORGANIC CHEMISTRY II: SURVEY OF THE CHEMISTRY OF THE NONTRANSITION ELEMENTS. (4 cr; prereq 8-703 or ♯)
Reactions and properties of the nontransitional elements, including the rare gases and their compounds.

8-705. ADVANCED INORGANIC CHEMISTRY III: APPLICATIONS OF LIGAND FIELD THEORY. (4 cr; prereq 8-704 or ♯)
Development of ligand field theory, at a relatively advanced level, and numerous applications of the theory to problems of stability reactivity, magnetic properties, and optical properties of transition metal compounds.

8-751, 8-752, 8-753. ADVANCED INORGANIC CHEMISTRY LABORATORY METHODS. (Cr ar; prereq ♯)
Synthesis and physical measurements of selected compounds. Equilibria and kinetics of selected reaction systems. Introduction to research techniques.

8-790. SEMINAR: MODERN PROBLEMS IN INORGANIC CHEMISTRY. (1 cr per qtr; prereq △)

8-990. RESEARCH IN CHEMISTRY. (Cr ar; prereq △)

8-991, 8-992, 8-993. SPECIAL TOPICS IN CHEMISTRY. (Cr ar; prereq △)

CHILD PSYCHOLOGY (CPsy)

Professor

John H. Flavell, *director of graduate study*
Willard W. Hartup, *director*
Norman Garmezy
Marian D. Hall
Shirley G. Moore
Herbert L. Pick, Jr.
Merrill F. Roff
Mildred C. Templin
Robert D. Wirt

Associate Professor

William Charlesworth
A. Jack Hafner
Carl P. Malmquist
John C. Masters
Anne D. Pick
Philip H. Salapatek
Sandra Scarr-Salapatek

Assistant Professor

W. Andrew Collins
Michael P. Maratsos
L. Alan Sroufe
Cynthia Turnure
Robert H. Wozniak
Albert Yonas

Prerequisites—Courses in child psychology are open to all regularly enrolled graduate students who meet the prerequisites as listed in the *Class Schedule*. It is expected that all entering graduate students with a major in child psychology shall have completed at least 12 hours in psychology and 3 hours in statistics.

Language Requirement—None.

Master's Degree—Offered under both Plan A and Plan B, usually as an integral part of the Ph.D. program.

Doctor's Degree—Work leading to the Ph.D. degree is offered.

Information about additional requirements for graduate training in child psychology may be obtained from the chairman of admissions in the Institute of Child Development.

5-303. ADOLESCENT PSYCHOLOGY. (4 cr; prereq 5 cr introductory psychology) Collins, Masters, Sroufe
Physical, cognitive, and social development during adolescence.

5-311. BEHAVIOR PROBLEMS. (4 cr; prereq 3-301 or equiv) Sroufe
Types, origin, development, and treatment of behavior difficulties in normal children.

5-313. PSYCHOLOGY OF ATYPICAL CHILDREN. (4 cr; prereq 3-301 or equiv) Templin
Problems of research, assessment, and behavior associated with atypicality; evaluation of research in areas of major concern for sensory, language, intellectual, and physical deviation.

5-315. INTRODUCTION TO MENTAL RETARDATION. (4 cr, §SpEd 5-120; prereq 3-301 or equiv)
Psychological and educational problems related to the mentally retarded.

5-319. CLINICAL PROCEDURES WITH CHILDREN. (4 cr; prereq 12 cr in psychology, educational psychology, sociology or child psychology)
Survey of methods of clinical psychology; basic concepts and research problems in clinical work with children. Primarily for students not majoring in clinical psychology.

5-330. DIRECTED EXPERIENCES WITH CHILDREN. (4 cr; prereq 3-301 and ‡; S-N only) Wozniak
Intellectual and/or social development of children as individuals or members of peer groups. Quarter experiences offered in case study, social behavior, cognitive stimulation of children.

5-331. PROCESSES OF SOCIALIZATION OF CHILDREN. (4 cr; prereq 3-301) Collins, Hartup, Masters
Processes of social learning; identification, imitation, reward and punishment, internalization, and object choice.

5-333. PERSONALITY DEVELOPMENT. (4 cr; prereq 5-331) Masters
Psychoanalytic and behavior theory formulations and related research literature in content areas (e.g. attachment, dependency, aggression, and sex typing).

5-335. PEER RELATIONS. (4 cr; prereq 5-331) Moore
Peer influences; social interactions and social relations; developmental changes.

5-339. PARENT-CHILD RELATIONS. (4 cr; prereq 5-331)
Discussion of parent-child relationships and evaluation of relevant research literature.

5-341. PERCEPTUAL DEVELOPMENT. (4 cr; prereq 3-301) Yonas
Perceptual learning and the development of sensory and perceptual processes.

5-343. COGNITIVE DEVELOPMENT. (4 cr; prereq 3-301) A Pick
Development of cognitive processes; relevant theory, research literature, and methodology.

5-345. LANGUAGE DEVELOPMENT. (4 cr; prereq 3-301) Templin
Development of structure and function of language; factors influencing development; methodological problems, language scales, theories.

5-347. LEARNING IN CHILDREN. (4 cr; prereq 3-301) Wozniak
Introduction to current research on learning and problem solving in children; application to practical contexts.

5-970. DIRECTED READINGS IN CHILD PSYCHOLOGY. (Cr ar; prereq ‡)
Independent reading.

5-990. DIRECTED RESEARCH IN CHILD PSYCHOLOGY. (Cr ar; prereq ‡)
Individual empirical investigation.

8-301. ADVANCED CHILD PSYCHOLOGY. (3 cr; prereq ‡) Charlesworth
Theory and research in child psychology with emphasis on perception, language, learning, cognition, personality, and social development in children.

8-304. RESEARCH METHODS IN CHILD PSYCHOLOGY. (3 cr; prereq ‡) A Pick
Review of principal research methods and designs in child psychology.

8-310. SEMINAR: CURRENT ISSUES IN CHILD PSYCHOLOGY I. (1 cr per qtr; prereq ‡)
Problems and issues in professional child psychology for first-year graduate students.

8-320. SEMINAR: CURRENT ISSUES IN CHILD PSYCHOLOGY II. (1 cr; prereq ‡)
Problems and issues in professional child psychology for advanced graduate students.

8-329. GENETICS AND DEVELOPMENT. (3 cr)
Theory and research on genetic factors in human behavioral development, including patterns of development, individual differences, and species-specific behaviors.

8-333. ADVANCED PERSONALITY DEVELOPMENT. (3 cr; prereq ‡) Hartup, Masters
Critical evaluation of current theory and research.

8-336. ADVANCED SOCIAL DEVELOPMENT. (3 cr; prereq ‡) Hartup, Moore
Theory and research related to the acquisition of social behavior by children, including the effects of interaction with the social environment.

8-338. DEVELOPMENTAL PSYCHOLOGY OF COMMUNICATION. (3 cr; prereq ‡)
Research related to the development of interpersonal communication behaviors, and developmental aspects of the processes and effects of mass communication.

8-341. ADVANCED PERCEPTION IN CHILDREN. (3 cr; prereq Psy 5-031 and ‡) H Pick
Review and discussion of experimental and theoretical literature on children's perception; change of perception with age and experience.

8-343. ADVANCED COGNITIVE DEVELOPMENT. (3 cr; prereq 12 cr in child psychology or psychology) Flavell
Development of thinking in children; theories of concept formation, problem solving, and reasoning.

8-345. ADVANCED LANGUAGE DEVELOPMENT. (3 cr; prereq Ling 5-001 and 12 cr in child psychology or psychology and ‡) Flavell, Maratsos
Critical evaluation of current theory and research in language development.

8-347. ADVANCED LEARNING IN CHILDREN. (3 cr; prereq Psy 5-013 or ‡) Wozniak
Discussion of experimental literature on theoretically critical issues in children's learning.

8-351. THEORY AND PRACTICES IN THE PRESCHOOL. (3 cr; prereq ‡) Moore
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.

8-355. BEHAVIOR OF PRESCHOOL CHILDREN. (3 cr; prereq ‡) Moore
Use of group setting for study and guidance of personality and social development of young children.

8-360. SEMINAR: DEVELOPMENTAL PSYCHOLOGY. (Cr ar; prereq ‡)
Intensive study of selected topics.

8-605. DEVELOPMENTAL PSYCHOPATHOLOGY. (3 cr; prereq 8-333 and ‡)
Dynamics of psychopathology in children; critical evaluation of current theory and research.

CIVIL ENGINEERING (CE)**

Professor
Charles Fairhurst, *head*
Alvin G. Anderson
Charles E. Bowers
Daniel L. Gerlough
Lawrence E. Goodman
Miles S. Kersten
John F. Ripken
Edward Silberman

Associate Professor
Walter J. Maier, *director of graduate study*
Paul P. Christiano
Jesse E. Fant
John W. Hayden
Matthew J. Huber
Walter K. Johnson
Chieh S. Song
Heinz Stefan

Assistant Professor
Ladislav Cerny
G. Lee Christensen
Howard I. Epstein
Gerald W. Johnson
Lyle P. Pederson
Eugene L. Skok, Jr.

Students who wish to do major work in civil engineering, offered by the Department of Civil and Mineral Engineering, should consult the director of graduate study, 112 Mines and Metallurgy Building.

Graduate programs are undergoing extensive review and a number of changes in course offerings are anticipated within the next biennium. In particular, there will be a trend to regroup courses into 4-credit modules.

** Professional degrees in engineering are administered by the Institute of Technology.

Language Requirement—For the Master's degree, none. For the Ph.D. degree, the language requirement is as follows:

Transportation—no language requirement
Environmental engineering—no language requirement
Water resources and hydromechanics—no language requirement
Soil mechanics and materials—no language requirement
Structural engineering—French, German, or Russian

Master's Degree—Offered under Plan A. Plan B may be accepted when approved by the student's adviser.

Doctor's Degree—Programs leading to the Ph.D. degree are offered in each of the major areas of specialization. These are structural design and analysis; hydraulic engineering (including hydromechanics, hydrology, and water resources management); sanitary engineering; transportation engineering; and soil mechanics. Degree candidates are expected to concentrate the major part of their work in one of these areas. Their supporting programs are developed in consultation with their adviser and should provide a well-rounded course of study in related disciplines.

General

5-001. BUILDING AND CONSTRUCTION CONTRACTS AND SPECIFICATIONS. (4 cr) Westin
Synopsis of law of contracts, sales, agency, negotiable instruments, real property, personal property, partnerships, corporations, insurance contracts, workmen's compensation, labor law, mechanics' liens, government construction contracts, and torts with applications to performance of engineering and construction contracts.

5-097/5-098/5-099. ADVANCED DESIGN, ANALYSIS, RESEARCH, OR SEMINAR 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 area of civil engineering including but not limited to hydraulics and hydrology, land development, materials, sanitary engineering, soil mechanics, structures, and transportation.

8-097/8-098/8-099.* CIVIL ENGINEERING RESEARCH. (3-5 cr per qtr; prereq ♯) Staff
Original work in concrete, structural steel, soils, hydraulics, municipal, sanitary, or transportation problems. Investigations, reports, tests, designs.

Transportation Engineering and Land Development

5-100. LAND SURVEYING. (4 cr; prereq 3-100, 3-102 or ♯) Fant
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.

5-101. GEODETIC SURVEYING. (4 cr; prereq 3-100, 3-102 or ♯) Johnson
Precise survey control nets, astronomic azimuth, and error analysis for geodetic surveys. Theory and field problems in electronic surveying, celestial observations, and least squares adjustments.

5-200. GEOMETRIC DESIGN OF HIGHWAYS. (4 cr; prereq 3-200, 3-102 or ♯)
Forecast of traffic volume demand; impact of vehicle type on geometric design; vertical and horizontal alignment; intersection design; highway capacity.

5-201. HIGHWAY TRAFFIC CHARACTERISTICS AND OPERATIONS. (4 cr; prereq 3-200 or equiv)
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.

5-202. AIRPORT DESIGN. (4 cr; prereq 3-200, 3-300)
Nature of air transport. Airfield site selection and runway patterns. Geometric design of runways; capacity. Drainage and pavement design.

5-210. INTRODUCTION TO TRANSPORTATION PLANNING. (4 cr; prereq ‡)
Outline of transportation planning process as applied to urban areas; data requirements and travel characteristics; trip generation analysis; models of travel distribution; transit characteristics and usage; selection and evaluation of alternate proposals; transportation and land use linkages.

5-304. DESIGN OF HIGHWAY AND AIRPORT PAVEMENTS. (4 cr; prereq 3-300, 3-700)
Theories of pavement design, flexible and rigid; equivalent wheel loads. Strength tests and frost action. Design procedures for flexible and rigid pavements.

8-200. SEMINAR: THEORY OF TRAFFIC FLOW. (3 cr; prereq ‡)
Recent theoretical approaches to traffic behavior, including fluid analogy models, queuing models, car-following models, and simulation.

8-201. SEMINAR: URBAN TRAFFIC OPERATIONS. (3 cr; prereq ‡)
Problems of urban traffic operations, including signal systems, signs, and markings; other traffic engineering measures; and administrative matters.

8-202. SEMINAR: FREEWAY TRAFFIC OPERATIONS. (3 cr; prereq ‡)
Operational problems of freeways and other high-type highway facilities.

8-210. SEMINAR: ADVANCED TRANSPORTATION PLANNING. (3 cr; prereq 5-210 or ‡)
Advanced techniques used to evaluate alternate transportation designs, including equilibrium volumes, system capacity, highway and congestion costs, modal split, urban rapid transit concepts, methodology of evaluating alternative transportation designs.

Soil Mechanics and Construction Materials

5-310. FOUNDATION ENGINEERING. (4 cr; prereq 3-300)
Applications of soils engineering to design and construction of various foundation types. Shallow foundations, deep foundations, retaining structures.

5-311. SHEAR STRENGTH OF SOILS. (4 cr; prereq 3-300)
Methods for evaluating strength of various soils to be used for engineering projects.

5-312. SLOPE STABILITY. (4 cr; prereq 3-300)
Analysis of safety of various slopes and embankments considering such aspects as seepage forces, shear strength, and slope geometry.

5-701. CEMENTED MATERIALS: PROPERTIES, EVALUATION, AND MIXTURE DESIGN. (4 cr; prereq 3-700; 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.

5-702. MANUFACTURE AND QUALITY CONTROL OF CONSTRUCTION MATERIALS. (4 cr; prereq 3-700; 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.

8-300w/8-301s.* ADVANCED SOIL MECHANICS LABORATORY. (3 cr per qtr; prereq ‡)
Kersten, Pederson
Consolidation; permeability; direct shear; triaxial compression; California bearing ratio; stabilometer resistance value; and other special laboratory problems in soil mechanics.

8-302. ADVANCED HIGHWAY LABORATORY. (3 cr; prereq 3-700)
Special experimental studies of highway materials.

8-303. SPECIAL PROBLEMS IN CONCRETE MATERIALS. (2-3 cr; prereq 3-700)
Short laboratory research studies.

8-310. FOUNDATION AND HARBOR ENGINEERING. (3 cr)
Earth pressure theories. Flexible bulkheads and retaining walls. Footings, piles, cofferdams, caissons.

Water Resources Engineering and Hydromechanics

5-401. WATER RESOURCES ENGINEERING. (5 cr; prereq 3-400 or AEM 5-200 or ‡)
Introduction to hydrology including precipitation and flood analysis; hydraulic engineering, including conduit flow, pumps, open channel flow, culvert flow, flow measurement, and waves; hydraulic structures; introduction to systems approach.

5-402. HYDRAULIC ANALYSIS. (4 cr; prereq 5-401 or ‡)
Computer application in hydraulic engineering, open channel controls, spillways and stilling basins, bridge waterways, culvert analyses, selected problems in conduit flow, wave action on breakwaters, elementary water hammer and surge analysis.

5-405. HYDROLOGY. (4 cr; prereq 5-401 or ‡)
Hydrologic cycle, precipitation, evaporation infiltration, runoff analysis, flood routing, statistical procedures in hydrology, urban hydrology, introduction to mathematical models of medium and large watersheds.

5-410. OPEN CHANNEL HYDRAULICS. (4 cr; prereq 3-400, 5-401 or ‡)
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.

5-420. INTRODUCTION TO WATER RESOURCES MANAGEMENT. (4 cr)
Present state of the water resource; water resources planning; implementation.

5-435. INTERMEDIATE FLUID MECHANICS WITH APPLICATIONS. (4 cr; prereq 3-400)
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.

8-400.* HYDRAULIC TRANSIENTS. (3 cr; prereq 5-401 or ‡)
Hydraulic transients encountered in coastal and water resource engineering, including oscillatory, solitary, tidal, and floor waves; water hammer; hydraulic jumps; forced vibration of gates and other components of hydraulic structures; hydrodynamic flutter.

8-410.* FLUID TURBULENCE. (3 cr; prereq 5-435; offered when demand warrants)
Statistical theory of turbulence with particular application to free turbulence.

8-412.* MECHANICS OF SIMILITUDE AND DIMENSIONAL ANALYSIS. (3 cr; prereq 5-401)
Applications of dimensional analysis to hydraulic problems and to similitude. Theory of models, conditions for similarity in the case of hydraulic structures, elastic structures, aircraft, ships, waves, etc.

8-413.* MECHANICS AND SEDIMENT TRANSPORT. (3 cr; prereq 5-410 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, etc.

8-415.* WATER POWER. (3 cr; prereq 5-405)
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.

8-416. HYDRAULIC PUMPS AND TURBINES. (3 cr; prereq 3-400 or ‡)
Introductory theory of hydraulic pumps, turbines, motors, and transmissions including energy concepts, drag and lift of hydrofoils, and limitations of cavitation.

8-417. HYDRAULIC MEASUREMENTS. (3 cr; prereq 3-400 or ‡)
Laboratory and field methods and instruments for measurement of hydraulic pressure, velocity, and discharge.

8-420. WATER RESOURCES SYSTEMS. (4 cr; prereq 5-420, some background in computer use)
Application of system approach to planning and design.

8-421.* INCOMPRESSIBLE POTENTIAL FLOW. (3 cr, §AEM 5-204; prereq 5-435 or ‡)
Potential flow methods and their application to engineering problems.

8-422.* INCOMPRESSIBLE BOUNDARY LAYER FLOW. (3 cr, §AEM 5-201; prereq 5-435 or ‡)
Some applications of boundary layer methods to engineering problems.

8-425.* GROUNDWATER HYDRAULICS. (3 cr; prereq 3-400 or ‡)
Flow of fluids through porous media including fundamental equations, potential flow theory, and approximate solutions; application of these theories to seepage through and under dams and cofferdams, wells, well point systems, and stratified media.

8-431/8-432/8-433. HYDRODYNAMICS OF THE BOUNDARY LAYER. (3 cr per qtr; prereq 5-435 or ‡)
Laminar and turbulent boundary layers and their interaction with the potential flow. Free turbulent flows.

8-430. LAKE, RESERVOIR, AND OCEAN HYDRODYNAMICS. (3 cr; prereq 3-400 or equiv)
Transport and dispersion of mass, momentum, and heat in large natural bodies of water. Hydrodynamics and design of water withdrawal and recharge facilities.

8-435, 8-436, 8-437. SPECIAL TOPICS IN HYDRODYNAMIC THEORY. (3 cr per qtr; prereq 8-433 or ‡; offered when demand warrants)
Linearized theory, wave motion, cavity and separated flows, and other topics to meet special requirements of students.

8-497/8-498/8-499.* 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

5-500. ANALYSIS AND DESIGN OF WATER SUPPLY SYSTEMS. (4 cr; prereq 3-500 or ‡)
Planning and engineering design considerations in developing water supply systems for urban centers. Supply quality, storage, treatment, distribution, and cost analysis.

5-501. ANALYSIS AND DESIGN OF WASTE WATER SYSTEMS. (4 cr; prereq 3-500 or ‡)
Planning and engineering design considerations in developing waste water disposal systems for urban centers. Characterization of volumes and quality of waste streams, treatment and ultimate disposal of domestic and industrial waste waters, storm water runoff. Environmental effects, cost, and political aspects of ultimate disposal.

5-505. MANAGEMENT OF THE AQUATIC ENVIRONMENT. (4 cr; prereq ‡)
Man's impact on the aquatic environment. Water quality objectives; mathematical models are used to assess quantitative effects of pollution sources. Alternatives for pollution abatement considered in terms of the model. Interrelationships between solid and waste disposal, air quality, and water quality.

5-510. SOLID WASTE MANAGEMENT. (4 cr; prereq ‡)
Solid waste disposal for urban areas in terms of volume, composition, and chemical characteristics. Methods and equipment of collection and treatment. Various disposal methods in terms of their effects on environment and unit costs.

8-500.* WATER PLANT DESIGN. (3-5 cr; prereq 5-501)
Design of water purification works.

8-501.* ADVANCED SANITARY ENGINEERING (WATER). (3-5 cr; prereq 5-501)
Principles of new water technology including treatment for reuse and recycle. Inspections and analysis of innovative water works systems.

8-505.* WASTE WATER PLANT DESIGN. (3-5 cr; prereq 5-506)
Design of treatment plant.

8-506.* ADVANCED SANITARY ENGINEERING (WASTE WATER AND INDUSTRIAL WASTES). (3-5 cr; prereq 5-506)
Principles of advanced (tertiary) treatment and ultimate disposal. Investigation of complete waste water treatment systems.

8-507.* INDUSTRIAL WASTE DISPOSAL. (3 cr; prereq 5-501)
Quantity and quality characteristics of industrial wastes. Problems with separate treatment or disposal to municipalities. Legal responsibility and ordinances. Determination of equitable charges. Economic studies.

8-510. SANITARY ENGINEERING UNIT OPERATIONS. (3-5 cr; prereq 5-501)
Lectures, laboratory studies, and pilot-plant scale studies on screening, hydraulic separation, chemical coagulation, aeration, filtration, disinfection, drying, incineration, and digestion.

8-515. CHEMICAL AND BIOLOGICAL ASPECTS OF SANITARY ENGINEERING I. (3 cr; prereq ‡)
Principles of biochemistry and microbiology pertinent to an understanding of microbiological growth phenomena in waste water treatment processes and in natural waters.

8-516. CHEMICAL AND BIOLOGICAL ASPECTS OF SANITARY ENGINEERING II. (3 cr; prereq 8-515 or ‡)
Analytical approach to biological purification of waste water based on mass transfer and growth rate considerations.

8-550. ANALYSIS AND MODELING OF AQUATIC ENVIRONMENTS. (4 cr; prereq ‡)
Analysis and modeling of the aquatic environment presented by interdisciplinary group from ecology, limnology, fluid mechanics, and environmental engineering. Physical, biological, and chemical components of stream and lake systems; quantitative descriptions of pseudo-steady state condition. Kinetics of biological and chemical processes developed and incorporated into overall models.

8-551. SEMINAR: MODELS OF AQUATIC ENVIRONMENTS. (1-5 cr; prereq 8-550)
Case studies of specific aquatic streams and lake systems.

Structural Engineering

8-605. APPROXIMATE METHODS OF STRUCTURAL ANALYSIS I. (4 cr; prereq 5-601 or ‡)
Application of modern computational methods, e.g., finite difference and finite element techniques, to the analysis of equilibrium, eigenvalue, and propagation problems in structural and foundation engineering.

8-606. APPROXIMATE METHODS OF STRUCTURAL ANALYSIS II. (4 cr; prereq 8-605 or ‡)
Application of advanced computational methods to the analysis of equilibrium, eigenvalue, and propagation problems in discrete and continuous systems.

8-608. ADVANCED THEORY OF STRUCTURES. (4 cr; prereq ‡)
Theoretical foundations of structural analysis; energy methods, bending and twisting of structural elements, analysis of plates.

8-609. PRINCIPLES OF STRUCTURAL STABILITY. (4 cr; prereq ‡)
Classification of discrete and continuous conservative and nonconservative systems; buckling analysis of structural members, frameworks, plates, etc., by classical and numerical methods.

8-610. 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.

8-612. STRUCTURAL DESIGN BY ULTIMATE LOAD THEORY. (4 cr; prereq 5-600 or ‡; offered alt yrs)
Plastic analysis and design of structures with applications to grillages, continuous beams, portal and gabled frames; investigation of collapse mechanisms, minimum weight design and plastic deformations.

8-620. STRUCTURAL DYNAMICS I. (4 cr; prereq AEM 3-036 or ‡; offered alt yrs)
Response of continuous systems to dynamic loads; vibration of frameworks, plates, shells; dynamic soil structure interaction; design considerations.

8-621. STRUCTURAL DYNAMICS II. (4 cr; prereq 8-620 or ‡; offered alt yrs)
Response of continuous systems to dynamic loads, vibration of frameworks, plates, shells; dynamic soil structure interaction; design considerations.

8-697/8-698/8-699. SEMINAR: STRUCTURES. (4 cr per qtr; 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.

CLASSICS

Professor

Robert P. Sonkowsky, *chairman*
Tom B. Jones
William A. McDonald
R. Joseph Schork
Donald C. Swanson

Associate Professor

Gerald M. Erickson
Jackson Hershbell
A. Thomas Kraabel
Sheila McNally

Assistant Professor

William D. E. Coulson
Elizabeth Fisher
George Rochefort
Mary Xiroyanni

Instructor

Walter Nichipor

The Department of Classics offers advanced degrees in two primary programs, as well as certain M.A. programs for which special requirements must be met prior to admission: I—Greek, Latin, Classics.** II—Classical Area Studies. III—Special Degree Programs in Classical Area Studies with a Major in Archaeology.

I. Degree Programs in Greek, Latin, Classics

Prerequisites—An undergraduate major (or its equivalent) in Latin or Greek, or a knowledge sufficient to enable the student to pass the diagnostic examination (see below) at a level sufficient to begin graduate reading courses (except 8-120) in at least one of the two languages, with at least intermediate ability in the other. Evaluation of applications is never based solely on the *quantity* of previous work; qualified students lacking these suggested prerequisites are encouraged to apply.

Language Requirement—For the M.A., reading knowledge of one modern foreign language; for the Ph.D., two modern foreign languages. German, French, Italian, *and* Modern Greek are most frequently recommended.

Admission—Students holding the B.A. degree are admitted, upon departmental recommendation, to the Graduate School as candidates for the M.A. degree only. Admission to post-M.A. work is dependent upon proficiency examinations, M.A. work, and the discretion of the department. (Proficiency examinations certify an M.A. from another institution.) Admission to Ph.D. candidacy is dependent upon the submission and approval of a Ph.D. program and passing of the Ph.D. preliminary examinations.

First Year of Studies—All entering candidates for the M.A. must take a diagnostic examination in both Greek and Latin. The student's adviser will use the results to suggest appropriate courses. Lat or Grk 5-794 (Proseminar: Introduction to Classical Studies) must be taken, usually in the spring quarter.

Proficiency Examinations—These examinations, given in September and at the end of each quarter, are designed to test reading comprehension, literary analysis, and oral reading in Greek and Latin and to certify the student's ability to do independent work at the seminar level.

M.A. Degree—This degree is defined most conveniently according to what may be called its consequences:

1. The M.A. in Greek, Latin, or Classics can serve as an entrée to a doctoral program in Greek, Latin, or Classics**—provided that the student so intending passes both proficiency examinations *or* one examination with the understanding that no Ph.D. program can be submitted until the second proficiency examination is passed. Other general Graduate School requirements for the M.A. (Plan B††) are as follows:

   a. 45 graduate credits in one of these schemes:

      Greek Major:

      27 credits in Greek
      18 credits in related fields (at least 9 in Latin)

      Latin Major:

      27 credits in Latin
      18 credits in related fields (at least 9 in Greek)

** 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," which indicates courses requiring no knowledge of Greek or Latin.

†† The M.A. (Plan A) is advised in exceptional cases only.

*Classics*** *Major:*

27 credits in a combination of courses in Greek *and* Latin (at least 9 of the 27 must be in one of the two languages)

18 credits in related fields

b. Three Plan B papers

c. An oral examination at the discretion of the examining committee.

2. The M.A. in Greek, Latin, or Classics** can serve as an end in itself, if the student terminates formal graduate study in the department. Such a student may prepare both proficiency examinations or may decide to take only one proficiency examination. The other requirements are the same as above.
3. The M.A. in Greek, Latin, or Classics** can in special cases serve as an entrée to a doctoral program in Classical Area Studies (see group II below and note the Ph.D. prerequisites).

The Second and/or Third Year of Studies—This period is devoted to advanced courses, seminars, and to preparation for the preliminary examinations, which should be taken before the end of the third year of study.

The Preliminary Examinations—These examinations are taken after the submission and approval of a Ph.D. program. They are preliminary to Ph.D. candidacy. There are four written examinations: Greek author, Latin author, "historical" field, "special" field. There is a preliminary oral examination, at which candidates are examined further and at which they submit the 250-word statement of their proposed dissertation (see the General Information section of this bulletin for details).

The Dissertation Year—During this period students will work closely with their thesis adviser in researching and preparing their dissertation. There is a final oral examination on the dissertation.

Related Fields for the M.A. Degree may consist of graduate courses offered in the Department of Classics (provided that such courses are not in the same specific category as the "major" courses) *or* of courses offered by other departments *or* of a combination of both options. Each "field" must consist of at least 6 credits. Students choose these courses in close consultation with their adviser.

The Supporting Program or Minor for the Ph.D. Degree may consist of work offered in the Department of Classics or other departments or both. Students arrange this in consultation with their adviser.

II. Degree Programs in Classical Area Studies

Prerequisites—Acceptable prerequisites for this program vary, but they normally include an undergraduate major (or its equivalent) in Latin or Greek, or a knowledge sufficient to enable the student to pass the diagnostic examination (see above) in at least one of the two languages, with demonstrated ability in the special area of the student's interest. The latter will be evaluated by the departmental admissions committee.

Language Requirement—Same as for group I above.

** 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," which indicates courses requiring no knowledge of Greek or Latin.

Admission—All B.A. applicants are admitted, upon departmental recommendation, to the Graduate School as candidates for the M.A. degree only. For admission to the doctoral program in Classical Area Studies see below.

M.A. in Classical Area Studies—

1. 21 graduate credits in one of the two classical languages.
2. A minimum of 18 credits in a special area such as: ancient history, ancient religions, archaeology, classical philology, the teaching of classical languages, etc. Programs of this type may be arranged only in consultation with the student's adviser in the special area and should include two "related fields" (see above).
3. 6 credits of electives approved by the adviser.
4. Students planning to apply for permission to work toward the Ph.D. degree in Classical Area Studies should note the requirement in a second ancient language (see following).

Ph.D. in Classical Area Studies—The department offers a doctorate in Classical Area Studies with emphasis on a special area such as one of the following: ancient history, ancient philosophy, ancient religions, archaeology, classical philology, the teaching of classical languages, etc. (Interested students may suggest other such special areas.) Prerequisite to this Ph.D. program are passage of proficiency examination in one classical language and reading competence in another ancient language. If the language is classical, competence is certified by the diagnostic examination mentioned above; otherwise, by special arrangements. The student's Ph.D. program, including the minor or supporting program, will be arranged in close consultation with the adviser in the student's special area.

III. Special Degree Programs in Classical Area Studies with a Major in Archaeology

Prerequisites—Prerequisites for admission normally include some basic undergraduate courses in Greek and Roman art, history, or literature in translation. There are no admission requirements in the Greek and Latin languages for the M.A., but applicants are reminded that, since rapid acquisition of an operational proficiency in modern foreign languages and in Latin or Greek will be necessary in the program, evidence of ability to learn languages is highly desirable.

Language Requirement—For the M.A., reading knowledge of one modern foreign language appropriate to the student's archaeological interests. For the Ph.D., reading knowledge of two modern foreign languages appropriate to the student's archaeological interests.

M.A. in Archaeology

Admission—All B.A. applicants are admitted, upon departmental recommendation, to the Graduate School as candidates for the M.A. degree only.

1. 21 credits in archaeology courses in the Department of Classics.
2. 24 credits in related areas, such as art history, ancient history, anthropology, Greek or Latin, and other studies ancillary to archaeology. For students with no previous training in ancient Greek or Latin, a minimum of 3 of the 24 credits will be in Grk or Lat 8-120. In that case undergraduate prerequisites for Grk or Lat 8-120 will be taken in the first year of graduate work.

Ph.D. in Archaeology

Admission to the Ph.D. program is contingent upon completion of the M.A. requirements or the equivalent and permission of the department.

The student's Ph.D. program, including the minor or supporting program, will be arranged in consultation with the student's adviser, subject to the approval of the department.

Greek (Grk)

5-012. PROSE COMPOSITION. (2 cr; prereq 3-106 or △; for grad majors)

5-264/5-265/5-266. SURVEY OF GREEK LITERATURE. (4 cr per qtr; prereq ¶5-012)
5-264: Epic and lyric poetry. 5-265: Prose. 5-266: Drama. (Replaces old course 165-166-167)

5-371/5-372/5-373, 5-374/5-375/5-376, 5-377/5-378/5-379. GREEK LITERATURE. (3 cr per qtr)
Authors vary from term to term and from year to year. One or more appropriate authors studied in a given course. 5-371: Oratory. 5-372: Tragedy. 5-373: Comedy. 5-374: History. 5-375: Philosophy. 5-376: Religious texts (Kraabel). 5-377: Epic. 5-378: Lyric. 5-379: Romance.

5-381. BYZANTINE TEXTS. (3 cr; prereq 2 yrs of Classical Greek or ♯)
Study of representative texts of Byzantine literature in the original.

5-621. GREEK PALEOGRAPHY. (3 cr; prereq 5 cr Upper Division Greek or ♯)
Introduction to styles of writing found in Greek literary papyri and later manuscripts and investigation of the transmission of ancient Greek texts.

5-794. PROSEMINAR: INTRODUCTION TO CLASSICAL STUDIES. (3 cr, §Lat 5-794; required of all new grad students; prereq grad major or ♯)
Survey of research in classical scholarship, methods and bibliography, textual history and criticism.

5-970. DIRECTED STUDY. (1-5 cr per qtr; prereq ♯, △)

5-980. DIRECTED TEACHING. (Cr ar; prereq ♯, △)

5-990. RESEARCH. (Cr ar)

8-120. GREEK TEXT COURSE. (3 cr; prereq 3-052 or △; restricted to students in departments *other* than Classics and to Classical Area Studies students majoring in archaeology)
Students will attend 3-000 level Greek courses if they meet the prerequisites for these courses. Supplementary work at the discretion of the instructor.

8-371/8-372/8-373. SEMINAR: GREEK RHETORIC. (3 cr per qtr)

8-380. SEMINAR: LATIN LITERATURE IN BYZANTINE TRANSLATION. (3 cr)
Investigation of the literary quality and cultural role of Greek translations of classical Latin literature in Byzantium; examination and analysis of the "rediscovered" works of Ovid, Cicero, Virgil, Boethius, Augustine, and Aristotle in terms of the Byzantine cultural milieu.

8-510. SEMINAR: PHILOSOPHY. (3 cr)
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*).

8-910. SEMINAR. (3 cr)
Various author seminars, such as Greek lyric poetry, Greek tragedy, Greek rhetoric, Greek comedy, Homer, Pindar, and Euripides, will be offered under this number.

Modern Greek (MdGk)

5-970. DIRECTED STUDY. (1-5 cr per qtr; prereq ♯, △)

5-980. DIRECTED TEACHING. (Cr ar; prereq ♯, △)

5-990. RESEARCH. (Cr ar)

Latin (Lat)

5-012. PROSE COMPOSITION. (2 cr; prereq Lat 3-106 or △)

5-038. ORAL INTERPRETATION OF CLASSICAL LATIN LITERATURE. (5 cr, §Th 5-831; prereq 2 yrs Latin or equiv and Th 3-801 or 3-321 or ‡) Sonkowsky
Phonetics, prosody, and oral performance of selected texts in classical Latin.

5-235. MEDIEVAL LATIN. (3 cr; prereq ‡)
Survey of Latin literature from 5th to 12th century; Carolingian and 12th-century Renaissance.

5-264/5-265/5-266. GRADUATE SURVEY. (4 cr per qtr; prereq ¶5-012)
5-264: Latin literature of the Republic. 5-265: Latin literature of the Augustan Age. 5-266: Latin literature of the Empire.

5-371/5-372/5-373, 5-374/5-375/5-376, 5-377/5-378/5-379. LATIN LITERATURE. (3 cr per qtr)
Authors vary from term to term and from year to year. One or more appropriate authors studied in a given course. 5-371: History. 5-372: Epistles and essays. 5-373: Oratory. 5-374: Epic and pastoral poetry. 5-375: Lyric and elegiac poetry. 5-376: Drama. 5-377: Satire. 5-378: Law. 5-379: Religious Texts (Kraabel).

5-701/5-702/5-703†. STRUCTURE OF LATIN. (1-2 cr per qtr; prereq sr or grad, 10 Upper Division cr or equiv, ‡)
Integrated review of basic Latin structures; experience in application of current linguistic theories to Latin texts; practice in the substitution, transformation, and expansion of Latin patterns; special problems in reading Latin.

5-715. NEW CRITICAL APPROACHES TO CLASSICAL TEXTS. (3 cr; recommended for Latin teaching majors; prereq 15 cr Upper Division Latin, ‡)
Designed to bring teachers up to date in significant research, especially in authors read in secondary schools. Recent approaches to Caesar, Cicero, Ovid, Virgil, Horace, Catullus, Livy, Tacitus are described and evaluated.

5-794. PROSEMINAR: INTRODUCTION TO CLASSICAL STUDIES. (3 cr, §Grk 5-794; required of all new grad students; prereq grad major or ‡)
Survey of fields of research in classical scholarship, methods and bibliography, textual history and criticism.

5-970. DIRECTED STUDY. (1-5 cr; prereq ‡, △)

5-980. DIRECTED TEACHING. (Cr ar; prereq ‡, △)

5-990. RESEARCH. (Cr ar)

8-120. LATIN TEXT COURSE. (3 cr; prereq 3-052 or △; restricted to students in departments *other* than Classics and to Classical Area Studies students majoring in archaeology).
Students will attend 3-000 level Latin courses if they meet the prerequisites for these courses. Supplementary work at the discretion of the instructor.

8-380. SEMINAR: LATIN LITERATURE IN BYZANTINE TRANSLATION. (3 cr)
Investigation of the literary quality and cultural role of Greek translations of classical Latin literature in Byzantium; examination and analysis of the "rediscovered" works of Ovid, Cicero, Virgil, Boethius, Augustine, and Aristotle in terms of the Byzantine cultural milieu.

8-440. THE ETRUSCAN ORIGINS OF ROME. (3 cr, §Clas 8-440; prereq ‡)
Examination of literary and archaeological sources for the presence and influence of the Etruscans in early Rome.

8-470. SEMINAR: JUVENAL. (3 cr; prereq ‡)
Critical analysis of the satires under the following biases: role of humor and rhetoric; Juvenal's place in Roman Satire; his attitudes compared with literary contemporaries Tacitus and Martial; validity of traditional meaning.

8-710. SEMINAR: LATIN METRICS. (3 cr) Sonkowsky
Nature and function of the meters of Latin poetry.

8-910. SEMINAR. (3 cr)
Various author seminars, such as Roman drama, Cicero, Lucretius, odes and epodes of Horace, Ovid, and Juvenal, will be offered under this number.

Classical Philology (ClPh)

5-715. INTRODUCTION TO CLASSICAL PHILOLOGY. (2 cr; prereq ‡)
Sounds and forms of the classical languages; principles of linguistic paleontology. Course essential to all other work in classical philology.

5-716. HISTORY OF GREEK. (4 cr; prereq 5-715 or equiv and 2 yrs Greek)
Semantic and formal development of Greek, from Mycenaean to Romaic; assigned readings, reports, lectures.

5-717. HISTORY OF LATIN. (4 cr; prereq 5-715 or equiv or ‡ and 2 yrs Latin)
Readings in Old Latin philological texts; introduction to Latin etymology, word formation, loanwords, historical syntax.

5-718. GREEK DIALECTS. (4 cr; prereq 5-715 and 2 yrs Greek or ‡)
Introductory survey of epigraphic and literary monuments illustrating ancient Hellenic dialectology. Some consideration of the age-and-area hypothesis and of proto-Greek.

5-733. VULGAR LATIN. (4 cr; prereq ‡; recommended for all students of language)
Lectures on development of Romance languages; readings of documents that reveal the lexical, phonological, and syntactic systems of colloquial Latin.

5-735. OSCAN-UMBRIAN. (4 cr; prereq 5-715 and 5-717 or ‡)
Epigraphic and onomastic techniques for the interpretation of Indo-European languages of early Italy.

5-970. DIRECTED STUDY. (1-5 cr; prereq ‡ and △)

8-797/8-798/8-799. SEMINAR: STUDIES IN EARLY MEDITERRANEAN EPIGRAPHY AND ONOMASTICS. (3 cr per qtr; prereq ‡)
Survey of one or more of the principal subcultures (e.g., Gaulish, Etruscan, Lydian) associated with Greco-Roman antiquity.

Classics (Clas)

For Which No Latin or Greek is Required

CLASSICAL HUMANITIES

5-001. GREEK AND ROMAN LYRIC POETRY. (4 cr; prereq two courses in English literature beyond Engl 1-003, or 1-004, or in foreign literature, or △)
Readings in translation from Greek lyric poets, Catullus, Horace, and minor Latin lyricists, with attention paid to the cultural patterns of the times and to the survival of such poetry into modern times.

5-002. ANCIENT SATIRE. (4 cr; prereq two courses in English literature beyond Engl 1-003, or 1-004, or in foreign literature, or △)
The 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.

5-003. THE ANCIENT NOVEL AND ROMANCE. (4 cr; prereq two courses in English literature beyond Engl 1-003, or 1-004, or in foreign literature, or △)
The development of the ancient novel. Readings in translation from the ancient Greek novelists and from Apuleius and Petronius.

5-004. EROTICISM AND FAMILY LIFE IN THE GRECO-ROMAN WORLD. (4 cr)
Analysis of Greek and Roman family life in the shaping of personality; diachronic change in modes of erotic expression; narcissism and homosexuality; status of women; evolving views of sexual morality compared to present trends. Examples from art and literature.

5-005. MADNESS AND DEVIANT BEHAVIOR IN ANCIENT GREECE AND ROME. (4 cr; prereq soph, 2 cr in Classics)
Analysis of 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.

5-061. INTRODUCTION TO BYZANTINE CIVILIZATION. (3 cr, §1-061)
Greco-Roman backgrounds of Byzantine civilization. Culture of the Eastern Empire through the study of history, religion, education, art, literature in translation. Requires additional work for graduate credit.

5-071. RELIGION IN ANTIQUITY: GREEK, HELLENISTIC. (4 cr, §3-071; prereq ‡) Kraabel
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 3-071; students do additional work for advanced credit.

5-072. RELIGION IN ANTIQUITY: BEGINNINGS OF CHRISTIANITY. (4 cr, §3-072; prereq ‡) Kraabel
First-century Israel under Roman rule. Jesus of Nazareth. Earliest Christian communities. Jewish Christianity. Mission to gentiles. Paul the apostle. Beginnings of New Testament. Meets with 3-072; students do additional work for advanced credit.

5-073. RELIGION IN ANTIQUITY: ROMAN, EARLY CHRISTIAN. (4 cr, §3-073; prereq ‡) Kraabel
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 second and third centuries. Influence of Greco-Roman culture upon emerging Church. Constantine and Julian. Meets with 3-073; students do additional work for advanced credit.

5-081. CLASSICAL EPIC IN TRANSLATION. (4 cr, §3-081)
Reading of Homer's *Iliad, Odyssey,* Virgil's *Aeneid,* with attention to cultural context of epic, the heroic character, epic formulas, and poetic techniques. Meets with 3-081, but advanced independent work in addition to regular class assignments is required.

5-082. GREEK TRAGEDY IN TRANSLATION. (4 cr, §3-082)
Aeschylus, Sophocles, Euripides—introductory lectures on origin of European drama as distinct literary form, on characteristics of Greek tragedy, and ancient theaters and theatrical conventions. Careful discussion of selected tragedies. Major emphasis on understanding problems posed in relation to cultural patterns of the time. Meets with 3-082, with additional independent work required.

5-083. ARISTOPHANES AND ROMAN DRAMA IN TRANSLATION. (4 cr, §3-083)
Aristophanes, Menander, Plautus, Terence, Seneca—introductory material organized as in Clas 5-082, with emphasis on tradition of comedy. Reading of about a dozen comedies and three Senecan tragedies. Meets with 3-083, but advanced independent work in addition to regular class assignments is required.

5-085. GREEK PHILOSOPHY: THE PRESOCRATICS TO PLATO. (4 cr; prereq jr)
Fragments of the Presocratics and Sophists and selected dialogues of Plato.

5-086. GREEK PHILOSOPHY: ARISTOTLE AND POST-ARISTOTELIAN THOUGHT. (4 cr; prereq △)
Excerpts from the writings of Aristotle, with special attention to his metaphysical and ethical writings. Fragments of Stoic and Skeptic writers; the extant works of Epicurus; Diogenes Laertius; Sextus Empiricus; Plutarch's polemical works against the Stoics.

5-115. CLASSICAL HUMANITIES PROSEMINAR. (4 cr; prereq △)
Integrates various disciplines within field of Classics. Several faculty members present introductions to special studies. Coordinator conducts discussions toward synoptic view of classical culture.

Spch 5-611. CLASSICAL RHETORIC. (4 cr; prereq Spch 1-101 or 1-105)
Greek and Roman theories of speechmaking; historical and philosophic context and influence on education.

5-970. DIRECTED STUDY. (1-5 cr; prereq ‡ and △)

5-980. DIRECTED TEACHING. (Cr ar; prereq ‡ and △)

5-990. RESEARCH. (Cr ar)

ARCHAEOLOGY

5-089. INTRODUCTION TO BIBLICAL ARCHAEOLOGY. (4 cr; prereq jr) Kraabel
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. Requires additional work for graduate credit.

5-101. INTRODUCTION TO PREHISTORIC GREEK ARCHAEOLOGY. (4 cr; prereq jr or ‡) McDonald
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.

5-102. GREEK SCULPTURE. (4 cr, §ArtH 5-102; prereq jr or ‡)
Survey of the styles and techniques of Greek sculpture from the archaic period down to the end of the fourth century B.C. Emphasis on the sculptors and the styles of the various schools throughout Greece, Sicily and southern Italy, and Asia Minor.

5-103. HELLENISTIC ART AND ARCHAEOLOGY. (4 cr, §ArtH 5-103; prereq jr or ‡)
Greek architecture, sculpture, ceramics, painting, and minor arts from the beginning of the fourth century B.C. to the end of the Hellenistic period. Attention paid to city planning, public buildings, and the topography of such sites as Athens, Olynthos, Corinth, Priene, Pergamon.

5-104. ROMAN ARCHITECTURE. (5 cr, §ArtH 5-104; prereq ArtH 1-008 or 3-008 or ArtH/Clas 3-162) McNally
The types and techniques of buildings in the city of Rome and throughout the Empire from the fifth century B.C. to the fourth century A.D. Includes discussion of major archaeological sites.

5-105. ROMAN PAINTING AND MOSAICS. (5 cr, §ArtH 5-105; prereq ArtH 1-008 or 3-008 or ArtH/Clas 3-162) McNally
General introduction to Roman painting and mosaics followed by discussion of specific problems and of sites such as Pompeii and Antioch.

5-106. GREEK PAINTING. (5 cr, §ArtH 5-106; prereq 5-102 or 5-103; offered when feasible) Cooper, McNally
Methods of research and analysis in classical art as applied to study of vases; investigation of original objects and of sources.

5-107. ROMAN SCULPTURE. (4 cr, §ArtH 5-107; prereq ArtH 1-008 or 3-008 or ArtH/Clas 3-162)
Sculpture from Rome and its provinces from the first century B.C. to the fourth century A.D. with special emphasis on the role of sculpture in Roman politics and religion.

5-108. GREEK ARCHITECTURE. (4 cr, §ArtH 5-108; prereq ArtH 1-008 or 3-008 or ArtH/Clas 3-152) Cooper, McNally
Archaic and Classical examples of religious and secular architecture with special consideration of their setting in major archaeological sites.

5-109. INTRODUCTION TO ETRUSCAN ART AND ARCHITECTURE. (4 cr, §ArtH 5-109; prereq jr or ‡)
A survey of the architecture, sculpture, painting, and minor arts of the Etruscans. Attempt to place this art into its political, religious, and social setting. Brief attention paid to the methods of Etruscan archaeology.

5-110. PROSEMINAR: CLASSICAL ARCHAEOLOGY. (4 cr; prereq ‡)

5-120. FIELD RESEARCH IN ARCHAEOLOGY. (3-6 cr; prereq ‡)
Field excavation, survey, and research in 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.

8-114. SEMINAR: THE TOPOGRAPHY OF ATHENS. (3 cr, §ArtH 8-114; prereq ‡) Coulson

8-151. TOPOGRAPHY OF ANCIENT ROME. (3 cr, §ArtH 8-151; prereq ‡) McNally

8-190. SEMINAR: PROBLEMS IN ANCIENT ART. (3 cr, §ArtH 8-190; prereq ‡)

8-215. SEMINAR: THE EXCAVATION AT NICHORIA IN MESSENIA. (3 cr; prereq ‡) McDonald

8-272. SEMINAR: PROBLEMS IN CLASSICAL ART. (3 cr, §ArtH 8-272; prereq ‡) McNally

8-440. THE ETRUSCAN ORIGINS OF ROME. (3 cr, §Lat 8-440; prereq ‡)
Examination of the literary and archaeological sources for the presence and influence of the Etruscans in early Rome.

COMPARATIVE LITERATURE (CLit)

Professor
John D. Hurrell
Herman Ramras
Armand Renaud
R. Joseph Schork
Reiko Tsukimura
Gerhard H. Weiss

Associate Professor
Peter E. Firchow

Assistant Professor
J. Allen Simpson

Degree of Master of Arts

The Master's degree is offered under Plan B only.

Prerequisite for Admission—An undergraduate major in one field of language and literature or its equivalent. All doubtful cases will be decided by the committee.

Language Requirements—In addition to being completely proficient in English, candidates for the Master's degree must, during their first year of graduate work, pass reading examinations in French or German and, in addition, one of the following: French, German, Italian, Spanish, Russian, Greek, Latin, Swedish, Norwegian, Chinese, Japanese, or any other appropriate language whose literature is taught at the University of Minnesota. These examinations will be conducted by or under the supervision of the committee. One examination must be taken during the first quarter of residence, and the second before the end of the first year.

Program of Study—Candidates for the Master's degree will arrange a program of study with their adviser, who will be a member of the Committee on Comparative Literature. The comparative literature seminar, CLit 8-951/8-952 (Theory and Methods of Comparative Literature), is required for the M.A.; competence in French or German is prerequisite for admission to the seminar. CLit 8-951/8-952 must be taken as a unit. Of the remaining required credits, at least 21 must be taken in a single literature and the rest represent a coherent comparative study of a period or literary type. This program of study should involve course work in at least two languages, and must have the approval of the chairman of the Committee on Comparative Literature.

Examination—Toward the end of their course of study (which should normally not take longer than 2 years), candidates for the Master's degree will take a written and oral examination as follows:

1. Two 3-hour written examinations on course work.
2. A 1-hour oral examination predominantly on comparative literature. A basic reading list will be available for the candidate's preparation.

Degree of Doctor of Philosophy

Prerequisites for Admission—A Master's degree in comparative literature, or in any one field of language and literature, or the equivalent. Admission to candidacy for the degree depends on the completion of the comparative literature seminar, CLit 8-951/8-952, or its equivalent.

Language Requirements—A thorough reading knowledge of three foreign languages (one of which must be either French or German) will be required for the Doctor's degree. Candidates should have passed all language examinations prior to submitting the Ph.D. program forms to the Graduate School.

Program of Study—Candidates will arrange their program in consultation with an appropriate adviser from the Committee on Comparative Literature and the chairman of the program. In their proposed course of study for the Doctor's degree, candidates will designate a principal subfield of study, which is the area of their dissertation topic, and a secondary subfield. These subfields may be either a historical period or a literary type as it is represented in at least three literatures. In exceptional cases, a study in depth, involving only two literatures, may be authorized by the adviser with the concurrence of the Committee on Comparative Literature.

Preliminary Examinations—(a) Candidates will pass two 4-hour written examinations administered by the committee with the cooperation of the student's adviser. The first examination will deal primarily with literary criticism and will be based on a reading list submitted by the candidate and approved by the committee. This list must be submitted at least 1 quarter prior to the scheduled date of the examination. The second examination will be based on the candidate's principal and secondary subfields and will deal predominantly with primary literary works. (b) The preliminary oral examination will be based in part on the candidate's written examination and will also cover those areas in the two subfields not previously covered in the written examination.

Note—The major proportion of course work for degrees in comparative literature is offered by the graduate departments of literature and languages. In special cases, approval may be given for graduate courses in such departments as philosophy, history, or art.

8-951/8-952.† SEMINAR IN COMPARATIVE LITERATURE. (3 cr) Comparative Literature Committee
Guided research in a few selected areas with due regard for methods applicable in a study of comparative literature.

8-961. MODERNISM. (3 cr; prereq reading knowledge of French or German) Firchow
Groupings and movements of literature in 20th-century Europe and America and their relations to each other.

8-970. DIRECTED READING IN COMPARATIVE LITERATURE. (1-3 cr; prereq grad student in comparative literature, △)

COMPUTER AND INFORMATION SCIENCES (CICS)

Professor

J. Ben Rosen, *head*
William D. Munro, *associate head, director of graduate study*
Eugene Ackerman
Gordon B. Davis
Wolfgang Giloi
K.S.P. Kumar
E. Bruce Lee
Marian B. Pour-El
Marvin L. Stein
Hans F. Weinberger

Associate Professor

Douglas H. Anderson
Frederic N. Bailey
Kenneth M. Brown
Krzysztof S. Frankowski
Richard P. Halverson
Stephen J. Kahne
Richard Y. Kain
Jay A. Leavitt
Peter C. Patton

Assistant Professor

Donald L. Boyd
William R. Franta
Allen R. Hanson
Oscar H. Ibarra
Larry L. Kinney
Naftaly Minsky
Peter Nicholson

Graduate work in computer and information sciences is designed to train students in the science, technology, and current methods of research being used in connection with high speed computing devices and the information they process, as well as with the applications of these devices to a broad spectrum of problems. There is significant research being carried out at Minnesota in the basic areas of: theory and construction of compilers and operating systems; programming languages; data structures; computer graphics; artificial intelligence and heuristic programming; machine (hardware) organization and design; microprogramming; numerical analysis; mathematical programming; automata theory and computational complexity; formal languages; and hybrid systems. Additionally there is research being done in the applications of computers to medicine, psychology, biology, art, etc. As an integral part of their graduate work, students will use an outstanding University computing facility which provides access to

Control Data 6600 and 6400 Computer Systems, an advanced hybrid system, and smaller affiliated computers.

Prerequisites—A degree in any major, with a substantial and excellent background in mathematics. (Students with an inadequate mathematical background will remove the deficiency prior to starting their graduate program proper.)

Master's Degree—The master of science is offered under Plans A and B. Students are expected, by means of a written examination, to show competence in the basic material normally taken during the first year of their graduate program. (The qualifying examination for the doctorate may be used to satisfy this requirement.) In addition, candidates will be required to demonstrate proficiency in the utilization of a computer by successfully writing and executing a significant and adequately documented computer program; this may be done in conjunction with a thesis or Plan B paper, a graduate seminar, or an independent study course under the major adviser.

Doctor's Degree—Because of the breadth of possibilities available for research at the doctoral level in computer science, the student's program can range from one which is highly interdisciplinary in nature to one in which several core areas of computer science are combined. Thus students will usually plan, with their adviser, a supporting program of study rather than a traditional minor.

Normally during the first quarter of their second year, students will take a written qualifying examination, consisting of two parts: (a) general knowledge of the basic subject matter in computer science; this material is related to students' (normal) first year of graduate study, and (b) in depth knowledge of one of the areas covered by students during their (normal) first year. Doctoral students will also demonstrate competence in utilizing the computer, as described in the section on the Master's degree. After passing the written qualifying examination, completing their course work and language requirements, students must pass a preliminary oral examination, in which they will be expected to show in considerable depth a knowledge of those core subjects and supporting areas in which they have specialized and in which they plan to do their doctoral dissertation. They must demonstrate sufficient grasp of the dissertation subject and its literature to pursue independent research in that field. After completion of the thesis, which must demonstrate originality and constitute a significant contribution to the field, students must defend their thesis in a final oral examination.

Language Requirement—For the Master's degree, none. For the Doctor's degree, one foreign language, usually French, German, Japanese, or Russian. A petition for an alternative may be made.

5-001f. THEORY AND APPLICATION OF LINEAR PROGRAMMING ALGORITHMS. (4 cr; prereq 1-101 or 1-105 or 3-101, Math 3-211 or Math 3-142, or ‡; informal lab)
Convex polyhedral sets; extreme points; linear systems; primal and revised simplex algorithms; duality theory and Kuhn-Tucker conditions; postoptimality analysis; obtaining initial feasible solutions; storage and retrieval problems; use of commercial linear programming codes.

5-002w. COMPUTATIONAL METHODS FOR NONLINEAR PROGRAMMING. (4 cr; prereq 5-001 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.

5-101f,w. STRUCTURE AND PROGRAMMING OF SOFTWARE SYSTEMS I. (4 cr; prereq 3-107 or 5-199 or ‡; informal lab)
Subroutine coding conventions; argument transfer; interrupts and traps; macros; I/O equipment and operations; buffers; conditional assembly and program segmentation. Students will write assembly language programs for an existing, modern computer.

5-102w,s. STRUCTURE AND PROGRAMMING OF SOFTWARE SYSTEMS II. (4 cr; prereq 5-101 or ‡; informal lab)
(Continuation of 5-101) Relocatability and base addressing. Creating an assembler: source code scanning, symbol table management, stacking, template macro processing, etc. Microprogramming. Students will design and run an assembler.

5-104f. SYSTEM SIMULATION: LANGUAGES AND TECHNIQUES. (4 cr; prereq 3-107; informal lab)
Simulation methodology including random number generation, queueing, service times, discrete random variables, design of experiments. Simulation languages flow and event oriented: GPSS, SIMULA, SIMSCRIPT. Model building. Applications to job shops, business, operations research, and operating systems.

5-105s. THEORY OF MACHINE ARITHMETIC. (4 cr; prereq 3-107 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.

5-106s. STRUCTURE OF HIGHER LEVEL LANGUAGES. (4 cr; prereq 3-107 or ‡)
Formal definition of programming languages. Syntax. Semantics. The Algol report. Introduction to Algol. Applications. Extensions of concepts to other languages. List structures. List languages. List processing. Basics of compilers and compiler implementation.

5-107f. COMPUTER GRAPHICS. (4 cr; prereq 3-107 or ‡)
Arrangement of data base and display files. Representation of data types of display equipment available, calligraphic and raster. Character generators. Display processors. Clipping, windowing, and the hidden surface problem. Applications.

5-108w. MATRIX DESCRIPTION AND SYNTHESIS OF LOGICAL ALGORITHMS FOR MICROPROGRAMMING. (4 cr; prereq 3-107, 5-201, Math 3-211, or ‡; informal lab)
A special matrix calculus is developed and applied to the description and synthesis of combinational, iterative and sequential networks. Applications to state reduction, minimization of logical algorithms and structural implementation of microprograms.

5-121w. DATA STRUCTURES. (4 cr; prereq 5-101 or ‡)
Basic concepts of data and its representation. Linear lists and strings; arrays and orthogonal lists; tree structures. Storage systems and structures; storage allocation and compactification; multilinked structures. Applications.

5-199f,w,s. PROBLEMS IN LANGUAGES AND SYSTEMS. (1-4 cr per qtr [may be repeated for cr]; prereq ‡)
Special courses or individual study arranged with faculty member. Graduate students who have not had 3-107 should sign up for that material as 5-199. See Professor Munro for details.

5-200s. INTRODUCTION TO ANALOG AND HYBRID COMPUTATION. (4 cr; prereq 1-101 with ‡, and Math 3-221 or Math 3-061, or ‡; 3 lect and 1 lab)
Organization of analog and hybrid computers. Programming for analog and hybrid computers. Interface equipment including analog-to-digital and digital-to-analog conversion. Simulation languages. Case studies and problem solutions.

5-201w/5-202s. COMPUTER ENGINEERING. (4 cr; prereq 3-107 or ‡; 3 lect and 1 lab per qtr)
(Same as EE 5-350/5-351) Boolean analysis, algebra, and operators in relay circuits. Analysis of Boolean networks. Limitations of practical circuits. Fan-in, fan-out relays. Algebraic synthesis. Multilevel factorization. The Cray borrow pyramid. Synchronous sequential circuits, Mealy model, flip-flop and clocking practices. System block diagrams. Register types and transfer methods. Clock generation and control. Polyphase clock generation. Sequences, sequence functions, ring counters.

5-299f,w,s. PROBLEMS IN MACHINE DESIGN. (1-4 cr per qtr [may be repeated for cr]; prereq ‡)
Special courses or individual study arranged with faculty member.

5-301f,w. NUMERICAL ANALYSIS. (4 cr, §Math 5-472; prereq Math 3-221, or 3-142 and 3-211, or ‡; a knowledge of FORTRAN is assumed; informal lab)
General concept of iteration formulas. Solution of equations. Newton's method. Linear systems. Finite differences. Interpolation. Numerical differentiation and integration. Introduction to initial value problems.

5-302w,s. NUMERICAL ANALYSIS. (4 cr, §Math 5-473; prereq 5-301, Math 5-601, or ‡; informal lab)
General theory of linear approximations. Norms. Error estimates. Convergence rates. Least squares. Orthogonal polynomials. Chebychev interpolation theory. Gaussian quadrature. Solution of nonlinear systems of equations. Multipoint iteration formulas. Starting values. Iterative schemes for linear algebra. Conditioning. Jacobi's method. Differential equations. Initial value problems. Systems of equations. Runge-Kutta. Stability.

5-304s. COMPUTATIONAL ASPECTS OF MATRIX THEORY. (4 cr; prereq 5-302 or ‡; informal lab)
Computational pitfalls. Conditioning. Iterative methods. Relaxation methods. Various reduction and elimination schemes. Hessenberg matrices. Methods of Lancos, Givens, Householder. Eigenvalue problems. Bounds for eigenvalues.

5-305s. NUMERICAL SOLUTIONS OF INITIAL AND BOUNDARY VALUE PROBLEMS. (4 cr; prereq 5-302 or ‡; informal lab)
Linear two-point boundary value problems. The eigenvalue problem. Tau and Galerkin methods. Nonlinear two-point problems. Shooting method. Newton-Kantorovich method. Elements of numerical solutions of problems in partial differential equations. Laplace, heat, and wave equations.

5-399f,w,s. PROBLEMS IN NUMERICAL ANALYSIS. (1-4 cr per qtr [may be repeated for cr]; prereq ‡)
Special courses or individual study arranged with faculty member.

5-400f. INTRODUCTION TO AUTOMATA THEORY. (4 cr; prereq 1-106 or ‡; informal lab)
Turing machines, computable functions, unsolvability of the halting problem. Finite state models: equivalence, minimization, synthesis of finite state systems, state assignment, decomposition. Survey of other automata.

5-401w. INTRODUCTION TO FORMAL LANGUAGES. (4 cr; prereq 5-400; 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.

5-499f,w,s. PROBLEMS IN COMPUTATIONAL THEORY OR LOGIC. (1-4 cr per qtr [may be repeated for cr]; prereq ‡)
Special courses or individual study arranged with faculty member.

5-501f. ARTIFICIAL INTELLIGENCE AND HEURISTIC PROGRAMMING. (4 cr; prereq 1-106 or ‡; informal lab)
Concept of a "mechanized" intelligence; the IQ of current systems. Game playing, particularly heuristic search techniques. Introduction to neural networks and their mechanical analogues. Methodologies in pattern recognition and applications. The frame problem in AI and implications for robotics. Natural language processing and deductive question answering.

5-502f. INTRODUCTION TO OPERATING SYSTEMS. (4 cr; prereq 5-102 or ‡; informal lab)
Definition and historical development of operating systems. Classification of systems as batch-processing, interactive, and real-time systems. Abstractions and implementations of properties common to most systems. Concurrency and related control problems. Resource allocation. Storage allocation. Program modularity. Sharing. Multiplexing. Protection. Performance optimization.

5-503w. INTRODUCTION TO COMPILERS. (4 cr; prereq 5-102 or ‡; informal lab)
Compiler structure. Simple compilation: scanning, statement recognition, expression translation, generation of reverse Polish, triplets, quadruplets and assembly language code. Simple economization. Symbol table organization, memory organization and recursion. Selfcompilation by means of bootstrapping. Syntax-directed translation via context-free grammars and other formalisms. Illustrative examples.

5-511. ADVANCED TOPICS IN ARTIFICIAL INTELLIGENCE. (4 cr; prereq 5-501 and 5-400, or ‡)
"Systems" employing AI techniques; examples including Shakey (the SRI robot), the hand-eye project at Edinburgh, the MIT robot project, etc. Methods of integrating eyes, hands, ears, etc., into a functioning unit. Natural language facilities including representational schemes, parsing algorithms and semantic memories. Students will design and implement phases of a large system.

5-599/5-699/5-799. PROBLEMS: NONNUMERIC COMPUTATION, CONTROL SCIENCE, INFORMATION SCIENCE. (1-4 cr per qtr [may be repeated for cr]; prereq ‡)
Special courses or individual study arranged with faculty member.

8-101f/8-102w/8-103s. COMPUTER OPERATING SYSTEMS: MODELING AND ANALYSIS. (3 cr per qtr; prereq 5-502 or ‡)
Introduction: 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: queueing 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.

8-201/8-202/8-203. MATHEMATICS OF COMPUTERS AND CONTROL DEVICES. (3 cr per qtr; prereq 5-302 or ‡)
Theory of elementary control and computing devices, open and closed systems, dynamic and transient responses. Synthesis and analysis of systems. Analog and digital computers.

8-301/8-302. COMPUTATION OF SPECIAL FUNCTIONS AND FORMULAS. (4 cr per qtr; prereq 5-305 or ‡)
Polynomials and rational functions. Errors, Nth root, logarithmic, circular, and hyperbolic functions. Multiple precision. Heuristic considerations.

8-303/8-304. COMPUTATIONAL METHODS FOR INITIAL AND BOUNDARY VALUE PROBLEMS. (4 cr per qtr; prereq 5-305 or ‡)
Two-point boundary value problems. Laplace's equation. Numerical approximation of 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 with individual assignments in current literature. The amount of credit is arranged with the faculty member in charge. For different seminars, credit may be obtained for the same course number more than once.

8-199. SEMINAR: LANGUAGES AND SYSTEMS. (1-3 cr per qtr; prereq ‡)

8-299. SEMINAR: MACHINE DESIGN. (1-3 cr per qtr; prereq ‡)

8-399. SEMINAR: NUMERICAL ANALYSIS. (1-3 cr per qtr; prereq ‡)

8-499. SEMINAR: COMPUTATIONAL THEORY AND LOGIC. (1-3 cr per qtr; prereq ‡)

8-501. PATTERN RECOGNITION. (4 cr; prereq ‡; informal lab)
Definition of the problems of pattern recognition, pattern detection, feature selection, etc. Measurement selection: what constitutes a "good" measurement. Feature extraction. Recognition methods: statistical, network, and heuristic. Context analysis. Linguistic analysis and picture description. Applications.

8-599. SEMINAR: NONNUMERIC COMPUTATION. (1-3 cr per qtr; prereq ‡)

8-699. SEMINAR: CONTROL SCIENCE. (1-3 cr per qtr; prereq ‡)

8-799. SEMINAR: INFORMATION SCIENCE. (1-3 cr per qtr; prereq ‡)

In addition to those courses offered above by the Department of Computer, Information, and Control Sciences, the following courses taught by members of the graduate faculty in computer and information science are considered as major courses.

Math 5-157/5-158/5-159. MATHEMATICS OF SYMBOL MANIPULATION

Math 5-162/5-163/5-164. MATHEMATICAL LOGIC

Math 5-476. THEORY OF APPROXIMATION IN NUMERICAL ANALYSIS

Math 8-181/8-182/8-183. FORMAL LANGUAGES AND AUTOMATA

Math 8-190/8-191/8-192. TOPICS IN LOGIC

Math 8-445. ADVANCED NUMERICAL ANALYSIS OF LINEAR SYSTEMS

Math 8-466. ADVANCED NUMERICAL ANALYSIS OF PARTIAL DIFFERENTIAL EQUATIONS

Math 8-675. INFORMATION THEORY

EE 5-250/5-251. CONTROL SYSTEMS

EE 5-350/5-351. PRINCIPLES OF COMPUTER ENGINEERING
EE 5-700/5-701. INFORMATION THEORY AND CODING
EE 5-702. STOCHASTIC PROCESSES AND OPTIMUM FILTERING
EE 5-703. MODULATION SYSTEMS
EE 5-750/5-751. SYSTEM ANALYSIS AND OPTIMAL CONTROL
EE 5-752. NONLINEAR SYSTEM DESIGN
EE 5-851/5-852. DIGITAL COMPUTER SYSTEMS
EE 8-200/8-201/8-202. TOPICS IN STATISTICAL THEORY OF COMMUNICATION
EE 8-240. SEMINAR: COMMUNICATION
EE 8-260/8-261/8-262. NONLINEAR SYSTEMS
EE 8-290. SEMINAR: CONTROL THEORY
EE 8-291. SEMINAR: SYSTEM THEORY
EE 8-350. MODELS FOR COMPUTING MACHINES
EE 8-351. ADVANCED COMPUTER SYSTEMS
EE 8-352. ADVANCED SWITCHING THEORY

CONTROL SCIENCES

Professor

Lawrence Markus (Mathematics), *chairman*
Neal R. Amundson (Chemical Engineering)
Rutherford Aris (Chemical Engineering)
K. S. P. Kumar (Electrical Engineering)
E. Bruce Lee (Electrical Engineering)
Bernard W. Lindgren (Mathematics and Statistics)
Warren S. Loud (Mathematics)
Katsuhiko Ogata (Mechanical Engineering)
J. B. Rosen (Computer, Information, and Control Sciences)
Patarasp R. Sethna (Aerospace Engineering)
Marvin L. Stein (Computer, Information, and Control Sciences)

Associate Professor

Fredric N. Bailey (Electrical Engineering)
Richard P. Halverson (Electrical Engineering)
Stephen J. Kahne (Electrical Engineering)
Kenneth Meyer (Mathematics)
John H. Park, Jr. (Electrical Engineering)
Charlotte Striebel (Statistics)
Frederick M. Waltz (Electrical Engineering)

Assistant Professor

William Garrard (Aerospace Engineering)
Peter Nicholson (Computer, Information, and Control Sciences)

The program in control sciences leads to the Ph.D. degree. No M.S. degree or minor specialization is planned in the field of control sciences.

Prerequisites—Candidates for the Ph.D. program in control sciences will normally have completed an undergraduate degree or an M.S. in one of the related fields of engineering, computer and information sciences, mathematics, statistics, or physics. Prior to admission to the program students must be admitted as graduate students to one of the relevant departments. Admission to the program must be approved by the Graduate School on recommendation of the student's department and the subcommittee on control sciences. Any applicant whose scientific and engineering training is adequate to follow the program will be considered.

Approval of Program—The candidate's tentative program will be planned with the aid of an adviser selected from those listed on the faculty of the Center for Control Sciences. This faculty will consider the program and transmit it to the Graduate School with recommendations. Approval and appointment of a thesis committee will be handled as usual.

Major Program—The course work in the major should normally be selected from those courses in science and engineering that are particularly relevant to the field of control sciences. Since this program is intended to provide an opportunity for a broad training, it is desirable that at least 9 credits of 8-000 series courses be selected from each of three of the related major areas. Candidates must prepare for a preliminary examination covering each of the following four basic divisions:

1. Mathematical and physical control models
2. Stability and control of linear and nonlinear deterministic processes
3. Stochastic processes and information theory
4. Numerical and computer techniques and implementation of control concepts in scientific and engineering processes

Normally students can prepare for the preliminary examination by completing 9 credits of 8-000 series or suitably advanced courses in each of the four divisions. The remaining course work for the Ph.D. will be selected in consultation with an adviser.

Minor Program—There will be no official minor program. Therefore, all courses on the doctoral program must be passed with a grade of B or better. All candidates are required to attain a high level of mathematical proficiency.

Language Requirement—All candidates must satisfactorily meet the requirement of two foreign languages, usually selected from French, German, or Russian.

CRIMINAL JUSTICE STUDIES (CJS)

Courses in Which Graduate Credit May Be Earned when Program-related

5-001, 5-002, 5-003. THE ROLE OF THE POLICE IN URBAN AMERICA. (4 cr per qtr; prereq 5-001 for 5-002 and 5-003...or ‡)
5-001: Review of the development of American policing; definition of its goals, evolution of its structure; and analysis of the milieu in which it operates. 5-002: Principles of police organization and management; functions of police agencies; executive responsibilities; policy formulation and implementation; management of staff units. 5-003: Organization and management of police services; theory and practice of administration; role of investigative, juvenile, vice, and other programs.

5-101. CRIMINAL LAW. (4 cr)
Examination of the general part of criminal law with particular attention to its philosophical underpinnings. The substantive law of homicide, theft, conspiracy, and attempt and defenses of insanity, self-defense, and mistake of fact or law.

5-102. CRIMINAL PROCEDURE. (4 cr)
Processes by which persons are convicted of crime. Topics include police discretion to arrest, the constitutional law of arrest, search and seizure, role of the prosecutor, plea bargaining, sentencing, and postconviction relief.

5-105. ORIGINS OF THE FIFTH AMENDMENT. (4 cr)
History of the right against self-incrimination from its origins to the ratification of the Constitution in 1791. Discussion and evaluation of Chief Justice Magruder's remark: "Our forefathers, when they wrote this provision into the fifth amendment, had in mind a lot of history which has largely been forgotten today."

5-106. LAW AND SOCIAL ISSUES. (4 cr; prereq Soc 3-101)
Examination of how far the law can go in solving pressing social issues which also impinge on individual liberties, such as sexual relations, drug use, abortion, family relationships, and so on.

5-201. POLICE AND COMMUNITY RELATIONS. (4 cr)
Critical issues in the police and community relationship; nature of the relationship; assessment of the problem; survey and evaluation of present programs; and an agenda for change.

5-202. COMPARATIVE CRIMINAL JUSTICE ADMINISTRATION. (4 cr)
Application of the comparative method to fields of law enforcement, court, and correctional administration; analysis of criminal justice activities in a variety of governmental settings.

5-970. DIRECTED STUDY. (1-15 cr; prereq #)

DENTISTRY and DERMATOLOGY

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

EAST ASIAN LANGUAGES

Professor
Chun-Jo Liu, *director of graduate study*
Edward M. Copeland
Richard B. Mather
Hide Shohara

Associate Professor
Stephen S. Wang, *chairman*
Owen Loveless
Reiko Tsukimura

Assistant Professor
Amy T. Matsumoto

Prerequisites—To be accepted as a graduate major in Chinese or Japanese, the applicant must present a satisfactory undergraduate record including 18 credit-hours in Chinese or Japanese and the completion of Chin or Jpn 5-103 with a grade average of B or above. In special cases provisional registration may be arranged.

SUBFIELDS OF SPECIALIZATION

Chinese

1. Literature of the Ancient Period (pre-Ch'in to A.D. 221)
2. Early Medieval Literature (the Six Dynasties, 221-589)
3. Late Medieval Literature (T'ang-Sung, 589-1280)
4. Early Modern Literature (Yüan-Ming-Ch'ing, 1280-1911)
5. Modern Literature (1911—)
6. Linguistics and Philology

Japanese

1. Literature of the Court (Nara-Heian 712-1185)
2. Medieval Literature (Kamakura-Ashikaga, 1195-1600)
3. Early Modern Literature (Tokugawa, 1600-1868)
4. Modern Literature (Meiji, 1868-1911)
5. Contemporary Literature (1911—)
6. Linguistics and Philology

Master's Degree

Offered under Plan B.

Language Requirement—A candidate for the Master's degree must have a reading knowledge of either French or German.

Major Requirement—A minimum of 27 graduate credits in Chinese (Japanese) including 3 in Chinese (Japanese) bibliography, 3 in Chinese (Japanese) linguistics, and an additional 18 graduate credits in two other related fields. The written requirement of the Graduate School will be fulfilled by passing one examination in cultural history and two others from the subfields indicated above.

Graduate Minor

Prerequisites—Registration as a graduate minor in Chinese (Japanese) is permitted only upon consultation with a graduate adviser in the fields.

Master's Degree—The general requirements of the Graduate School must be satisfied.

Doctor's Degree—Besides satisfying the general requirements established by the Graduate School, the candidate for the Ph.D. offering Chinese (Japanese) as a minor must pass a preliminary oral examination on one of the subfields of Chinese (Japanese) literature.

Doctor's Degree

Prerequisites—Required for admission to the Ph.D. candidacy—skill in reading, writing, and speaking Chinese (Japanese) and an ability to write clear and literate English; a general knowledge of Chinese (Japanese) literature and culture. Recommended: training in one European literature.

Language Requirement—The language requirement for the Ph.D. is Chinese, Japanese, and two of the following: French, German, Russian. When relevance to specialization is shown, an alternate may be substituted for one of the two European languages.

Required Courses—A minimum of 42 graduate credits in the major language, including 6 credits in Chinese bibliography (Chin 8-001) and 3 credits in Japanese bibliography (Jpn 8-001) for Chinese majors and the converse for Japanese majors.

Examinations—Written comprehensive examinations on the development of Chinese (Japanese) language and on the history of Chinese (Japanese) literature, concluding with an oral examination to demonstrate the candidate's knowledge of the historical and philological matrix of selected passages in given works.

Chinese (Chin)

5-112. HISTORY OF THE CHINESE LANGUAGE. (4 cr) Wang

5-113. STRUCTURE OF STANDARD CHINESE. (4 cr; prereq intro course in linguistics) Wang

5-201, 5-202, 5-203. SURVEY OF CHINESE LITERATURE. (4 cr per qtr; prereq 9 cr in literature, 3-103) Liu

5-251/5-252/5-253. INTRODUCTION TO CHINESE BUDDHIST TEXTS. (4 cr; prereq 3-103 or ‡)

5-261, 5-262, 5-263. SIX DYNASTIES LITERARY TEXTS. (4 cr per qtr; prereq 3-103; offered 1973-74 and alt yrs) Mather

5-271, 5-272, 5-273. POETRY OF THE T'ANG AND SUNG PERIODS. (4 cr per qtr; prereq 1-103; offered 1972-73 and alt yrs) Mather

5-274, 5-275, 5-276. CHINESE LITERATURE OF THE YÜAN, MING, AND CH'ING PERIODS. (4 cr per qtr; prereq 3-103, 5-601, or ‡)) Liu

5-281, 5-282, 5-283. TWENTIETH-CENTURY CHINESE LITERATURE. (4 cr per qtr; prereq 5-601) Liu

5-601. VERNACULAR TEXTS. (4 cr; prereq 1-106, 3-103 or ‡)

5-602. ADVANCED CONVERSATION AND COMPOSITION. (4 cr; prereq 3-103)

5-603. CHINESE DOCUMENTS. (4 cr; prereq 3-103 or ‡; offered 1972-73 and alt yrs)

5-701, 5-702, 5-703. STUDIES IN CHINESE LINGUISTICS. (4 cr per qtr; prereq 5-112 or ‡) Wang

5-970. RESEARCH IN CHINESE LITERATURE. (4 cr per qtr; prereq 3-103 or ‡) Mather and staff

8-001, 8-002, 8-003. BIBLIOGRAPHY AND RESEARCH METHODS. (3 cr per qtr; prereq 3-103, 5-601, ‡)

8-004. SEMINAR: CHINESE LINGUISTICS. (3 cr; prereq 5-111, 5-112 or ‡) Wang

8-301. SEMINAR: VERNACULAR CHINESE LITERATURE. (3 cr; prereq 5-601, 8-003) Liu

8-464, 8-465, 8-466. MING AND CH'ING HISTORY. (3 cr per qtr; prereq reading knowledge of Chinese) Taylor
Same as Hist 8-464, 8-465, 8-466.

8-901. SEMINAR: CHINESE. (3 cr per qtr) Staff

Japanese (Jpn)

5-111/5-112/5-113. STRUCTURE OF JAPANESE. (4 cr per qtr; prereq 3-103, 3-003, and Ling 3-003, or ‡) Loveless
Phonology, morphology, syntax.

5-201, 5-202, 5-203. SURVEY OF JAPANESE LITERATURE. (4 cr per qtr; prereq 3-103) Tsukimura

5-261/5-262. CLASSICAL JAPANESE PROSE. (4 cr per qtr; prereq 3-103; offered 1973-74 and alt yrs)

5-271/5-272. POETRY OF THE NARA AND HEIAN PERIODS. (4 cr per qtr; prereq 3-103; offered 1972-73 and alt yrs) Copeland

5-281/5-282/5-283. MODERN JAPANESE LITERATURE. (4 cr per qtr; prereq 5-603) Staff

5-471/5-472. HISTORY OF JAPAN. (3 cr per qtr) Marshall
Same as Hist 5-471/5-472.

5-521/5-522. PROSEMINAR: HISTORY OF JAPAN. (5 cr per qtr; prereq ‡) Marshall
Same as Hist 5-521/5-522.

5-601/5-602/5-603. READINGS IN CONTEMPORARY JAPANESE TEXTS. (4 cr per qtr; prereq 3-103) Shohara

5-970. HONORS COURSE: RESEARCH IN JAPANESE LITERATURE. (4 cr; prereq 3-103 or ‡) Staff

8-001, 8-002, 8-003. BIBLIOGRAPHY AND RESEARCH METHODS. (3 cr per qtr; prereq 3-103, 5-603, ‡) Staff

8-301, 8-302. SEMINAR: NOH DRAMA. (3 cr per qtr; prereq 3-103) Tsukimura

8-501. MEIJI LITERARY REFORM. (3 cr; prereq 3-103) Copeland

8-901. SEMINAR: JAPANESE. (3 cr per qtr) Staff

Luchuan (Lch)

8-111. STRUCTURE OF STANDARD OKINAWAN. (3 cr; prereq Jpn 3-103 or ‡) Loveless

8-112. READINGS IN OKINAWAN LINGUISTICS. (3 cr; prereq Jpn 3-103 or ‡) Loveless

8-113. COMPARATIVE LUCHUAN LINGUISTICS. (3 cr; prereq Jpn 3-103 or ‡) Loveless

8-901. SEMINAR: LUCHUAN. (3 cr per qtr) Staff

Thai

8-901. SEMINAR: THAI. (3 cr per qtr) Staff

Tibetan (Tib)

5-101/5-102/5-103. BEGINNING TIBETAN. (4 cr per qtr) Wang

5-121/5-122/5-123. INTERMEDIATE TIBETAN. (4 cr per qtr; prereq 3-103) Staff

8-901. SEMINAR: TIBETAN. (3 cr per qtr) Staff

ECOLOGY AND BEHAVIORAL BIOLOGY (Ecol)

Professor

Alan J. Brook, *head*
Harrison B. Tordoff, *director of graduate study*
Egolfs V. Bakuzis
Huai C. Chiang
Eville Gorham
Donald B. Lawrence
William H. Marshall
D. Frank McKinney
David F. Parmelee
Richard E. Phillips
Edwin L. Schmidt
Joseph Shapiro
John R. Tester
Herbert E. Wright, Jr.

Associate Professor

Robert C. Bright
Edward J. Cushing
Herbert M. Kulman
Robert O. Megard
Donald B. Siniff

Assistant Professor

Elmer C. Birney
Kendall W. Corbin
Robert K. Maxwell
John G. McColl
Philip J. Regal

Prerequisites—For major work, at least 20 credits in biology including an introductory course (Biol 1-001/1-002 or equivalent); mathematics through calculus; a 2-term sequence in statistics (or 1 term of statistics and 1 term of computer programming); a year of general chemistry; 2 terms of either organic chemistry or physical chemistry; and a year of college physics. Deficiencies either in the biological or physical sciences must be made up as early as possible during graduate study. Each student's competence in biology will be assessed as early as possible after the student's admission.

Language Requirement—For the Master's degree, none. For the Ph.D. degree, one language.

Master's Degree—A Master's degree is offered under both Plan A and Plan B.

Doctor's Degree—After Ph.D. students have selected their research topic, reviewed the pertinent literature, and formulated methods of approach, they must present the thesis proposal in a seminar attended by at least three members of the ecology faculty and by interested graduate students. The purpose of the seminar is to assist students in planning their work and to inform the faculty of student research in its formative stage.

Note—Ecology is a very broad field including diverse biological and physical disciplines. Accordingly, credit in ecology can be granted for courses drawn from various departments. Thus students' programs should include courses from the following list that can be supplemented by other courses listed under other department headings: Psy 5-017, 5-134, 5-012, or 5-012/5-013, 5-041/5-042, 5-061, 5-062, 5-031, 5-071; Zool 5-114, 5-116, 5-170; Ent 5-400; Geo 5-601; Soil 5-612, 5-532. In consultation with their advisers, students should plan a program suited to their individual needs.

5-014f. ECOLOGY OF PLANT COMMUNITIES. (5 cr; prereq 3-004 or Biol 3-041) Cushing
Description, classification, and mapping of plant communities, theory of their structure, interrelationships, development, and stability. Field trips to local vegetation types; analysis of quantitative data.

5-015w. STRUCTURE AND FUNCTIONING OF ECOSYSTEMS. (4 or 6 cr; prereq Biol 3-041, ‡) McColl
Energy flow and cycles of water and nutrients, in relation to productivity, development, and regulation of ecosystems.

5-016s. ECOLOGICAL PLANT GEOGRAPHY. (3 or 5 cr; prereq 3-004 or Biol 3-041 or ‡; offered 1973-74 and alt yrs) Lawrence, Cushing
Ecological principles of plant distribution and landscape analysis, vegetation regions of North America, interpretation of regional vegetation patterns.

5-017s. ECOLOGICAL LIFE HISTORIES OF PLANTS. (5 cr; prereq Biol 3-045, Bot 3-132, ‡; offered 1972-73 and alt yrs)
Influence of environmental factors on each developmental stage of life cycle under natural conditions. Individual species assigned for study at Cedar Creek Natural History Area. Weekly half-day field trips.

5-018su. WETLAND ECOLOGY. (5 cr; prereq 15 cr in biological subjects, introductory chemistry, or ‡...Biol 3-041 recommended; offered in Lake Itasca Biology Session)
Nature, origin, and development of lake, marsh, swamp, and bog ecosystems, environmental control, and productivity.

5-019su. QUATERNARY PALEOECOLOGY. (5 cr; prereq Ecol 3-001 or Biol 3-041 or ‡; offered 1972 and alt yrs in Lake Itasca Biology Session)
Problems and techniques in reconstruction of past communities and ecosystems from fossil evidence in deposits of Quaternary age. Field and laboratory methods in collection and description of stratigraphic sequences and identification and quantitative analysis of fossil assemblages.

5-021. PHYSIOLOGICAL ECOLOGY. (4 cr; prereq Biol 5-051 or Zool 5-104, Biol 3-041, ‡...statistics recommended) Schmidt
Current problems of distribution and abundance of animals in the natural environment.

5-022s. ANIMAL BEHAVIOR. (4 cr; prereq ‡) McKinney
Introduction to ethology; causation, development, evolution, and adaptive significance of behavior.

5-023w. BEHAVIORAL ADAPTATIONS. (5 cr; prereq 5-022, Biol 3-041, ‡) McKinney
Lectures and discussions on current problems in areas of overlap between ethology, ecology, and evolution with special emphasis on social systems, spacing mechanisms, and communication.

5-024f. PHYSICAL ASPECTS OF FIELD BIOLOGY I. (5 cr; prereq 1 yr physics, 1 yr calculus) Maxwell
Use of continuity principle in relating meteorological parameters to biologic systems and modeling of environmental interactions with organisms.

5-025. PHYSICAL ASPECTS OF FIELD BIOLOGY II. (5 cr; prereq 5-024) Maxwell
Elements of a measuring system and determination of meteorological parameters to study physical relationships between an organism and its environment.

5-026. PHYSICAL ASPECTS OF FIELD BIOLOGY III. (2-5 cr; prereq 5-025 or ‡; also offered in Lake Itasca Biology Session) Maxwell
Field application of principles of biometeorology and basic measuring systems presented in Ecol 5-024 and 5-025.

5-027. HUMAN POPULATION, ENVIRONMENT, AND RESOURCES. (4 cr)
Local, national, and world demographic problems. Impact of population on environment, resources, and resource allocation; ecological implications. Birth and death control programs. Demographic models; optimal rate predictions.

5-028s. ADVANCED ECOSYSTEM ANALYSIS. (5 cr; prereq 5-015, ‡) McColl
Individual projects including literature review, field data collection and/or laboratory analyses and synthesis of results. Projects relating to cycling of water or chemical elements, or to energy flow in ecosystems at Cedar Creek Natural History Area. Weekly half-day field trips.

5-029w. POPULATION ECOLOGY. (4 cr; prereq 3-004 or Biol 3-041, one course in statistics) Tester, Siniff
Factors involved in regulation, growth, and general dynamics of populations. Data needed to describe populations; population growth; consideration of population models; intensive discussion of regulatory mechanisms.

5-812su. AQUATIC ECOLOGY. (5 cr; prereq 15 cr incl Biol 1-002 or 3-011 or Biol 1-106 or Zool 1-013; offered in Lake Itasca Biology Session)
Conditions for life in water and distribution of aquatic animals.

5-813su. ADVANCED LIMNOLOGY. (5 cr; prereq 5-812; offered in Lake Itasca Biology Session)
Current topics in limnological research with emphasis on analysis of aquatic productivity. Lectures, laboratory, and field work.

5-814su. COMMUNITY STRUCTURE AND FUNCTION. (5 cr; prereq 3-004 or Biol 3-041 or ‡; offered in Lake Itasca Biology Session)
Communities represented in Itasca Park and vicinity and their dynamic relationships. Relationships of local communities to flora and fauna of Minnesota as a whole. Use of modern methods of community analysis and measurement of environmental factors.

5-815su. FIELD ETHOLOGY. (5 cr; prereq Biol 3-011...Zool 5-077 or 5-834 recommended; offered in Lake Itasca Biology Session)
Behavioral evolution, motivation, and ontogeny, stressing relationship between environment and behavior by using field research techniques.

5-816su. ECOLOGY OF FRESHWATER ALGAE. (5 cr; prereq Bot 5-231 or 5-811 or ‡; offered in Lake Itasca Biology Session) Brook
Aspects of algal ecology in lakes and ponds; phytoplankton, benthos, and periphyton; also in streams, bogs, soils, and other terrestrial habitats. Laboratory instruction in relevant research techniques.

5-817su. VERTEBRATE ECOLOGY. (5 cr; prereq 3-004 or Biol 3-041; offered in Lake Itasca Biology Session) Siniff, Tester
Field work on populations and their relationships to local environments; habitat analysis and ecological research methods. Individual and team research projects, field trips, and lectures.

5-818su. QUANTITATIVE ECOLOGY. (5 cr; prereq 9 cr in ecology; offered in Lake Itasca Biology Session) Siniff
Lectures, discussions, and field studies on populations, communities, and ecosystems. Emphasis on methods of sampling and measuring ecological parameters and on data analysis and interpretation.

5-819su. SOILS AND THE ECOSYSTEM. (5 cr, §Soils 5-532; prereq 3-004 or Biol 3-041 or ‡; offered in Lake Itasca Biology Session)
Formation and distribution of soils in relationship to vegetation, climate, and other soil-forming factors. Interrelationships of soils in the ecosystem.

8-002s. QUANTITATIVE ASPECTS OF ECOLOGICAL SYSTEMS. (4 cr; prereq 5-015, 3 cr ecology, 5 cr statistics; offered 1973-74 and alt yrs) Siniff, McColl
Ecological concepts which normally require quantitative measurements and synthesis of measurements to interpret organisms-environment interactions. Measurements such as density estimates and distribution and abundance patterns among species; division of community resources among species and species diversity. Quantitative characteristics of random variables used in defining these concepts. Concepts used in quantifying the structure and function of natural ecosystems as a whole.

8-390. GRADUATE SEMINAR. (Cr ar; prereq ‡) Staff

8-391. ADVANCED WORK IN ECOLOGY AND BEHAVIORAL BIOLOGY. (Cr ar; prereq ‡) Staff
Individual work in a special aspect of the area.

See Geology and Geophysics for the following course descriptions:

Geo 5-601. LIMNOLOGY. (4 cr; prereq Chem 1-005 or equiv, ‡) Shapiro

Geo 8-602.* ADVANCED LIMNOLOGY. (3 cr; prereq 5-601 or equiv, ‡; offered 1973-74 and alt yrs) Shapiro

Geo 8-603.* METHODS FOR ANALYSIS OF NATURAL WATERS. (2 cr; prereq 5-601 or equiv, ‡; two 3-hr periods per wk) Shapiro

ECONOMICS (Econ)

Professor

Norman J. Simler, *chairman*
Francis M. Boddy
O. H. Brownlee
John A. Buttrick
John S. Chipman
Edward Coen
Walter W. Heller
James M. Henderson
Clifford Hildreth
Leonid Hurwicz
John H. Kareken
Anne O. Krueger
E. Scott Maynes
Herbert Mohring
Marcel K. Richter
Vernon W. Ruttan
John G. Turnbull

Associate Professor

Edward M. Foster, *director of graduate study*
Peter Gregory
John C. Hause
James P. Houck, Jr.
Thomas J. Muench
Thomas J. Sargent
T. Paul Schultz
Christopher A. Sims
Harlan M. Smith
Neil Wallace

Assistant Professor

Peter K. Clark
John Danforth
Charles Freedman
Jean-Claude Keoune
Craig E. Swan
Robert Shiller

Prerequisites—Courses in economics are open to all regularly enrolled graduate students who can meet course prerequisites as listed in the *Class Schedule* or who obtain permission of instructor. Students who desire to major or minor in economics shall satisfy the director of graduate study in economics that they are prepared to undertake graduate work in economics. Normally they shall have had work in economics and mathematics as an undergraduate. An undergraduate grade average of better than B and admission to the Ph.D. program is normally required for majors.

Master's and Doctor's Degrees—Interested students should obtain a statement of requirements from the director of graduate study in economics.

General

5-021. ECONOMICS, ETHICS, AND ECONOMIC PHILOSOPHY. (5 cr; prereq 1-002 or equiv; offered when feasible) Smith
The 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.

5-031, 5-032, 5-033. CURRENT ECONOMIC ISSUES. (3-5 cr per qtr [may be repeated with ‡]; prereq 3-101, 3-102 or equiv or ‡; offered when feasible) Smith
Current controversies over economic policy and problems that underlie controversies. Selected topics.

5-041. DECISION MAKING FOR CONSUMERS. (4 cr, §1-041)
Application of economic principles to major decisions of consumers. Payoff to improved decisions versus cost of search. Sources of consumer information. Decision making under uncertainty. Expenditure control. Saving; optimal distribution of assets; insurance principles. Consumer protection. Economics of health care.

5-051. ECONOMIC BEHAVIOR OF THE HOUSEHOLD. (4 cr; prereq 3-101, 3-102) Maynes, Bryant
Sample survey techniques. Concept of saving. Models of household behavior. Review of regression analysis. Traditional demand analysis; consumer anticipations approach to forecasting demand. Consumption-saving hypotheses. Consumption and capital. Value of time.

5-053. ECONOMIC ORGANIZATION OF THE HOUSEHOLD. (4 cr undergrad, 3 cr grad, §AgEc 5-580; prereq 3-101) Maynes, Bryant
Household as a multiproduct firm producing monetary and in-kind income, human capital, and satisfaction. The household and its relationships with the labor market, consumer-good market, housing market, and public-good market. The household, information, and uncertainty.

5-055. GOVERNMENT AND THE CONSUMER. (4 cr undergrad, 3 cr grad, §AgEc 5-590; prereq 3-101) Maynes, Bryant
Consumer sovereignty. Measures of consumer well-being. Publicly supplied goods and services. Effects of government policies on the consumer in private and public markets. Informational imperfections. Consumer protection and redress.

5-970. READINGS IN ECONOMICS. (Cr ar; prereq consent of adviser, ‡) Staff
Areas useful to individual programs and objectives not available in regular course offerings.

8-010. ADVANCED TOPICS IN GENERAL ECONOMICS. (Cr ar [may be repeated for cr]; prereq ‡; offered when feasible)
Topics to be announced. Course may be offered in several sections at the same time and with different topics.

8-041, 8-042. ADVANCED TOPICS IN CONSUMER BEHAVIOR. (3 cr per qtr; prereq ‡; offered when feasible)

8-051. ADVANCED ECONOMIC BEHAVIOR OF THE HOUSEHOLD. (3 cr; prereq 5-161, 5-164, regression analysis)

8-052. ADVANCED ECONOMIC BEHAVIOR OF THE HOUSEHOLD. (3 cr; prereq 8-051)

8-990. INDIVIDUAL GRADUATE RESEARCH. (Cr ar)

Theory

5-111. FOUNDATIONS OF MATHEMATICS FOR SOCIAL SCIENTISTS. (4 cr; prereq Math 1-111 or equiv or ‡)
Sets. Relations. Partially ordered systems. Functional relations. Elements of logical calculus. Groups. Matrices. Applications mostly in economics, decision and game theory, some in statistics.

5-141. BUSINESS CYCLES. (4 cr; prereq 3-102, 3-151 or equiv; offered when feasible) Smith
Ups and downs of business: explanations of causes, statistical data on such fluctuations. Relationship of cycles to economic growth. Methods of forecasting. Examination of proposals for economic stabilization.

5-151. ELEMENTS OF ECONOMIC ANALYSIS: FIRM AND HOUSEHOLD. (3 cr, §3-101; prereq 1-002 or equiv, 1 qtr calculus, or ‡)
Individual decision making by households and by firms under conditions of monopoly, competition, and monopolistic competition.

5-152. ELEMENTS OF ECONOMIC ANALYSIS: INCOME AND EMPLOYMENT. (3 cr, §3-102; prereq 1-002 or equiv, 1 qtr calculus, or ‡)
Determinants of national income, employment, and price level; aggregate consumption, investment, and asset holding.

5-161/5-162/5-163. MICROECONOMIC THEORY. (5 cr per qtr for undergrads...3 cr per qtr for grads; prereq 3-101 or 5-151, 2 qtrs calculus, 1 qtr linear algebra, ‡ for undergrads)
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.

5-164/5-165/5-166. MACROECONOMIC THEORY. (3 cr per qtr for grads; prereq 3-102, 1 qtr calculus, 1 qtr linear algebra) Kareken, Krueger, Sargent, Sims, Swan, Wallace
Basic macroeconomics course for grad majors, but honors undergrads are encouraged to enroll. 5-164/5-165: Primarily statics; general equilibrium models for determining real output, employment, price level, and rate of interest; components of demand for goods (especially consumption and investment demand) and financial assets. 5-166: Problems of dynamics: models of economic fluctuations and growth together with mathematical techniques required for their analysis.

5-171/5-172. HISTORY OF ECONOMIC THOUGHT. (3 cr per qtr; prereq 5-162, 5-164; offered when feasible) Buttrick, Krueger
5-171: Classical economists, Marx, and beginnings of neoclassical economics. 5-172: Development of neoclassical economics through the 1930's. Origins of macrotheory.

5-181/5-182/5-183. DECISION MAKING AND OPERATIONS ANALYSIS. (3 cr per qtr; prereq 3-101 or 5-151, 2 qtrs calculus, 1 qtr linear algebra) Henderson, Muench
Applications of various mathematical techniques of maximization and minimization to business problems. Calculus, linear programming, nonlinear programming, and dynamic programming methods applied to production, inventory, transportation, selling, and financial problems. Electronic computer programs used where feasible.

8-104. INCOME DISTRIBUTION. (3 cr; prereq 5-151, 5-152 or equiv; offered when feasible) Hause
Statistics of personal and functional income distribution. Wages, rent, interest, and profit under pure and imperfect competition. Aggregative theories of distribution as a whole. "Exploitation" and "maldistribution" problems.

8-111/8-112/8-113. INTRODUCTION TO MATHEMATICAL ECONOMICS. (3 cr per qtr; prereq Math 3-211 or equiv, 3-142...5-243 recommended...coreq Math 5-612 or equiv, 5-161) Muench, Richter
Use of mathematical models in economic theory; the more standard techniques developed in 8-111 and 8-112; 8-113 may include special topics.

8-121. APPLIED WELFARE ECONOMICS. (3 cr; prereq 5-163 or ‡; offered when feasible) Hurwicz, Richter
Applications of welfare concepts for analysis of typical policy issues with emphasis on development of student's skills.

8-161/8-162/8-163. MATHEMATICAL ECONOMICS. (3 cr per qtr; prereq Math 3-211 or equiv, 3-142 [5-243 recommended], 5-163 or 8-113...coreq Math 5-612) Chipman, Hurwicz, Richter
Mathematical models underlying contemporary economic theory.

8-181, 8-182. ADVANCED TOPICS IN MICROECONOMICS. (3 cr per qtr; prereq ‡; offered when feasible)

8-184, 8-185. ADVANCED TOPICS IN MACROECONOMICS. (3 cr per qtr; prereq ‡; offered when feasible)

Econometrics

5-261/5-262/5-263. APPLIED ECONOMETRICS. (3 cr per qtr; prereq 3-101, 3-102, Stat 5-122, 1 qtr linear algebra) Freedman, Sims, Swan
Conceptual basis of econometric theory (omitting many proofs of theorems) with application to economic models. Lab section required.

8-211/8-212/8-213. ECONOMETRICS. (3 cr per qtr; prereq 5-151, 5-152, Stat 5-133 or Stat 5-122 and ‡, Math 5-243 or equiv) Chipman, Hildreth, Muench, Sims
8-211: Multivariate normal distribution. Normal linear regression. General linear hypotheses. Maximum likelihood estimation for various single equation models. Autoregressive disturbances. 8-212: Linear regression model and least squares: Gauss-Markov theorem specification error, aggregation, multicolinearity, estimation subject to and testing of linear restrictions, minimum-mean-square-error estimation and production. Simultaneous equations model: identification, limited and full information maximum likelihood procedures, two- and three-stage least squares, recursive models, asymptotic properties of simultaneous equations estimators. 8-213: Distributed lag models. Introduction to frequency domain statistics.

8-281, 8-282. ADVANCED TOPICS IN ECONOMETRICS. (3 cr per qtr; prereq ‡; offered when feasible)

Development

5-301. ECONOMIC DEVELOPMENT. (4 cr, §5-331; not open to economics majors; prereq 1-001, 1-002 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.

5-307. COMPARATIVE ECONOMIC SYSTEMS. (4 cr, §5-337; not open to economics majors; prereq 1-001, 1-002 or equiv) Maynes
Functions of all economic systems—the market economy, liberal socialism, the centrally planned economy. Analysis of American and Soviet economies.

5-311. ECONOMY OF LATIN AMERICA. (4 cr, §5-341; not open to economics majors; prereq 1-001, 1-002 or equiv) Gregory and staff
Current economic problems: exchange controls, land reform, inflation, and fluctuation in prices of basic commodities. Evaluation of foreign aid proposals.

5-313. ECONOMY OF THE U.S.S.R. (4 cr; prereq 1-001, 1-002 or equiv) Boddy
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.

5-315. ECONOMICS OF ASIA. (4 cr; prereq 1-001, 1-002 or equiv)
Economic development of Asia following contact with Western civilization. Some present problems: population growth, capital formation, international economic relations, choice between types of economic organization.

5-331. ECONOMIC DEVELOPMENT. (4 cr, §5-301; prereq 3-101, 3-102 or equiv or ‡)
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.

5-337. COMPARATIVE ECONOMIC SYSTEMS. (4 cr, §5-307; prereq 3-102 or equiv or ‡) Maynes
Functions of all economic systems—the market economy, liberal socialism, the centrally planned economy. Analysis of American and Soviet economies.

5-341. ECONOMY OF LATIN AMERICA. (4 cr, §5-311; prereq 3-102 or equiv or ‡) Gregory and staff
Analysis of current economic problems: exchange controls, land reform, inflation, and fluctuation in prices of basic commodities. Evaluation of foreign aid proposals.

5-347, 5-348. DEVELOPMENT OF THE AMERICAN ECONOMY. (4 cr per qtr; prereq 3-101, 3-102 or ‡) Green
Application of economic theory and empirical methods to topics in American economic development, particularly during the 19th-century period of accelerated growth and industrialization.

8-311/8-312. ECONOMIC GROWTH AND NATIONAL PLANNING. (3 cr per qtr; prereq 5-163, 5-166, plus a course in this section)
Models of process of economic growth; exogenous factors to which growth is attributed. Techniques useful in planning, e.g., input-output, national income accounting programming. Questions of policy.

8-321. ADVANCED COMPARATIVE ECONOMIC SYSTEMS. (3 cr, §5-307, §5-337; prereq 5-151, 5-152 or equiv or ‡) Maynes
Functions of all economic systems: market economy, liberal socialism, centrally planned economy. Analysis of American and Soviet economies.

8-381, 8-382. ADVANCED TOPICS IN ECONOMIC DEVELOPMENT. (3 cr per qtr; prereq ‡; offered when feasible)

International Economics

5-401. INTERNATIONAL ECONOMICS. (4 cr, §5-431; not open to economics majors; prereq 1-001 or equiv)
Significance of foreign trade and investment. International payments and foreign exchange. Gold standard. International Monetary Fund and Bank. Arguments over tariffs and foreign aid policies.

5-411. U.S. FOREIGN ECONOMIC POLICY. (4 cr; prereq 5-401 or equiv; offered 1972-73 and alt yrs)
Development of U.S. foreign economic policy in the 20th century and current issues of U.S. foreign economic policy.

5-431. INTERNATIONAL ECONOMICS. (4 cr, §5-401; prereq 3-101, 3-102 or equiv or ‡)
Case for free trade. Effects of tariffs; protection of infant industries; common markets. Balancing international receipts and payments, role of exchange rate changes, international monetary reform.

5-461/5-462/5-463. INTERNATIONAL TRADE AND PAYMENTS THEORY. (3 cr per qtr for grads; prereq 5-164, 5-162) Chipman, Krueger
5-461: Gains from trade, tariffs, customs, unions, impact of trade on wages. 5-462: Relation of trade theory to growth and development, general equilibrium analysis. 5-463: Balance of payments disequilibrium, exchange rates, capital movements, international liquidity.

8-481, 8-482. ADVANCED TOPICS IN INTERNATIONAL TRADE THEORY. (3 cr per qtr; prereq 5-161, 5-164, 5-463 or equiv or ‡; offered when feasible) Chipman

Labor

5-531. ECONOMIC HISTORY OF LABOR. (4 cr; prereq 3-501 or 3-551 or ‡; offered when feasible) Gregory
Historical analysis of labor in American economic development; labor force characteristics, wage level and structure, migration. Origins and growth of labor organizations and other labor market institutions. Economic and social consequences of these developments.

5-534. ECONOMIC SECURITY. (4 cr; prereq 3-501 or 3-551 or ‡) Turnbull
Public and private approaches to problems of economic insecurity. Nature and causes of economic insecurity. Details of and economic and social implications of private and public programs. Emphasis on economics of income and employment maintenance and stabilization rather than upon legal or administrative aspects of policy.

5-537. LABOR MARKET BEHAVIOR AND REGULATION. (4 cr; prereq 3-501 or 3-551 or ‡; offered when feasible) Simler
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.

5-541. CONTEMPORARY LABOR ISSUES. (4 cr; prereq 3-501 or 3-551 or ‡) Gregory
Analysis of important labor problem areas. Current issues examined in light of their broader economic, legal, political, and social implications.

5-561/5-562. WAGES AND EMPLOYMENT. (3 cr per qtr for grads; prereq 5-161, 5-164) Simler
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 the union.

8-581, 8-582. ADVANCED TOPICS IN LABOR ECONOMICS. (3 cr; prereq ‡; offered when feasible)

Industrial Organization

5-611. ECONOMICS OF ENVIRONMENTAL CONTROL. (4 cr; prereq 1-001, 1-002 or equiv)
General model of the problem. Partial models appropriate to specific cases. Prediction of rate of environmental deterioration and evaluation of its cost. Ranking of alternative superior technologies. Policies to promote discovery of superior technologies and to encourage their adoption.

5-621. ECONOMICS OF URBAN PROBLEMS. (4 cr; prereq 1-001, 1-002 or equiv)
Private versus social costs. Housing: space, quality, integration; rehabilitation, renewal. Security: economics of crime and crime prevention. Education: causes and effects of educational deprivation; quality, equality, integration. Transportation: auto, bus, rapid transit; selecting optimal mix. City size: economies and diseconomies of size.

5-661. ECONOMICS OF LOCATION. (3 cr for grads; prereq 5-161 for grads)
Analysis of location of economic activity in relation to resources and markets. Effects of changes in transport costs. Problems associated with urban growth.

5-671/5-672/5-673. INDUSTRIAL ORGANIZATION AND GOVERNMENT REGULATION. (3 cr per qtr for grads; prereq 5-161 for grad) Hause, Mohring
Profit maximization and other theories of business behavior; profits, assets, and barrier 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.

8-681, 8-682. ADVANCED TOPICS IN INDUSTRIAL ORGANIZATION. (3 cr per qtr; prereq ‡; offered when feasible) Staff

Money

5-701. MONEY, BANKING, AND MONETARY POLICY. (4 cr, §3-701, §3-751; not open to economics majors; prereq 1-001, 1-002 or equiv or ‡)
Economic role of financial institutions with special emphasis on commercial banks, money supply, and monetary policy.

5-761/5-762. MONETARY ECONOMICS. (3 cr per qtr for grads; prereq 5-164, 5-162) Kareken, Sargent, Wallace
Economic role of principal financial institutions. Determinants of value of money. Principal problems of monetary policy.

8-711/8-712. DEVELOPMENT OF MONETARY THEORY AND POLICY. (3 cr per qtr; prereq 5-761, 5-164 or equiv or ‡; offered when feasible)
Principal issues in monetary theory. Contributions to the literature of importance in development of monetary theory.

8-781, 8-782. ADVANCED TOPICS IN MONETARY ECONOMICS. (3 cr per qtr; prereq ‡; offered when feasible)

Public Finance

5-811. STATE AND LOCAL FINANCE. (4 cr; prereq 3-851 or equiv) Boddy
Main problems of state and local finance and proposed solutions; interstate comparisons and coordination of practices and policies.

5-831. COST-BENEFIT ANALYSIS. (4 cr; prereq 3-101 or equiv) Coen
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. Treatment of market imperfections, risk, and uncertainty.

5-861/5-862/5-863. PUBLIC FINANCE. (3 cr per qtr for grads; prereq 5-165, 5-162 for economics grad, or 3-102, 3-731, 1 qtr calculus or ‡ for others) Brownlee, Foster, Heller

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.

8-881, 8-882. ADVANCED TOPICS IN PUBLIC FINANCE. (3 cr per qtr; prereq ‡; offered when feasible)

EDUCATION**

Professor

John F. Alexander
Ayers L. Bagley
Bruce E. Balow
W. Forrest Bear
Robert H. Beck
Emma M. Birkmaier
David C. Bjorkquist
Donald H. Blocher
Clarence H. Boeck
Henry Borow
Marjorie M. Brown
Arnold F. Caswell
Frederick M. Chapman
Naomi C. Chase
Raymond O. Collier
Mary E. Corcoran
Evelyn N. Deno
Robert Dykstra
Ruth E. Eckert
William H. Edson
John H. Flavell
Dewey G. Force, Jr.
Roxana R. Ford
William E. Gardner
Norman Garmezy
Charles J. Glotzbach
Carl V. Goossen
Theda Hagenah
Willard W. Hartup
W. Reid Hastie
Vernon L. Hendrix
Wells Hively, Jr.
Clifford P. Hooker
Cyril J. Hoyt
Robert L. Jackson
Eloise M. Jaeger
Donovan A. Johnson
William A. Kavanaugh
Stanley B. Kegler
Robert J. Keller
G. Gordon Kingsley
Ronald T. Lambert
Dale L. Lange
Darrell R. Lewis
John C. Manning
R. Paul Marvin
Keith N. McFarland
Jack C. Merwin
Warren G. Meyer
Norman W. Moen
Shirley G. Moore
Gordon M. A. Mork
Jerome Moss, Jr.
Van D. Mueller
Howard F. Nelson
Gerhard Neubeck
R. Norine Odland
Clyde A. Parker
Neville P. Pearson
Milo J. Peterson
Gene L. Piché
Herbert L. Pick
Samuel H. Popper
Alton L. Raygor
Maynard C. Reynolds
Merrill F. Roff
Helen M. Slocum
Martin B. Snoke
John D. Stecklein
Louise A. Stedman
James E. Stochl
Gordon I. Swanson
Mildred C. Templin
W. Wesley Tennyson
Edgar M. Turrentine
Edith West
Emma B. Whiteford
Frank B. Wilderson, Jr.
Roger E. Wilk
Howard Y. Williams
Marjorie U. Wilson
Robert D. Wirt
Frank H. Wood

Associate Professor

Gary F. Alkire
William M. Ammentorp
Alan R. Anderson
Bruce D. Anderson
Douglas H. Anderson
Eugene M. Anderson
Richard D. Ashmun
William M. Bart
Donald A. Biggs
Robert L. Borg

** Advanced work leading to the professional degree of master of education (M.Ed.) is offered by the College of Education in agricultural education, art education, earth science (geology), home economics education, mathematics education, music education, physical education, recreation, and school health education. Interested persons should consult the *College of Education Bulletin.*

Robert H. Bruininks
Charles R. Bruning
Russell W. Burris.
William R. Charlesworth
Shirley M. Clark
John J. Cogan
W. Ray Cross
Stanley L. Deno
Arthur K. Ellis
Eugene D. Gennaro
David L. Giese
H. Robert Giles
A. Jack Hafner
Marian D. Hall
Harlan S. Hansen
Lorraine S. Hansen
Richard N. Hey
Charles R. Hopkins
Kenneth R. Howey
Thomas J. Hummel
Alan H. Humphreys
David C. Johnson
David W. Johnson
Paul E. Johnson
Roger T. Johnson, Jr.
Richard D. Kimpston
Mary K. Klaurens
Donald G. MacEachern
Carl Malmquist
John C. Masters
Donald F. Moores
Don A. Morgan
Clarence E. Mueller
Neal C. Nickerson
Maurice E. Ostrander
Edgar A. Persons
Roland L. Peterson
W. Desmond Phillips
Anne D. Pick
Thomas R. Post
David J. Pucel
Robert R. Randleman
Frank L. Ryan
John E. Rynders
Philip H. Salapatek
S. Jay Samuels
Sandra W. Scarr-Salapatek
Robert L. Schreiner
Charles H. Sederberg
Warren F. Shaffer
Bruce D. Sillers
Thomas C. Slettehaugh
Brandon B. Smith
Norman Sprinthall
Thomas F. Stark
James S. Terwilliger
James E. Turnure
Richard F. Weatherman
Richard A. Weinberg
Wayne W. Welch
W. Keith Wharton
Arnold S. Woestehoff
Donald R. Zander

Assistant Professor

Mark W. Aulls
Ronald E. Bole
Glenn H. Bracht
Alan S. Briskin
W. Andrew Collins
James D. Condie
George H. Copa
Gerald M. Erickson
Lois J. Fiedler
Elizabeth R. Gallistel
Arthur M. Harkins
Thomas L. Jackson
E. Gary Joselyn
James Kent
Dorothy R. Loeffler
Tim L. Mazzoni
Robert W. McCauley
Gary McLean
Jon R. Morris
Curtis D. Norenberg
George K. Olson
P. David Pearson
James R. Rest
John E. Rhetts
G. James Rockwell
Stephen W. Schultz
Robert C. Serfass
Morris I. Shrago
Jacqueline Shick
Thomas Shroyer
L. Alan Sroufe
Lela J. Stoner
Allen R. Sullivan
Cynthia Turnure
Wilbur L. Wakefield
Carolyn Weiss
Reynold Willie
Robert Wozniak
Albert Yonas
Mary L. Young

Instructor

Robert Crumpton
Rita M. Grismer
Jay D. Kain

Research Associate

Rosalyn A. Rubin

Prerequisites—For major or minor work in most of the fields of education at least 6 quarter credits of psychology and also a total of not less than 18 quarter credits of undergraduate work in education. Ordinarily, applicants should already hold a teaching certificate, and for some fields, such as school administration or counseling, teaching experience is strongly advised.

For programs in higher education and some areas of educational psychology, other appropriate preparation is required in place of, or in addition to the undergraduate credits in education. Consult appropriate departments for specific requirements.

For major work in recreation and park administration, a Bachelor's degree in recreation or in a related field such as art, landscape architecture, music, physical education, psychology, sociology, or speech is required. Applicants with a degree in a field other than recreation will be required to make up certain undergraduate deficiencies as determined by individual needs and/or to present successful professional experience(s) in the field of recreation and park administration.

Language Requirement—No language is required for the M.A. and Ed.D. degrees. For the Ph.D. degree, language competency may be required by individual departments. Ph.D. students should consult their advisers to determine whether they must fulfill a language requirement.

Master's Degree—Plan A majors may be chosen as follows: Students, with the approval of their adviser, may select a group of courses in one of the following fields, excluding the field of their minor, centering about their special interest in education.

Agricultural Education
Art Education
Business Education
Child Psychology
Distributive Education
Education**
Educational Administration**
Educational Psychology**
Elementary Education**
History and Philosophy of Education
Home Economics Education
Industrial Education
Mathematics Education
Music Education
Physical Education**
Recreation and Park Administration
Secondary Education**

Minors may be chosen as follows:

1. From any of the foregoing groups of courses when such grouping is not included in the major.
2. From any other field of study offered at the University of Minnesota in which satisfactory courses of graduate character are available and which is obviously related to the major field.
3. Students majoring in fields other than education may choose education or any of its subdivisions enumerated above as a minor when it appears that such a minor is appropriately related to the major field.

Under Plan B students will select a field of concentration in which they will attain from 21 to 27 credit hours. The field of concentration differs from a major in that it encourages the choice of a somewhat wider range of courses related to the students' interest. As in the case of the major, however, students will indicate their field of concentration according to the general arrangement of courses required for a major, as follows:

Agricultural Education
Art Education
Business Education
Child Psychology
Distributive Education
Education (in special cases)**
Educational Administration**
Educational Psychology**
Elementary Education**
History and Philosophy of Education
Home Economics Education
Industrial Education
Mathematics Education
Music Education
Physical Education**
Recreation and Park Administration
Secondary Education**

Additional Courses—The student may elect the additional courses required to complete the total of 45 credits from areas of education not included in the field of concentration and from any other fields of study offered at the University of Minnesota in which satisfactory courses of graduate character are avail-

** See Notes to Applicants for Admission to Graduate School on page 158.

able and which are obviously related to the student's interest. Teachers should include advanced study in their teaching fields.

Notes to Applicants for Admission to Graduate School—Students must indicate the exact major field in which they are interested. Where necessary, they should also state the main emphasis within the major field, as in the following examples:

Educational Administration (specify whether elementary school principal, secondary school principal, or school superintendent)

Educational Psychology (specify whether psychological foundations, counseling and student personnel psychology, school psychology, or special education)

Elementary Education (specify area of interest, such as children's literature, reading, science education, or other area of elementary instruction)

Physical Education (specify if emphasis is school health education)

Secondary Education (specify whether interest is in a teaching field, such as science education, English education, or in audio-visual education, general curriculum, or other secondary area)

Education (at M.A. level this major is planned for students in higher education whose area of concentration combines courses from several education departments; for secondary school teachers who desire a combination of education fields for the area of concentration, with related work in teaching subjects; and programs which emphasize special education involving courses from an unusually broad combination of departments; specify main field of interest)

For detailed information on current course offerings and on M.A., Ph.D., Ed. D., and Specialist Certificate programs, write to the department concerned.

Doctor's Degrees

Ph.D. Degree—A major may be chosen, with the adviser's approval, from the following:

Education—Under the Ph.D. major in education, students' programs may emphasize any one of the several areas listed above under majors for M.A. programs. Under this general major, students work with a doctoral adviser from the area of their own particular interest, include in their major program a core of courses from that area, and plan their research in relation to that special interest. Applicants for admission should specify the area of their main concern.

Educational Administration—The major emphasizes intensive study in a particular area of educational administration. While it is available to persons who may follow administrative careers, it is especially appropriate for students who plan to accept research and teaching positions in college and university departments of educational administration.

Educational Psychology—With an educational psychology major, doctoral programs may be designed to provide professional preparation in one of four specialized areas: psychological foundations (evaluation, learning, cognition, personality, social psychology, measurement, statistics, research design, instructional systems, and computer applications); counseling and student personnel psychology (school counseling, counseling psychology, college personnel work); school psychology; and special education.

For information about admission to graduate work and financial aid in the Department of Counseling and Student Personnel Psychology, applicants should write to the chairman of the department. Students are admitted to the program in the fall quarter only, except in unusual circumstances. Applicants must submit departmental application forms in addition to Graduate School admission forms by February 1 for fall quarter admission.

Physical Education—For the Ph.D. program in physical education, applicants indicate their interest in one of three areas: physical education, recreation and park administration, or school health education. The program requires a primary concentration and a minor or supporting field which has logical relationship to the concentration. Also required is a special research technique, a collateral field, or foreign language competency.

Vocational-Technical Education—Two options are available to students under the Ph.D. with a major in vocational education. The first requires intensive preparation as a curriculum specialist; the second leads to competence as a research-evaluation specialist.

A minor may be selected from any field of graduate study related to the field of major interest, including any one of the following areas of education not represented in the major:

Agricultural Education
Child Psychology
Education
Educational Administration
Educational Psychology
Elementary Education
History and Philosophy of Education
Home Economics Education
Industrial Education
Mathematics Education
Music Education
Physical Education
Recreation and Park Administration
Secondary Education

If a student's major is education and the minor is one of the above areas not represented in the major, the minor field is ancillary to the student's principal emphasis in graduate study, the latter always being included under the major.

Ed.D. Degree—A student for the doctor of education degree may major in one of the following areas:

Educational Administration—The Ed.D. program in educational administration is particularly suitable for individuals who will provide leadership in the operation of educational institutions and who are capable of applying the products of scholarly research within the school setting. It emphasizes breadth of preparation in education and in substantively related fields. Through independent study, internships, and clinical experience, students are encouraged to translate theoretical knowledge into practice in a school environment. The flexibility of this program makes it uniquely suited for students with diverse educational and experience backgrounds. For information, consult the Division of Educational Administration, College of Education.

Industrial Education—This Ed.D. program has been planned for instructional personnel in industrial education. It includes a minimum of 108 credits, an internship or clinical experience equivalent to 2 quarters of full-time study, and a field study project. One-half of the industrial education major and one-half of the work in related areas must be completed at the University of Minnesota, regardless of the number of credits transferred from other institutions.

Physical Education—Under the major in physical education (Ed.D.) students will declare their field of concentration in (a) physical education, (b) recreation and park administration, or (c) school health education.

Further, they will choose an area of emphasis from the following: (a) administration, or (b) curriculum, methods, and supervision. A supporting program, rather than a minor, is required. Three consecutive quarters during an academic year are included. Thus the Ed.D. becomes a 2-year program beyond the Master's degree. For information write to the department offering the field of concentration.

Vocational and Technical Education—Two options are available to students taking the Ed.D. with a major in vocational education. The first option leads to administrative competence in vocational education; the second involves preparation for an instructional specialist.

Specialist Certificate Programs

The Graduate School offers 2-year programs in the fields of general educational administration, special education, counseling, business education, mathematics education, general curriculum supervision, school psychological services, and distributive education, which lead to the certificate Specialist in Education. These program require the completion of a minimum of 90 credits. Students will 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. Any decision regarding continuation beyond the Master's degree in a specialist program will be dependent on an evaluation of performance in meeting the master of arts degree requirements. The specialist certificate programs now available are the following:

General Educational Administration (for superintendents and central office personnel)—In the first year, the student completes the requirements for the M.A., majoring in educational administration. The second year's program 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 includes many of the elements of the general educational administration program. Special emphasis is given to those aspects of administration which relate to the business operation of the school. The program is designed for the school business manager, the assistant superintendent in charge of business affairs, and persons in similar positions.

Intermediate Unit in Educational Administration—This administrative unit provides a supervisory, administrative, or coordinating function for local school districts within a geographic area larger than a school district and smaller than a state. Students in this program will follow the same common program as for other areas of school administration with the addition of a differentiated group of courses designed to prepare them for service in the intermediate unit in educational administration. Persons who have taken Master's level work in other areas of school administration can move to this program.

Secondary School Administration—This program is planned to prepare students to serve as high school principals, assistant principals, directors, or supervisors of secondary education and related positions. Students are admitted to the second year of the program after completion of a related program for the Master's degree in secondary school administration and supervision. The program emphasizes secondary school curriculum and instruction with support in educational psychology and child psychology as well as educational administration. Students who wish to work on this program are urged to plan early on an individual basis with graduate advisers. It is possible to emphasize the junior high school level or curriculum development.

Elementary School Administration—Requirements are arranged by areas of study, including emphasis on curriculum and instruction, as well as on administration in the elementary school. Students admitted to the second year of the program will plan individually with advisers for meeting the 2-year area requirements through supplementation of work presented for the Master's degree.

Counseling—This program is designed basically for the preparation of supervisors and directors or coordinators of guidance and counseling programs in school systems as well as providing advanced training for counselors. Students must satisfy all requirements for the Master's degree either at the University of Minnesota or elsewhere before being admitted to the program. Breadth of liberal studies is expected in the undergraduate background of candidates for this certificate. Persons who lack such foundation courses will be expected to add to their program work in the social, behavioral, and biological sciences. The program emphasizes competency in the following nine areas: counseling theory and practice; group counseling and group process; organizational intervention and consultation; career development; inner city, alienated, and minority youth; appraisal tools and techniques; the family; applied staff development and/or internship; and applied research problems and design.

School Psychological Services—In the first year, the student completes requirements for the M.A. 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—The program is designed for students preparing for administrative, supervisory, and consultant positions in special education. Flexibility allows concentration in a particular field (such as education of the gifted, the mentally retarded, or the blind), but generally students will be expected to develop competencies in several special education areas. Applicants should have had basic preparation and experience in at least one special education area, with certification for public school work.

Business Education—Concerned with both depth and breadth in professional training, the program prepares for specialist positions in business education, such as supervisors, coordinators, research directors, curriculum consultants, department chairmen, and teachers. Such specialists are needed in secondary schools, state departments of education, business and economic education centers, area vocational-technical schools, and junior colleges.

Distributive Education—The purposes of the program are to prepare persons for leadership positions and to help meet the manpower demands for trained practitioners above the teacher-coordinator level. The program is flexible to allow for breadth across several curriculum levels, as well as depth in a particular area of concentration. Applicants should have a Master's degree with emphasis in distributive education, at least 1 year of teaching experience, a career goal of specialization in distributive education, and meet the occupational experience requirements for teaching distributive education subjects.

Mathematics Education—Designed to prepare master teachers, state and local supervisors or consultants, specialists in mathematics curriculum development, or department chairmen, the program broadens and deepens background in mathematics, pedagogy, psychology, philosophy, and educational research. A 10-week internship provides supervised experience in professional activities germane to mathematics education. Two years of successful experience as a classroom teacher, a reasonably strong background in mathematics, and a Master's degree are prerequisites for admission.

General Curriculum Supervision (grades 7-12)—The program is planned for prospective secondary curriculum supervisors who will be concerned with resources and processes and can become agents of change. It emphasizes selection of content, use of media, production of resource materials, supervision of instruction, and organization for learning, research, and evaluation.

Admission to the Specialist in Education Program—Approval of the Graduate School upon recommendation of the graduate faculty in the field of specialty is required. Prospective students must complete an application form for admission to the Graduate School to be submitted with official transcripts of all college work completed to date. As an attachment to the application form the prospective students should indicate the names and addresses of three persons who are able to comment in detail on their qualifications for undertaking this sixth-year program. They will also be asked to take a graduate form of the Miller Analogies Test before the admission request will be reviewed. Students who have taken or contemplate the completion of the M.A. degree at Minnesota will request consideration for admission to the specialist program by filing a Graduate School Change of Status Form available in the Graduate School office.

After admission to the Graduate School for the specialist program and satisfactory completion of at least 9 credits beyond the Master's degree, students must file a program for the certificate on the appropriate form available in the Graduate School Office. This program form will list all courses completed beyond the Bachelor's degree which will be presented for the Specialist Certificate, as well as those courses which they propose to complete in fulfillment of the requirements for the award of the certificate.

Qualifying examinations in specific areas may be required by the major adviser and the departmental faculty of students who bring credits from other institutions. Such examinations are designed to aid students and their advisers in planning the program for the Specialist in Education Certificate, and will be taken preceding the date that the students apply for candidacy and file their approved programs.

All students in the specialist program must earn in residence at the University of Minnesota a minimum of 45 credits distributed as approved by the adviser and the graduate faculty in the area of specialization. At least 30 credits of the second year of the program must be earned at the University of Minnesota.

The 2-year program must be completed within a period of 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. Persons who have completed a Master's degree prior to September 1, 1956, are exempt from the 12-year completion time, but must complete requirements for the Specialist Certificate (beyond the Master's degree) within 7 years after being admitted to the program.

Art Education (ArEd)

5-001. ART MEDIA TECHNIQUES. (2 cr per qtr, max 12; prereq ‡)
Lectures, demonstrations, discussions, critique sessions exploring and learning various techniques and processes in creativity; handling specific media with each offering focusing on a single topic.

5-020. ADVANCED CONTEMPORARY CRAFTS. (4 cr; prereq 3-020)
In-depth experiences in techniques of metal jewelry with emphasis on design criteria, equipment, materials, and process.

5-302. CURRICULUM BUILDING IN ART EDUCATION: INNOVATIONS. (4 cr)
Selection, evaluation, and organization of material for teaching units and projects.

5-303. CURRICULUM BUILDING IN ART EDUCATION: PROGRAMS FOR EXCEPTIONAL CHILDREN. (3 cr) Olson, Slettehaugh
Selection, evaluation, and organization of material for teaching units and projects.

5-316. INTERCULTURAL EDUCATION THROUGH ART. (3 cr) Slettehaugh
Approaches to international understanding through recognition of aesthetic contributions of diverse peoples to American life.

5-318. ART EDUCATION IN EUROPE. (3 cr) Slettehaugh
Current practices, problems, and achievements in art education in western Europe compared with practices in American art education.

5-386. IMPROVING ART PROGRAMS IN THE SCHOOLS. (4 cr; prereq tchg exper or ‡)
For teachers of art: critical examination of present art programs in the schools.

5-389. APPLICATION OF AESTHETIC THEORY IN EDUCATION. (3 cr) Slettehaugh
Contemporary theories of art, their psychological and philosophical foundations. Open to teachers, supervisors, and administrators concerned with art in general education at all levels.

5-600. INTERNSHIP. (3-9 cr; prereq ‡)
Professional assignment for degree candidates under joint supervision of departments and cooperative agency.

5-605. PRACTICUM. (3-9 cr; prereq ‡)
Independent project under direction; will include gathering data, developing proposals, experimenting with evaluating innovative practices.

8-300. RESEARCH IN ART EDUCATION. (3 cr)
Research techniques.

8-306. SEMINAR: ART EDUCATION. (1 cr)
Reports, evaluation of problems, recent literature.

8-900.* PROBLEMS: ART EDUCATION. (Cr ar; prereq ‡)
Independent projects under staff guidance may include advanced studio practice or technical problems requiring experimental or library research.

Child Psychology (CPsy)

For course listings in this field, consult the main Child Psychology section of this bulletin.

Education (Educ)

5-104. ADULT EDUCATION. (3 cr)
Agencies, programs, philosophies, history, and trends. Each student will devote some time to a field of special interest.

5-105. ADULT BASIC EDUCATION: INTRODUCTION. (3 cr, §SpEd 5-182; prereq 12 cr in education or ‡)
Survey of student characteristics, methods, materials, research, and evaluation in adult basic education.

5-106. ADULT BASIC EDUCATION: CHARACTERISTICS OF ABE STUDENTS. (3 cr, §SpEd 5-183; prereq 12 cr in education or ‡)
Cultural, psychological, and social characteristics of the disadvantaged adult, general assessment, adult learning, and adult development.

5-107. ADULT BASIC EDUCATION: INSTRUCTIONAL METHODS AND MATERIALS. (3 cr, §SpEd 5-184; prereq 12 cr in education or ‡)
Specific educational assessment and research; methods and materials in reading, listening, arithmetic, and consumer mathematics; writing and speaking; evaluating outcomes of instruction.

5-108. ADULT BASIC EDUCATION: RESEARCH, EVALUATION, AND IMPLEMENTATION. (3 cr, §SpEd 5-185; prereq 12 cr in education or ‡)
Administration, funding, and evaluation of ABE programs; staffing patterns and research.

5-184. SUPERVISION OF STUDENT TEACHING. (3 cr; prereq 15 cr in education or ‡)
For persons planning to supervise or administer student teaching and other professional laboratory experiences in elementary and secondary education.

8-228.° PROBLEMS: HIGHER EDUCATION AND TEACHER EDUCATION. (Cr ar; prereq ‡)
Selected topics on college programs, instruction, organization, and administration.

8-229. SEMINAR: BASIC ISSUES IN HIGHER EDUCATION. (1-4 cr; prereq ‡)
For doctoral candidates; seminar will focus on major questions confronting American colleges and universities.

8-230. SEMINAR: DISSERTATION RESEARCH IN HIGHER EDUCATION. (1 cr per qtr; prereq ‡)
Three-quarter seminar for candidates designing or conducting studies; selecting a problem; designing an appropriate study; collecting, analyzing, and summarizing the data and preparing a written account; critical review of candidates' individual projects.

8-250. HIGHER EDUCATION IN THE UNITED STATES. (3 cr; prereq yr of grad study in any field or 18 cr in education)
Development, present status, and outlook for American colleges; purposes; current and projected programs; trends in curriculum, instruction, and administration; evaluation of outcomes.

8-251. CURRICULUM TRENDS IN AMERICAN COLLEGES. (3 cr; prereq 8-250, yr of grad study in any field or 18 cr in education)
Principles in development of college programs; current curricula in liberal arts and professional fields; general education courses and sequences.

8-252. EFFECTIVE COLLEGE TEACHING. (3 cr; prereq 8-250, yr of grad study in any field or 18 cr in education)
Teaching-learning relationship; study and appraisal of methods employed to encourage, guide, and appraise students' learning.

8-253. SEMINAR: IMPROVEMENT OF COLLEGE INSTRUCTION. (Cr ar; prereq ‡)
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.

8-254. DIRECTED EXPERIENCE IN COLLEGE INSTRUCTION. (Cr ar; prereq 8-252, △; may also count toward grad major in sociology)
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. A special section is offered each year in family life education.

8-260. SEMINAR: MATERIALS AND METHODS IN MARRIAGE EDUCATION. (4 cr; may also count toward grad major in sociology)
Content and methods employed in college marriage courses; supervised experience in selected teaching methods and in methods of evaluation.

8-284.° PROBLEMS: TEACHER EDUCATION. (3-9 cr; prereq ‡) Mork, Bruning
Research in supervision, organization, and administration and laboratory experiences on elementary and secondary levels.

8-285, 8-286. PROFESSIONAL EDUCATION OF TEACHERS. (3 cr per qtr; prereq 15 cr in education incl 5-184 and 8-250 or HEd 5-182 or CSPP 8-140 or ‡ for 8-285... 8-285 or ‡ for 8-286)
For present and prospective instructors, administrators, and personnel workers in teacher education institutions. Both quarters are recommended in sequence, but either may be taken without the other. Current issues and problems, selection and retention, curriculum, certification, experimental programs, and research.

Educational Administration (EdAd)

5-101. PUBLIC SCHOOL ADMINISTRATION. (3 cr; not open to majors in educational administration; prereq sr, 9 cr in education) Popper
Organization, administration, and general support of public schools in state and local school districts.

5-103. SUPERVISION AND ADMINISTRATION OF SPECIAL EDUCATION. (3 cr; prereq ‡) Weatherman
Procedures in establishing and improving educational programs for exceptional children.

5-120. PRACTICUM: POST-SECONDARY ADMINISTRATION. (3-6 cr, max 6)
Intensive group and individual examination of current and pertinent administrative problems in post-secondary but nonbaccalaureate institutions.

5-128. WORKSHOP: EDUCATIONAL ADMINISTRATION. (1-6 cr; prereq practicing educational administrator or ‡)
Laboratory approach provides opportunities for experienced administrators to concentrate study on common administrative and supervisory problems.

5-130. ADMINISTRATOR DEVELOPMENT SEMINAR. (3-9 cr [max 9 cr])
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 student pursuing professional certification programs.

5-139. LABORATORY IN DECISION MAKING. (1-4 cr per qtr) Alkire, Cross, Nickerson, Popper
Contribution of recent research and theory to effective administration; analysis of administrative behavior in realistic settings and relations of administration to human behavior.

5-167. JUNIOR HIGH SCHOOL. (3 cr; prereq 9 cr in education) Popper
Sources of the movement; purposes, functions, and limitations; fundamental problems, types, and curricular implications of reorganization.

5-180, 5-181. SEMINAR: ADMINISTRATION OF SPECIAL EDUCATION. (3 cr, §SpEd 8-560, §8-561) Weatherman
Problems of administration and organization of special education programs.

5-231. PRACTICUM IN SCHOOL-COMMUNITY RELATIONS. (1-4 cr) Popper
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.

5-233. PRACTICUM IN JUNIOR HIGH SCHOOL ADMINISTRATION. (1-4 cr) Popper
Projects such as articulation with elementary and senior high school; organizing to meet needs of the pre-adolescent; activity programs; guidance functions.

5-990. SEMINAR: ADMINISTRATION OF INDIAN PROGRAMS. (1-9 cr [max 9 cr], §AmIn 5-990)
Examination of various educational agencies dealing with Indian education and the development of research designs for the study and improvement of the administration of Indian educational programs.

8-201. FOUNDATIONS OF EDUCATIONAL ADMINISTRATION. (3 cr) Ammentorp
For all students preparing for administrative positions in schools. Sources, meaning, and application of administrative theory, organizational structure, human relations, and leadership roles as they relate to the conduct of school organizations.

8-202. FOUNDATIONS OF EDUCATIONAL ADMINISTRATION. (3 cr) Jackson, Mazzoni
For all students preparing for administrative positions in school organizations. Aspects of federal, state, and local relationships as they relate to the coordination and operation of public elementary and secondary schools.

8-203. THE COMMUNITY SCHOOL. (3 cr) Popper
Changing structure and process in school organization; evolving team model; multiple-skills process in socialization.

8-210. PUBLIC SCHOOL FINANCE. (3 cr) Mueller
Current practices; sources of revenue, types of taxes, theory of taxation, and formulas used for distribution of school aids; federal, state, and local support of education.

8-211. SCHOOL BUSINESS MANAGEMENT. (3 cr; prereq 8-210 or ‡) Mueller
Administration of school business affairs.

8-215. THE ELEMENTARY SCHOOL PRINCIPALSHIP. (3 cr; prereq 8-201, 8-202, or ‡) Alkire, Cross, Lambert
Problems in elementary school administration and the principal's role of leadership.

8-216. RECENT RESEARCH IN ELEMENTARY SCHOOL ADMINISTRATION. (3 cr; prereq 8-215) Alkire, Cross, Lambert
Examination of pertinent research literature.

8-217. SEMINAR: ELEMENTARY SCHOOL ADMINISTRATION. (3 cr; prereq 8-216 or ‡) Alkire, Cross, Lambert
Problems of administration and organization of instruction.

8-218. SEMINAR: THE SOCIAL ORGANIZATION OF SCHOOLS. (3 cr; prereq educational administration major or ‡)
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.

8-220/8-221†. ANALYSIS OF ADMINISTRATIVE PROBLEMS. (3 cr per qtr; prereq educational administration major or △) Hendrix, Morris
Quantitative techniques for analysis of problem and decision situations in administration of educational organizations.

8-222. ADMINISTRATIVE INFORMATION SYSTEMS. (3 cr; prereq 8-220, 8-221, educational administration major or ‡) Hendrix, Morris
Basic concepts and techniques for analysis and application of computer-based educational information systems in control and decision activities required for management of educational institutions and programs.

8-224. LEGAL ASPECTS OF PUBLIC SCHOOL ADMINISTRATION. (3 cr) Hooker
Constitutional, statutory, and common law bases of school administration; principles growing out of fundamental legal procedures.

8-226. EDUCATIONAL FACILITIES PLANNING. (3 cr) Alkire, Sederberg
Planning educational facilities for public and private school systems and institutions of higher education.

8-227. PUBLIC SCHOOL PERSONNEL PROGRAMS. (3 cr) Stark
Selection, assignment, evaluation, and development of school personnel; salary and conditions of service; policies of administrative, instructional, and noninstructional personnel.

8-230. SCHOOL-COMMUNITY RELATIONS. (3 cr) Popper
Theory and practice of educational interpretation; principles, techniques of working with groups; teacher's contact with the community; role of the pupil, professional, and lay organization.

8-234. SEMINAR: EDUCATIONAL FINANCE. (3 cr; prereq 8-210 or ‡) Mueller
Economic setting, sources and allocation of education finances; evaluation of local, state, and federal educational finance systems with reference to analysis of foundation aid formulas.

8-235. SEMINAR: HUMANISM IN SCHOOL ADMINISTRATION. (3 cr; prereq 8-218, educational administration major or ‡) Popper
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.

8-236. SEMINAR: EDUCATIONAL FACILITIES PLANNING. (3 cr; prereq 8-226 or ‡) Alkire, Sederberg
Application of principles of educational facility planning to development of education specifications.

8-237. SEMINAR: EDUCATIONAL LAW. (1-3 cr; prereq 8-224 or ‡) Hooker
Legal theory as it applies to education.

8-238. SEMINAR: THEORY AND RESEARCH. (3 cr; prereq 8-218, or 8-235, educational administration major or ‡) Hendrix, Morris
Research design involving thesis or field project; includes interrelatedness of formulation of conceptual framework and the analytical process; clinical and research problems.

8-240. SEMINAR: CLINICAL EXPERIENCES IN EDUCATIONAL ADMINISTRATION. (1-9 cr) Sederberg, Stark
For educational administration majors engaged in clinical experiences.

8-241. SEMINAR: INTERNSHIP IN EDUCATIONAL ADMINISTRATION. (1-9 cr) Ammentorp, Cross, Nickerson
For interns in elementary, secondary, and general school administration.

8-242. ADMINISTRATIVE ORGANIZATION AND STAFFING OF SCHOOL SYSTEMS. (3 cr; prereq ‡) Stark
Analysis of patterns and staff of public schools, emphasizing effective achievement of purpose in learning programs.

8-244/8-245/8-246†. SEMINAR: ADMINISTERING PUBLIC EDUCATION IN METROPOLITAN AREAS. (2 cr per qtr [max 6 cr]; prereq grad major in educational administration) Jackson, Mazzoni
Analysis of political, social, cultural, and fiscal developments.

8-253. ADMINISTRATION IN HIGHER EDUCATION. (3 cr; prereq Educ 8-250) Morgan, Wharton
Control, faculty and employee personnel administration, budget making and administration, financial accounting and reporting, protection of college funds, public relations.

8-264. THE SECONDARY SCHOOL PRINCIPALSHIP. (3 cr) Jackson, Nickerson
Role of the principal: qualifications, duties, and problems, including current issues and factors of staff and student relationships.

8-265. ADMINISTERING THE HIGH SCHOOL PROGRAM. (3 cr) Jackson, Nickerson
Practices and procedures in scheduling, improving curriculum, community relations, records and reports, school services, and program evaluation.

8-270.° PROBLEMS: ELEMENTARY SCHOOL ADMINISTRATION. (Cr ar; prereq ‡) Alkire, Cross, Lambert

8-271.° PROBLEMS: SECONDARY SCHOOL ADMINISTRATION. (Cr ar; prereq ‡) Ammentorp, Hendrix, Hooker, Jackson, Mazzoni, Morgan, Mueller, Nickerson, Popper, Sederberg, Stark

8-272.° PROBLEMS: EDUCATIONAL ADMINISTRATION. (1-3 cr per qtr) Alkire, Ammentorp, Cross, Hendrix, Hooker, Jackson, Lambert, Mazzoni, Morgan, Mueller, Nickerson, Popper, Sederberg, Stark
For superintendents and principals qualified to make intensive studies of a school system.

8-273. FIELD STUDY. (0-10 cr; prereq ‡) Alkire, Ammentorp, Cross, Hendrix, Hooker, Jackson, Lambert, Mazzoni, Morgan, Mueller, Nickerson, Popper, Sederberg, Stark
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 general planning and organization of their study without credit.

8-274. THE 2-YEAR COLLEGE. (3 cr) Morgan
Present status, development, functions, organization, curriculum, and trends in post-secondary but nonbaccalaureate institutions.

8-275. 2-YEAR COLLEGE ADMINISTRATION. (3 cr; prereq 8-274 or ‡) Morgan
Selected topics and problems associated with administration and administrative positions, and organization of post-secondary but nonbaccalaureate institutions.

8-276. SEMINAR: ADMINISTRATION OF CURRICULUM IN THE 2-YEAR COLLEGE. (3 cr; prereq 8-274)
Examination of principles of curriculum management within post-secondary but nonbaccalaureate institutions emphasizing methods of assessing faculty, courses offered, and administrative designs.

8-278. RECENT RESEARCH IN 2-YEAR COLLEGE ADMINISTRATION. (1-3 cr, max 3; prereq ‡)
Examination of pertinent research topics in 2-year college administration.

8-290. FINANCING HIGHER EDUCATION. (3 cr; prereq ‡) Ammentorp, Morgan, Wharton

8-291. PUBLIC RELATIONS FOR COLLEGES AND UNIVERSITIES. (3 cr; prereq ‡) Ammentorp, Morgan, Wharton

Educational Psychology (EPsy)

COUNSELING AND STUDENT PERSONNEL PSYCHOLOGY (CSPP)

5-101. FOUNDATIONS OF CAREER DEVELOPMENT. (3 cr) Borow, Tennyson
Vocational theory and career development research; occupational analysis and industrial structure; methods of classifying the world of work; analysis of labor force and employment trends; basic concepts and principles for effective work in educational and vocational planning and development.

5-110. COUNSELING PROCEDURES. (3 cr) Shaffer
For persons whose professional work includes counseling and interviewing; not for certification as school counselor. Emphasis on counseling relationship and principles of interviewing; utilizes case studies, role playing, and demonstration.

5-130. INTRODUCTION TO GUIDANCE. (3 cr; prereq 9 cr in education) Tennyson
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.

5-131. GROUP PROCEDURES IN GUIDANCE. (3 cr; prereq 9 cr in education, 5-130 or ‡) Hansen
Content and materials for homeroom groups, occupation units, and other guidance courses in junior and senior high school.

5-300. WORKSHOP: COUNSELING PSYCHOLOGY. (3-6 cr per qtr [max 12 cr]; prereq ‡)
For experienced counselors who want to design and test applications of counseling concepts to specific problems related to the profession.

5-320. GROUP COUNSELING: PRINCIPLES AND PROCEDURES. (3 cr; prereq counseling certification or ‡) A Anderson
Basic principles of group dynamics related to the group counseling process; emphasis on developing concepts, attitudes, and skills necessary; includes theory and laboratory experiences.

5-331, 5-332. CAREER DEVELOPMENT: PRINCIPLES AND PRACTICUM I, II. (3 cr per qtr) Borow, Hansen
Principles of career development with focus on the world of work, theories, vocational information and appraisal techniques, vocational guidance and programs and practices to meet needs.

5-505. SEMINAR: INTERNATIONAL AND INTERCULTURAL DIMENSIONS OF COUNSELING. (2 cr; prereq ‡)
Discussion of the effect cross-cultural and cross-national differences have in the counseling process in a selection of cultural settings.

5-620. PRACTICUM IN GROUP COUNSELING. (1-6 cr per qtr [max 6 cr]; prereq counseling certification and ‡) A Anderson
Supervised practice in counseling several groups, preferably in the setting in which the student intends to work; emphasis on systematic evaluation of progress through direct observations and tapes, and on developing skills in interpersonal perception, communication, and research.

5-900. INDEPENDENT STUDY: GUIDANCE AND COUNSELING. (Cr ar; prereq ‡) Biggs, Briskin, Condie, Fiedler, Hansen, Kingsley, Loeffler, Zander
Independent study of areas of special interest to students.

8-140. COLLEGE STUDENT PERSONNEL WORK—FOUNDATIONS AND SCOPE. (3 cr; prereq course in higher education [or concurrent regis] or ‡) Parker
For potential personnel workers in college or university; scope, administration, coordination, and evaluation of program.

8-150.° PSYCHOLOGICAL ASPECTS OF COUNSELING SUPERVISION. (3 cr; prereq 8-510, 8-604, ‡) Blocher, Sprinthall
Consideration of theories; review of relevant research; experience in development, management, and supervision of counseling practicum.

8-302/8-303/8-304.† COUNSELING THEORY AND PROCEDURES I, II, III. (3 cr per qtr; prereq PsyF 8-160, ¶8-602, ‡ for 8-302...8-302, ¶8-603, PsyF 5-122, ‡ for 8-303...8-303, ¶8-604, ‡ for 8-304) A Anderson, Briskin, Shaffer
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.

8-305/8-306/8-307.† FIELD PLACEMENT IN COUNSELING AND STUDENT PERSONNEL PSYCHOLOGY. (1-3 cr per qtr [max 9 cr]; prereq MA student in counseling and student personnel psychology, ¶8-302, 8-602 for 8-305...¶8-303, 8-603 for 8-306...¶8-304, 8-604 for 8-307)
Supervised involvement of beginning M.A. students in appropriate agencies.

8-341. DIAGNOSIS AND TREATMENT OF COLLEGE LEARNING DIFFICULTIES. (3 cr; prereq course in reading, ‡) Raygor
Introduction to principles and practice; readings in research literature with emphasis on reading and study skills.

8-500. MASTER'S SEMINAR: COUNSELING AND STUDENT PERSONNEL PSYCHOLOGY. (Cr ar [max 6 cr]; prereq M.A. student, ‡)
Discussion of significant issues in the field.

8-501. PROFESSIONAL SEMINAR. (Cr ar [max 10 cr]; prereq Specialist student, ‡)
Continuous enrollment required of all part-time students enrolled in specialist program.

8-502. DOCTORAL SEMINAR: COUNSELING AND STUDENT DEVELOPMENT PSYCHOLOGY. (Cr ar [max 6 cr]; prereq doctoral student in CSPP, ‡)
Seminar on issues in field.

8-510.* SEMINAR: ADVANCED COUNSELING THEORY. (1-3 cr; prereq Ph.D. student, ‡) Blocher, Parker, Sprinthall
Examination of theoretical positions in learning and personality development related to an emerging theory of counseling.

8-511.* SEMINAR: ADVANCED COUNSELING RESEARCH. (1-3 cr per qtr [max 6 cr]; prereq Ph.D. student, ‡) Blocher, Parker, Sprinthall
Seminar for doctoral students interested in designing and executing small-scale research projects.

8-520.* SEMINAR: RESEARCH IN GROUP COUNSELING. (1-6 cr [max 6 cr]; prereq 8-304, 8-604 or 5-320, 5-620 or ‡) A Anderson
Designed to develop interest and skill; focus on identification of significant issues and development of innovative ideas; individual and group research projects.

8-530. RESEARCH SEMINAR. (Cr ar [max 9 cr]; prereq M.A. student in CSPP or ‡) Hummel, Shaffer
Orientation to research.

8-540. SEMINAR: THE COLLEGE STUDENT. (1-3 cr; prereq 6 cr in psychology or educational psychology) Biggs, Parker
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.

8-541. COLLEGE STUDENT PERSONNEL WORK—HOUSING. (2 cr; prereq 8-140) Condie
Weekly seminar discussion of college student personnel work.

8-542. COLLEGE STUDENT PERSONNEL WORK—STUDENT ACTIVITIES. (2 cr; prereq 8-140) Zander
Weekly seminar discussion of college student personnel work.

8-543. COLLEGE STUDENT PERSONNEL WORK—DISCIPLINE AND ADMINISTRATION. (2 cr; prereq 8-140) Snoke
Weekly seminar discussion of college student personnel work.

8-602/8-603/8-604.† COUNSELING PRACTICUM I, II, III. (3 cr per qtr; prereq ¶8-302, ‡ for 8-602...¶8-303, 8-602, ‡ for 8-603...¶8-304, 8-603, ‡ for 8-604) A Anderson, Briskin, Shaffer
Supervised practice in counseling with individuals and groups; emphasis on systematic evaluation of progress through direct observations, video and audio tapes.

8-612. COUNSELING PRACTICUM: ADVANCED. (1-3 cr [max 6 cr]; prereq ‡) Blocher, Shaffer
Each student is assigned to a senior staff member for supervision; an opportunity to continue development of counseling skills.

8-613/8-614/8-615.† COUNSELING PRACTICUM: STUDENT COUNSELING BUREAU. (3 cr per qtr [max 9 cr]; prereq ‡)
Supervised experience in counseling at college and adult levels; 3 consecutive quarters beginning fall.

8-640. PRACTICE IN STUDENT PERSONNEL WORK. (1-3 cr per qtr [max 9 cr]; prereq 8-304, 8-604, 8-140, 8-540 or ‡) Snoke
Supervised practice in college student personnel work in settings selected to match student interest.

8-641. CLINICAL PRACTICE IN DIAGNOSIS AND TREATMENT OF COLLEGE LEARNING DIFFICULTIES. (3 cr; prereq 8-341) Raygor
Supervised practice in group and individual work.

8-701. INTERNSHIP: COUNSELING AND STUDENT PERSONNEL PSYCHOLOGY. (0-6 cr [max 9 cr for M.A. and specialist students, max 18 cr for Ph.D. students]) Shaffer and staff
Supervised employment at departmentally approved sites.

8-900.* RESEARCH METHODS IN COUNSELING AND STUDENT PERSONNEL PSYCHOLOGY. (1-3 cr [max 9 cr]; prereq M.A. student, ‡) Hummel
Research methodology and techniques; critical examination of literature; participation in formulating and executing a research proposal.

8-905.* PROBLEMS: COUNSELING AND STUDENT PERSONNEL PSYCHOLOGY. (Cr ar; prereq ‡) A Anderson, Blocher, Borow, Edson, Glotzbach, Hagenah, Hummel, Parker, Raygor, Shaffer, Snoke, Sprinthall
Independent study in areas of special interest.

PSYCHOLOGICAL FOUNDATIONS (PsyF)

5-110. INTRODUCTORY STATISTICAL METHODS. (3 cr)
(Not equivalent to PsyF 8-110, 8-310) Basic statistical techniques; comprehension of literature using elementary concepts and methods.

5-120. EDUCATIONAL MEASUREMENT IN THE CLASSROOM. (3 cr) Terwilliger
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.

5-121. BASIC PRINCIPLES OF MEASUREMENT. (3 cr; prereq 5-110 or 8-110 or Psy 3-801 or equiv)
Fundamental concepts, principles, and methods in educational and psychological measurement; educationally useful properties of tests; types and uses of derived scores; factor influencing reliability and validity.

5-125. PRINCIPLES AND METHODS OF EVALUATION. (3 cr)
Nature of inquiry in education (evaluation vs elucidation); internal and external validity of designs; analytical operations on data; overview of models.

5-141. PSYCHOLOGY OF SCHOOL LEARNING. (3 cr)
Survey of psychological conceptions of the learner, the schooling process and the implications of these conceptions for education.

5-144. LEARNING: THEORY AND PRACTICE. (4 cr; prereq 5-342 or ‡)
Methodologies of applied psychology; critical examination of psychological variables which support learning through instruction; procedures for interpretation of data.

5-147. PSYCHOLOGY OF THE INTELLECT. (4 cr, §5-150; prereq 5-432 or 5-141 or equiv) Bart
Examination of theories of intelligence and patterns of concept development with implications for educational practices (e.g., measurement practices and curriculum techniques).

5-148. PSYCHOLOGY AND PEDAGOGY OF READING. (3 cr)
Physiological, psychological, and linguistic factors influencing beginning and fluent reading and their implications for instruction.

5-149. BEHAVIOR ANALYSIS IN EDUCATION. (4 cr, §5-142 or §5-143; prereq 5-342)
Focus on practical applications of reinforcement theory, behavior analysis, precision teaching, programmed instruction.

5-162. PERSONALITY AND SOCIAL DEVELOPMENT. (3 cr, §5-160; prereq 5 cr introductory psychology)
Major concepts and research findings in adjustment and development, with special emphasis on educational implications.

5-170. SOCIAL PSYCHOLOGY OF EDUCATION. (3 cr) D W Johnson
Concepts and theories applied to educational problems and settings; laboratory sessions to make applications and develop skills in group behavior.

5-330. COMPUTER PROGRAMMING. (3 cr) D Anderson
Computer as a tool for research in the behavioral sciences; computer systems, language, and development of specific programs that demonstrate computer characteristics; laboratory experience.

5-342. EXPERIMENTAL PSYCHOLOGY OF SCHOOL LEARNING. (5 cr, §5-140)
History, models and theories, research methods of educational psychology; conditioning, learning, and cognition; collection and analysis of data in the laboratory setting.

5-581. INDIVIDUAL DIFFERENCES AND EDUCATIONAL PRACTICE. (4 cr, §5-100; prereq 5-121 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.

5-621. PRACTICUM: INSTRUMENTS AND PROCEDURES FOR EVALUATION. (3 cr, §8-621; prereq 5-125, 5-121 or equiv)
Developing curriculum evaluation instruments and procedures; introduction to methods and theories; focus on identifying evaluation problems; developing and implementing techniques for their solution.

5-641. PRACTICUM: PRECISION TEACHING AND BEHAVIOR MODIFICATION. (1-3 cr [max 12 cr], §5-640; prereq ‡) Hively
Supervised experimentation with practical emphasis.

5-681. INSTRUCTIONAL USES OF COMPUTERS. (3 cr, §5-630; prereq 5-141 or 5-342 or equiv)
Analysis and evaluation of computer uses in teaching and learning; drill and practice, tutorial, learner-controlled sequences, simulation and games, evaluation, instructional management and learning research; laboratory experience.

5-900. DIRECTED STUDY. (Cr ar; prereq ‡)

8-110, 8-111, 8-112. STATISTICAL METHODS. (3 cr per qtr; prereq 5-110 or Psy 3-801 or equiv for 8-110...8-110 for 8-111...8-111 for 8-112) Collier, MacEachern
Foundations of statistical theory; practice in applying the theories in the solution of educational and psychological problems.

8-113. DESIGN AND ANALYSIS OF EXPERIMENTS. (3 cr; prereq 8-112 or ‡) Collier, MacEachern
Functional approach to principles of efficient design of experiments and other types of observational programs; improved sampling techniques; methods of analyzing observational results.

8-114. MULTIPLE REGRESSION AND FACTOR ANALYSIS. (5 cr; prereq 8-111 or ‡)
Techniques as applied to the analysis of data in education and the behavioral sciences; experience with appropriate computer applications.

8-120.* METHODS IN EDUCATIONAL RESEARCH. (3 cr; prereq winter qtr M.A. students only, spring qtr Ph.D. students only) Hoyt
Methods and techniques employed in investigation and report of educational problems. Suggested for all candidates for degrees.

8-130. COMPUTER APPLICATION TO STATISTICAL ANALYSES. (3 cr; prereq 8-112 or equiv) D Anderson
Use of computer to analyze data from the behavioral sciences; interpretation of results; attention to large-scale problems.

8-520. SEMINAR: RESEARCH PLANNING. (1 cr per qtr) Hoyt
Functional approach to planning empirical research projects appropriate for the basis of a Ph.D. thesis. Students develop outlines of projects and present them for critical review of members of the seminar.

8-522. ADVANCED THEORY OF MEASUREMENT. (3 cr; prereq 5-121, 8-111 or ‡)
Principles underlying construction and use of psychological and educational measuring instruments and the limitations of tests for purposes of measurement and evaluation. Students may register concurrently or subsequently for 8-920 for individual extensions and applications.

8-523. THEORY OF PSYCHOLOGICAL SCALING. (3 cr; prereq 5-121 and 8-111 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 8-920 for individual extensions and applications.

8-524. MEASUREMENT AND EVALUATION OF COGNITIVE DEVELOPMENT. (3 cr; prereq ‡) Bart
Examination of ordinal scales of intelligence and of item-forms testing for specified cognitive processes; construction of measurement and/or evaluation instruments testing for levels of cognitive development; pilot studies instituted using some ordinal scales of cognitive development.

8-525. SEMINAR: SPECIAL TOPICS IN EDUCATIONAL EVALUATION. (3 cr per qtr; prereq 5-121, 5-125, 8-111 or ‡)
Special topics in the development and use of evaluation procedures in education.

8-530. SEMINAR: DEVELOPING COMPUTER APPLICATIONS. (3 cr; prereq 5-330, ‡) D Anderson
Specific problems of utilization of the computer in research and development activities in the behavioral sciences laboratory sciences.

8-544. SEMINAR: PSYCHOLOGY OF KNOWLEDGE ACQUISITION. (3 cr, §8-541; prereq ‡)
Theory and research; psychological foundations of the structures that constitute curriculum content.

8-547. SEMINAR: COGNITIVE PROCESSES OF THE ADOLESCENT AND EDUCATIONAL IMPLICATIONS. (3 cr, §8-552; prereq 5-151 or ‡)
Critical issues in the relationship between the development of cognitive processes in the adolescent and curriculum structure, pedagogy, measurement practices, and evaluation procedures; discussion of research literature.

8-548. PSYCHOLOGICAL ANALYSIS OF VERBAL LEARNING AND READING. (3 cr, §8-540; prereq 5-148 or intro course in learning or ‡)
Discriminatory, decoding, semantic, and syntactical aspects; designs and procedures used to investigate psychological problems.

8-562. PERSONALITY DEVELOPMENT AND SOCIALIZATION. (3 cr, §8-160; prereq grad course in personality or child psychology...¶8-960 recommended)
Consideration of major research strategies on the topic with emphasis on educational and developmental influences on personality.

8-565. DEVELOPMENT OF MORAL-POLITICAL JUDGMENT AND PROGRAMS IN VALUE EDUCATION. (2-4 cr; prereq ‡...¶8-960 recommended)
Consideration of research and theory in moral judgment and political socialization with emphasis on cognitive-developmental approach; consideration of value education programs.

8-571. PSYCHOLOGY OF CONFLICT RESOLUTION. (4 cr, §8-170; prereq 5-170 or equiv)
Review of the research and theory in the field and its application to practical settings.

8-572. ORGANIZATIONAL DEVELOPMENT AND CHANGE. (4 cr; prereq 5-170 or equiv)
Review of theory and research procedures and methods for changing organizations; special reference given to educational organizations.

8-573. SMALL-GROUP PROCEDURES USED FOR PERSONAL AND ORGANIZATIONAL CHANGE. (4 cr; prereq 5-170 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.

8-581. PEDAGOGICAL PRINCIPLES IN INSTRUCTIONAL DESIGN AND DEVELOPMENT. (4 cr, §8-531; prereq 5-141 or 5-342 or ‡)
Review and analysis of research and development in building teaching-learning programs through systematic use of developing technologies and instructional techniques.

8-670. PRACTICUM: GROUP LEADERSHIP. (3 cr; prereq ‡)
Supervised practice in leading a discussion or activity group.

8-681. SYSTEMS PRINCIPLES IN INSTRUCTIONAL DESIGN AND DEVELOPMENT. (4 cr; prereq 5-342, 8-581 or ‡)
Review and application of systems designs and principles to identify and augment human intervention in designing, developing, evaluating, and researching instructional systems; including PERT, flow charting, goal statements, evaluation, and monitoring procedures and human relations/interventions.

8-721. INTERNSHIP: EVALUATION. (3 cr per qtr, max 12; prereq ‡)
Practical experience on an evaluation project. Student will be given specified responsibilities under the supervision of an evaluator.

8-900.* RESEARCH PROBLEMS. (Cr ar; prereq ‡) D Anderson, Bart, Bracht, Burris, Collier, Corcoran, Giese, Hively, Hoyt, D Johnson, P Johnson, Joselyn, MacEachern, Merwin, Rest, Rhetts, Samuels, Stecklein, Terwilliger, Welch, Wilk

8-910.* PROBLEMS: STATISTICS FOR STUDENTS IN EDUCATION AND PSYCHOLOGY. (3 cr per qtr) Collier, MacEachern
Recent developments in statistical science; application to educational and psychological problems.

8-920.° PROBLEMS: MEASUREMENT. (1-3 cr [max 9]) Hoyt
Intensive study and individual research.

8-921. PROBLEMS: CURRICULUM EVALUATION. (Cr ar; prereq 5-621 or 8-525)
Designing, implementing, and analyzing strategies; students will work on their own problems, on evaluation problems in school of the area, or on problems associated with national curriculum projects.

8-930. RESEARCH PROBLEMS: COMPUTER APPLICATIONS. (Cr ar; prereq ‡)
Recent developments in computer applications to educational and psychological problems.

8-940. RESEARCH PROBLEMS: LEARNING AND COGNITION. (Cr ar; prereq ‡)
To develop research topics in the area of learning and cognition; formulation of appropriate research designs.

8-960. RESEARCH PROBLEMS: PERSONALITY. (Cr ar, max 9; prereq ‡)
To develop research topics in the area; formulation of appropriate research designs.

8-970. RESEARCH PROBLEMS: SOCIAL PSYCHOLOGY. (Cr ar; prereq ‡)
To develop research topics in social psychology; formulations of appropriate research designs.

8-980. RESEARCH PROBLEMS: INSTRUCTIONAL SYSTEMS. (Cr ar, max 9; prereq 8-561, 8-581 or ‡)
Guided reading and research consultation in the field; formulation of appropriate research designs.

SCHOOL PSYCHOLOGY (SchP)

8-100. INTRODUCTION TO SCHOOL PSYCHOLOGICAL SERVICES. (3 cr)
Role and function of the psychologist in the schools; relationship with children, teachers, administrators, parents, and community; approaches to assessment and treatment of educational and psychological disabilities; preference on registration to other than school psychology graduate students.

8-310. TECHNIQUES OF PSYCHOEDUCATIONAL ASSESSMENT. (5 cr; prereq PsyF 5-120 or 5-121 or equiv, ‡)
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 experience requires full day or 2 mornings per week.

8-311. TECHNIQUES OF PSYCHOEDUCATIONAL ASSESSMENT: SPECIAL POPULATION. (5 cr; prereq 8-310, ‡)
Individual assessment procedures appropriate for evaluating children with cerebral dysfunction, learning disabilities, physical handicaps; field experiences in specialized educational settings require full day or 2 mornings per week for practicum.

8-312. PERSONALITY APPRAISAL IN CHILDREN AND ADOLESCENTS. (5 cr; prereq ‡)
Individual assessment of personality functioning in school-age children and adolescents; administration, scoring, and interpretation of objective and projective instruments; full day or 2 mornings per week required for practicum.

8-510. SEMINAR: SCHOOL PSYCHOLOGY. (Cr ar; prereq ‡)
Intensive study of significant topics from the behavioral sciences as such topics apply to contemporary educational problems.

8-513. THEORIES AND METHODS OF INTERVENTION: INDIVIDUALS. (3 cr; prereq 8-310, 8-311, 8-312, 8-600 or ¶8-600)
Psychological intervention appropriate for disorders found in school-age populations; provides basic knowledge of various intervention methods: individual verbal psychotherapy, play therapy, milieu therapy, family intervention, conditioning techniques.

8-514. THEORIES AND METHODS OF INTERVENTION: GROUPS. (3 cr; prereq PsyF 5-170 or Psy 5-201 and SchP 8-312)
Training in the use of group techniques in schools: the use of T-group methods; to increase skills in problem solving, decision making, communication, and conflict resolution.

8-515. THEORIES AND METHODS OF INSTRUCTIONAL INTERVENTION. (3 cr; prereq 8-310, 8-311 or ‡)
Theoretical considerations and training in use of functional techniques and appropriate preventative and remedial procedures; emphasis on psychological implications of individual and classroom instructional practice and consultation skills with school personnel.

8-520. SEMINAR: RESEARCH IN SCHOOL PSYCHOLOGY. (1 cr per qtr [total 3 cr]; prereq ‡)
Seminar for doctoral candidates planning dissertation research in school psychology.

8-600. CLINICAL PRACTICE IN SCHOOL PSYCHOLOGY. (1-5 cr; prereq 8-310)
Supervised diagnosis and treatment of children referred to the Psycho-Educational Center; training in a broad range of approaches to problems of adjustment in school-age children, their families, schools, and community settings.

8-610. PRACTICUM: SCHOOL PSYCHOLOGICAL SERVICES. (1-5 cr; prereq ‡)
Field experience under supervision, typical functions of school psychologists; assessment procedures, case studies, consultation with parents, school personnel, and community agencies; participation in seminar required.

8-700. INTERNSHIP: SCHOOL PSYCHOLOGICAL SERVICES. (5-15 cr; for doctoral candidates in school psychology; prereq 8-610, ‡)
Advanced field experience.

8-900.* RESEARCH PROBLEMS. (Cr ar; prereq ‡)

8-910. DIRECTED STUDY IN SCHOOL PSYCHOLOGY. (1-5 cr; prereq ‡)
Reading and analysis of research on selected problems in school psychology.

SPECIAL EDUCATION (SpEd)

5-100. CHILDHOOD LANGUAGE DEVELOPMENT: CLASSROOM IMPLICATIONS. (3 cr)
Recent trends and findings in language acquisition; classroom implications for education of exceptional children.

5-101. EDUCATION OF EXCEPTIONAL CHILDREN. (3 cr)
Introduction to field of special education for classroom teachers and other school personnel.

5-110. DIAGNOSIS AND REMEDIATION OF LEARNING DISABILITY I. (3 cr; prereq ‡)
Survey, demonstration, and evaluation of special techniques for diagnosis and remediation of severe learning deficits appearing in reading and written language (including dyslexia) and basic quantitative concepts.

5-111. DIAGNOSIS AND REMEDIATION OF LEARNING DISABILITY II. (3 cr; prereq 5-110, ¶5-611, ‡)
Survey, demonstration, and evaluation of special techniques for amelioration of deficits in perceptive, integrative, and expressive processes.

5-112. EDUCATION OF LEARNING-DISABLED CHILDREN. (3 cr)
Analysis of considerations in design and conduct of services for learning-disabled children; approaches to education of such children.

5-120. INTRODUCTION TO MENTAL RETARDATION. (4 cr, §CPsy 5-315; prereq 5-101)
Issues which relate to educational practices; community planning; educational philosophy, administration and organization, and programming.

5-123. METHODS AND MATERIALS FOR SEVERELY RETARDED PRESCHOOL AND SCHOOL AGE PUPILS. (4 cr; prereq 5-101 or equiv)
Issues and problems in curriculum development; pupil assessment and evaluation techniques; materials and teaching strategies.

5-130. EDUCATION OF CRIPPLED CHILDREN. (3 cr; prereq 5-101 or ‡)
Characteristics and abilities; methods and materials for training; observation of teaching situations involving these groups; personal consultation scheduled in addition to class hours.

5-131. EDUCATION PROBLEMS OF THE NEUROLOGICALLY IMPAIRED. (3 cr; prereq 5-101 or ‡)
Problems in development, learning, and adjustment produced by neurological impairment; study and development of materials to meet educational needs; observations of teaching and personal conferences.

5-140. PSYCHOSOCIAL AND EDUCATIONAL ASPECTS OF DEAFNESS. (3 cr)
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 the psychological processes on acquistion of language, speech, and speech-reading.

5-141. METHODS OF TEACHING SCHOOL SUBJECTS TO THE HEARING IMPAIRED. (3 cr; prereq CDis 5-708 or ‡)
Adaptation of material and teaching methods for hearing-impaired children in reading, mathematics, social studies, and science.

5-142. EDUCATION OF THE AUDITORIALLY HANDICAPPED CHILD. (3 cr)
Group and individual observation of classes for auditorially handicapped children; individual and small group conferences.

5-143. TEACHING LANGUAGE TO THE HEARING IMPAIRED I. (3 cr; prereq 5-140)
Survey of the language curricula and teaching techniques in infant, nursery, preschool, and beginning primary programs for the deaf; overview of language development in the deaf and hearing child in the primary years.

5-144. TEACHING LANGUAGE TO THE HEARING IMPAIRED II. (3 cr; prereq ‡)
Devising language curricula and teaching techniques in primary, intermediate, and advanced programs for the deaf; comparative study of language development of the deaf and hearing in these years.

5-145, 5-146. TEACHING SPEECH TO THE HEARING IMPAIRED I, II. (3 cr per qtr; prereq ‡)
Survey of speech methodologies employed in teaching auditorially impaired children; major emphasis on techniques in teaching specific sounds, articulation, voice, and sentence rhythm stressing intelligibility of speech. Demonstration and practice are provided with individual and groups of auditorially impaired children.

5-150. EDUCATION OF EMOTIONALLY DISTURBED AND SOCIALLY MALADJUSTED CHILDREN. (3 cr; prereq ‡)
Discussion and evaluation of curricula, materials, and methods for instruction of disturbed and delinquent children in hospital, training school, and public school settings.

5-170. INTRODUCTION TO EDUCATION OF VISUALLY HANDICAPPED CHILDREN. (3 cr; prereq ‡)
Educational programs, services, and resources for blind and partially seeing children; historical background; philosophy; sociological and psychological problems.

5-171. BRAILLE I. (3 cr; prereq 5-170 or ‡)
Mastery of literary Braille code and introduction to the use of mathematics and music codes; analysis of specialized equipment; use of Braille writers and slates.

5-172. BRAILLE II. (3 cr; prereq 5-171)
Development of classroom materials involving literary Braille code; mastery of Nemeth Code of Mathematics; opportunity for mastery of music code; consideration of newer approaches in setting up text and reference materials.

5-173. METHODS OF TEACHING VISUALLY HANDICAPPED CHILDREN. (3 cr; prereq 5-170 or ‡)
Principles of preparation, selection, and effective use of instructional materials; adaptation of school environment; utilization of family, school, and community resources.

5-174. ORIENTATION AND MOBILITY FOR BLIND CHILDREN. (3 cr; prereq ‡)
Provides basic techniques to help blind children gain skill in orientation and mobility; lectures and demonstrations; practice in basic techniques; conferences on psychological and physical factors in mobility; discussions of cane, dog guide, and related methods of travel.

5-175. STRUCTURE AND FUNCTION OF THE EYE: EDUCATIONAL IMPLICATIONS. (3 cr; prereq ‡)
An ophthalmologist discusses anatomy and physiology of the eye; an educator presents the educational implications, consideration of vision screening, visual efficiency, aids; field trips, films, observations.

5-180. EDUCATION OF THE DISADVANTAGED. (3 cr; prereq 12 cr in psychology, educational psychology, or sociology)
Educational needs of children handicapped by behavior related to deficiencies of physical and/or cultural environment; adaptations of educational programs.

5-190. OUTSTANDING ABILITIES AND THE EDUCATIONAL PROCESS. (3 cr)
Critical analysis of the origin and development of terms such as giftedness, creativity, genius, talent, and intelligence; implications for educational practice; current issues and trends.

5-301. CONTINGENCY MANAGEMENT IN SPECIAL EDUCATION SYSTEMS. (3 cr)
Designing special instructional systems based on an experimental analysis of academic and social behavior.

5-302. WORKSHOP: SPECIAL EDUCATION. (Cr ar; prereq ‡)
Laboratory approach provides opportunities for school personnel to study specific problems related to special education.

5-320. WORKSHOP: EDUCATION OF TRAINABLE RETARDED CHILDREN. (6 cr; prereq ‡)
Curriculum and materials for teaching trainable mentally retarded children.

5-321. WORKSHOP: EDUCATION OF EDUCABLE RETARDED STUDENTS. (6 cr; prereq ‡)
Curriculum and materials for teaching educable mentally retarded students.

5-340. CLINICAL AND EDUCATIONAL PROCEDURES FOR PRESCHOOL AND PRIMARY HEARING-IMPAIRED CHILDREN. (6 cr; for professionals working with the hearing impaired; prereq tchr of hearing impaired or ‡)
Overview of education of the deaf; practical application to guided clinical experience with hearing-impaired children from ages 1 to 6.

5-601. PRACTICUM: SPECIAL EDUCATION. (Cr ar; prereq ‡)
Supervised experience in teaching or related work in schools or other agencies serving exceptional children.

5-610. PRACTICUM: DIAGNOSIS AND REMEDIATION OF LEARNING DISABILITY I. (3 cr; prereq ¶5-110, ‡)
Clinical practice in prescriptive teaching using a selected range of techniques presented in SpEd 5-110.

5-611. PRACTICUM: DIAGNOSIS AND REMEDIATION OF LEARNING DISABILITY II. (3 cr; prereq 5-610, ¶5-111, ‡)
Clinical practice in prescriptive teaching using a selected range of techniques presented in SpEd 5-111.

8-120. PSYCHOLOGICAL THEORY AND RESEARCH IN MENTAL RETARDATION. (3 cr; prereq ‡)
Review of research and theories in the context of relevant developmental theories; important contributions in primary sources concerning principles of behavior and applied problems.

8-121. FUNCTIONAL ANALYSIS OF BEHAVIOR IN MENTAL RETARDATES. (3 cr; prereq 8-120)
Empirical approach to retarded development based on experimental research in perception, learning, motivation, and emotion; derived principles of behavior applied to problems in the development of the retarded.

8-122. DESIGN AND INTERPRETATION OF BEHAVIORAL RESEARCH WITH THE MENTALLY RETARDED. (3 cr; prereq 8-121)
Objectives, selection of problems, design, methodology, interpretation, and reporting of experimental research, origin, and implementation of researchable questions, with training and practice in actual research.

8-150. ADVANCED COURSE: EDUCATION OF EMOTIONALLY DISTURBED AND SOCIALLY MALADJUSTED CHILDREN. (3 cr; prereq ‡)
Techniques of behavior modification, analysis of teacher-pupil interaction in study of classroom groups, and classroom management strategies with disturbed and delinquent children; current literature review; individual assignments.

8-151. THEORIES OF EDUCATING DISTURBED CHILDREN. (3 cr; prereq ‡)
Examination of the applications of major personality theories to education of children with behavioral disorders.

8-152. RESEARCH IN EDUCATION OF DISTURBED CHILDREN. (3 cr; prereq ‡)
Review; critical analysis of specific designs and procedures; critique of current status of research in the area.

8-153. RESEARCH DESIGNS IN EDUCATION OF DISTURBED CHILDREN. (3 cr; prereq ‡)
Identification of researchable problems, design, procedures, and interpretation.

8-500. SURVEY OF SPECIAL EDUCATION PROBLEMS. (3 cr; prereq 5-101 or experience and ‡)
For persons working in special education or in allied fields.

8-501. RESEARCH IN SPECIAL EDUCATION. (1 cr per qtr [total 3 cr])
Preparation for M.A. colloquium paper research; critique of research with handicapped children; review of research in special education.

8-502. SEMINAR: SPECIAL EDUCATION. (Cr ar; prereq ‡)
Special topics and schedules announced by department.

8-520. EDUCATIONAL AND SOCIO-CULTURAL THEORY AND RESEARCH IN MENTAL RETARDATION. (4 cr; prereq 5-101, PsyF 5-110, CPsy 5-315 or equiv or ‡)
Research and theory in mental retardation under selected topics: early education and training, service arrangements, academic performance, instructional and training strategies, epidemiological trends, impact of the retarded on the family and society, vocational preparation, adult adjustment, social position of the retarded, influence of social forces on the retarded, and legal and economic factors.

8-540. LANGUAGE ACQUISITION AND LEARNING THEORY. (3 cr; prereq ‡)
Recent trends in developmental psycholinguistics; consideration of behavioristic, neobehavioristic, and biological theories.

8-560, 8-561. SEMINAR: ADMINISTRATION OF SPECIAL EDUCATION. (3 cr per qtr, §EdAd 5-180 or 5-181)
Problems of administration and organization of special education programs.

8-580. SEMINAR: THE DISADVANTAGED. (3 cr; prereq ‡)
Psychological theory and research with implications for educational planning and procedures.

8-601. 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.

8-602. RESEARCH PRACTICUM. (Cr ar; prereq ‡)
Supervised experience in research.

8-900.* PROBLEMS. (Cr ar; prereq ‡)
Individual readings or other forms of study following plans developed with a graduate faculty member.

Elementary Education (Elem)

5-100. ELEMENTARY SCHOOL CURRICULUM. (3 cr; prereq 3-101) Goossen, Howey
Selection and organization of subject matter for courses; methods, problems, and findings of research by subjects.

5-101. PROGRAMS AND PROCEDURES OF CURRICULUM DEVELOPMENT. (3 cr; prereq 5-100 or SeEd 5-113) Goossen, Howey
Leadership in procedures; operational processes; major considerations in planning and organizing; interpersonal relationships, and evaluation of improvement programs.

5-102. PREPARATION OF CURRICULUM MATERIALS. (3 cr; prereq 5-100 or SeEd 5-113)
Selecting and organizing units, courses of study, curriculum guides, and writing materials, individually and in groups.

5-103. WORKSHOP: CURRICULUM LABORATORY PRACTICE. (0-3 cr; prereq 5-100 or SeEd 5-113, ‡)
Analysis and construction of units, courses of study, and curricula according to needs, interests, level, and specialization.

5-104. PRACTICUM: LABORATORY SCHOOL TEACHING (K-6). (Cr ar; prereq elem student tchg or elem school tchg exper, ‡)
Experience in teaching and/or research.

5-105. FOUNDATIONS OF ELEMENTARY SCHOOL METHODS. (3 cr; prereq 9 cr in education)
Psychology and philosophy related to improvement of elementary school instruction; utilization of research findings.

5-106. SPEECH IN THE ELEMENTARY SCHOOL. (3 cr; prereq sr)
Lectures, discussion, individual projects, role of the elementary teacher in promotion of good speech; prevention of speech problems, handling of speech defects; projects related to the teacher's own teaching situation.

5-107. DIAGNOSIS AND TREATMENT OF LEARNING DIFFICULTIES. (3 cr) Manning, Schreiner
Evaluation of the results of teaching; diagnosis of pupil difficulty; development and prevention; tests as aids to teaching; following up a testing program.

5-108. SUPERVISION AND IMPROVEMENT OF INSTRUCTION. (3 cr; prereq 9 cr in education) Lambert
Functions and duties of a supervisor; techniques; analysis of classroom activities.

5-109. SUPERVISORY STRATEGIES IN PLANNING, OBSERVING, CONFERENCING. (3 cr; prereq ‡)
Overview of responsibilities of the supervising teacher; material development and practice in basic supervisory skills and functions.

5-300. LITERATURE FOR THE ELEMENTARY SCHOOL. (3 cr) Green, Odland
Evaluative survey of books for children; research related to children's reading interests; selection of literature.

5-316. TEACHING AND SUPERVISION OF ENGLISH IN THE ELEMENTARY SCHOOLS. (3 cr; prereq 3-316 or elem tchg exper) Chase, Dykstra, Green
Improvement of instruction, study of trends in English education.

5-317. MATERIALS LABORATORY FOR TEACHING ENGLISH IN ELEMENTARY SCHOOLS. (3 cr; prereq 3-316 or elem tchg exper) Chase, Dykstra, Green
Examination and evaluation of textbooks, programmed materials, and audio-visual resources for elementary school language arts instruction.

5-318. CREATIVE WRITING FOR AND BY CHILDREN. (3-6 cr, max 6; prereq 3-300 or 3-336 or elem tchg exper and ‡)
Language arts in the elementary school for experienced teachers, supervisors, graduate students, and college instructors; emphasis on creative aspects of the writing of children's literature and the children's own writing.

5-331. TEACHING AND SUPERVISION OF READING IN THE ELEMENTARY SCHOOL. (3 cr; prereq 9 cr in education) Aulls, Manning, D Pearson, Schreiner
Objectives, materials, and teaching procedures; current practices and curricula; class and individual projects; observation of reading techniques and material in the demonstration school.

5-333. INSTRUCTIONAL LEADERSHIP IN ELEMENTARY READING. (3 cr; prereq 5-331 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.

5-334. READING DIFFICULTIES. (3 cr; prereq 5-331 or SeEd 5-344) Aulls, Manning, D Pearson, Schreiner
Causes, prevention, and correction; remedial practices useful to the classroom teacher, school counselor, and reading specialist.

5-335. CLINICAL DIAGNOSIS OF READING DIFFICULTIES. (3 cr; prereq 5-334) Schreiner
Relationship to psychological factors and clinical remedial correction.

5-336. CLINICAL PRACTICE IN REMEDIAL TEACHING. (3 cr; prereq 5-334 or 5-107, ‡) Schreiner
Remedial tutoring of individual children who have difficulty in school learning.

5-337. BEGINNING READING INSTRUCTION. (3 cr; prereq 3-331 and ‡)
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.

5-338. TEACHING READING IN THE INTERMEDIATE GRADES. (3 cr; prereq 3-331 and ‡)
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.

5-346. TEACHING SCIENCE IN THE ELEMENTARY SCHOOL. (3 cr; prereq elem tchg exper or ‡) Goossen, Humphreys, R Johnson
Materials, resources, and methods of teaching science at the elementary level.

5-347. WORKSHOP: CURRICULUM IMPLEMENTATION IN ELEMENTARY SCHOOL SCIENCE. (3-6 cr; prereq elem tchg exper) Goossen, Humphreys, R Johnson
Offered with focus on a single program for each offering: treating concept foundation, goals, and teaching and evaluation procedures.

5-348. WORKSHOP: OUTDOOR SCIENCE EDUCATION. (3 cr; prereq elem tchg exper) Goossen, Humphreys, R 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 changes as well as more specific topics such as rocks and minerals, plants and animals, and stargazing.

5-349. ELEMENTARY SCHOOL SCIENCE: CURRICULUM AND SUPERVISION. (3 cr; prereq 3-346 or 5-346) Goossen, Humphreys, R Johnson
Program foundations including elements from philosophy, psychology, the science disciplines; design of in-school curriculum improvement models; program evaluation; pupil reporting procedures.

5-350. ELEMENTARY SCHOOL SCIENCE: MATERIALS AND RESOURCES. (3 cr; prereq 5-349) Goossen, Humphreys, R Johnson
Experiences in the use of educational materials and media common to the teaching of modern elementary school science.

5-361. TEACHING SOCIAL STUDIES IN THE ELEMENTARY SCHOOL. (3 cr; prereq 3-101 or equiv) Cogan, Ellis, Ryan
Content and organization of social studies programs; programs of understanding, improving the learning situation, and effective use of materials.

5-362. MATERIALS LABORATORY FOR ELEMENTARY SOCIAL STUDIES TEACHERS. (3 cr; prereq 3-361 or 5-361 or ‡) Cogan, Ellis, Ryan
Printed, audio-visual, and other materials; investigation and evaluation of teaching materials and devices.

5-363. WORKSHOP: CURRICULUM IMPLEMENTATION IN ELEMENTARY SCHOOL SOCIAL STUDIES. (Cr ar [max 9 cr]; prereq elem tchg exper, ‡)
Analysis of new instructional materials and recent curriculum developments in the field; training in innovative instructional procedures.

5-376. CURRENT TRENDS IN KINDERGARTEN 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.

5-377. KINDERGARTEN: MATERIALS AND RESOURCES. (3 cr; prereq 3-377 or 5-376 and tchg exper)
Experience in the selection and use of commercial and teacher-made educational materials and media common to teaching in the kindergarten.

8-300. SPECIAL COLLECTIONS OF CHILDREN'S LITERATURE. (3 cr) Odland
Comparative study of national and international special collections of original manuscripts, art work, first editions, and other bases for collecting children's books; research of student's choice in Kerlan collection.

8-316. RESEARCH IN ENGLISH COMPOSITION IN ELEMENTARY SCHOOLS. (3 cr; prereq 5-316 or equiv) Chase, Dykstra
Review of research in oral and written language of children; needed research indicated by current classroom procedures.

8-317. RESEARCH IN SKILL DEVELOPMENT IN SPELLING, HANDWRITING, AND LISTENING. (3 cr; prereq 5-316) Chase, Dykstra
Review of findings with implications for the classroom teacher; evaluation criteria and needed research.

8-331. RESEARCH FOUNDATIONS FOR READING INSTRUCTION. (3 cr; prereq 5-331, ‡) Clymer, Manning, D Pearson, Schreiner
Critical review and analysis of classical research studies in the psychology, pedagogy, and sociology of reading; criteria for appraising research findings; educational implications.

8-332. RECENT RESEARCH IN READING. (3 cr; prereq ‡) Manning, D Pearson, Schreiner
Critical analysis of methodology and findings of current research; appraising research methods, population limitations, and educational implications.

8-333. SEMINAR: READING INSTRUCTION. (0-3 cr; prereq ‡) Manning, D Pearson, Schreiner
Provides graduate students with opportunity to present their research designs and to criticize those of their peers. Faculty members will present designs for studies in progress; study of problems at all levels.

8-346.* RESEARCH FOUNDATIONS OF ELEMENTARY SCHOOL SCIENCE TEACHING. (3 cr; prereq 5-346 or ‡) Goossen, Humphreys, R Johnson
Research findings and their implications for the improvement of instruction in science in elementary schools.

8-347. THE ELEMENTARY SCHOOL SCIENCE PROGRAM: ARTICULATION AND COORDINATION. (3 cr; prereq 5-350 or 8-346) Goossen, Humphreys, R Johnson
Relation to K-12 science programs and to other aspects of the elementary school curriculum.

8-361. CURRICULUM CONSTRUCTION IN ELEMENTARY SOCIAL STUDIES. (3 cr; prereq 3-361 or 5-361 or ‡) Cogan, Ellis, Ryan
Detailed analysis of curriculum building; goals, selection of content, grade-level placement, development of teaching procedures, and evaluation.

8-362. RESEARCH IN ELEMENTARY SOCIAL STUDIES. (3 cr, §SeEd 8-362; prereq 5-361 or ‡) Cogan, Ellis, Ryan
Critical review of research findings and relevant theoretical formulations of major studies; criteria for appraising research methods, educational implications.

8-363. SEMINAR: ELEMENTARY SOCIAL STUDIES EDUCATION. (3 cr; prereq 3-361 or 5-361 and 8-362 or ‡) Cogan, Ellis, Ryan
Development of proposals and design models for empirical research; problems of social studies instruction for grade levels K-6.

8-364. SEMINAR: ELEMENTARY SCHOOL SOCIAL STUDIES AND THE SOCIAL SCIENCES. (3 cr; prereq 5-361, 5-362, ‡) Ellis
Analysis of structural components of social science disciplines; implications of social science processes and content for elementary school social studies.

8-391. SEMINAR: ELEMENTARY SCHOOL PROBLEMS. (No cr)

8-392. WORKSHOP: IMPROVEMENT OF INSTRUCTION. (1-4 cr)
For school principals, superintendents, and supervisors responsible for instruction program to develop understanding of problems, kindergarten through secondary school; programs for gifted and handicapped, courses of study, planning.

8-916.* PROBLEMS: TEACHING ENGLISH. (Cr ar) Chase, Dykstra, Green
For those qualified to undertake individual research.

8-931.* PROBLEMS: READING. (Cr ar; prereq 5-331 or SeEd 5-344 or ‡) Aulls, Balow, Chase, Dykstra, Manning, Odland, D Pearson, Schreiner
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.

8-961.* PROBLEMS: TEACHING SOCIAL STUDIES. (Cr ar; prereq 5-361 or SeEd 5-155, 8-104 or ‡) Cogan, Ellis, Ryan
Individual research.

8-976. PROBLEMS: TEACHING KINDERGARTEN. (3 cr; prereq ‡)
Opportunity for in-depth study or research related to self-selected interest areas in kindergarten education.

8-991.* PROBLEMS: IMPROVEMENT OF INSTRUCTION. (Cr ar; prereq ‡) Staff
For students qualified to make intensive studies of problems related to school supervision.

8-992. RESEARCH IN EDUCATIONAL DIAGNOSIS. (3 cr) Schreiner
Recent research in methods of diagnosis in education, and techniques of preventative and remedial teaching.

History and Philosophy of Education (HEd)

5-080. EDUCATION IN CHINA. (3 cr)
Analysis of the nature and scope of the educational system in China emphasizing discussions on education and nation building; historical, economic, political, and social factors involved in educational policy; emphasis on the People's Republic of China.

5-101. HISTORICAL FOUNDATIONS OF MODERN EDUCATION. (3 cr) Beck, Bagley
Background course for all other courses in history and philosophy of education. Analysis and interpretation of important elements in modern education derived from the Greeks, Romans, the Middle Ages, and the Renaissance.

5-110. INTERCULTURAL EDUCATION: SOCIAL SCIENCE AND SYSTEMS PERSPECTIVES. (3 cr) Harkins
Application of social science and systems analyses to educational theories, ideologies, and operating contexts; preparation of students for later ethnically focused courses on educational problems of particular minority populations in the United States.

5-112. INTERCULTURAL EDUCATION: SPANISH-SPEAKING POPULATIONS. (3 cr) Harkins
Application of anthropological analysis to educational theories, ideologies, and operating contexts; emphasis on Spanish-speaking populations of the United States.

5-113. INTERCULTURAL EDUCATION: AFRO-AMERICAN POPULATIONS. (3 cr) Harkins
Application of social science analysis to educational theories, ideologies, and operating contexts; emphasis upon Afro-American populations of the United States.

5-121. ANALYSIS IN EDUCATIONAL PHILOSOPHY. (3 cr)
Application of philosophical analysis to educational theories and philosophies.

5-125. ADOLESCENCE IN CHANGING SOCIAL INSTITUTIONS. (3 cr) Clark
Special status and conditions of adolescents in industrial societies; participation of youth in the socializing institutions: family, education, economic, religious, and political problems related to adolescent development; emphasis on school peer relations.

5-131. COMPARATIVE EDUCATION. (3 cr) Beck, Corcoran
European, Asiatic, and American systems and philosophies of education; possibilies of international education.

5-132. EDUCATION IN THE THIRD WORLD. (3 cr)
Introduction to comparative and international education focusing on the role of education in ameliorating the social, economic, and political problems of nations in Asia, Africa, and Latin America.

5-141. CRITICAL ISSUES IN CONTEMPORARY EDUCATION. (3 cr) Beck
Introduces graduate students to ideas involved in current theory and practice.

5-149, 5-150, 5-151. SOCIAL HISTORY OF AMERICAN EDUCATION. (3 cr per qtr [total 9 cr])
Impact of education on social and institutional developments from colonial period to present. Although schools, both private and public, will receive attention, education will be defined to include work of family, religious congregation, popular press, clubs, and other private associations.

5-155. HISTORY OF WESTERN EDUCATIONAL THOUGHT. (3 cr) Beck, Bagley
Major educational classics of Western civilization: Plato, Aristotle, Cicero, Quintillian, Montaigne, Milton, Locke, Rousseau, and others.

5-156. HISTORY OF IDEAS IN AMERICAN EDUCATION. (3 cr) Bagley
Readings in American political, economic, and social development related to education; reference to the emerging system of public education. Recommended as background for HEd 5-170, but not a prerequisite.

5-170. AMERICAN PRAGMATISM AND EDUCATION. (3 cr) Bagley
Analysis and interpretation of the educational philosophy of pragmatism (experimentalism); readings from Dewey, Kilpatrick, Bode, Counts, Childs, and others.

5-171. ANTHROPOLOGY AND EDUCATION. (3 cr, §Anth 5-371)
Cross-cultural perspectives in examining educational patterns, the implicit and explicit cultural assumptions underlying them; methods and approaches to cross-cultural studies in education.

5-182. COMPARATIVE PHILOSOPHIES OF EDUCATION. (3 cr) Beck
Examination of competing philosophies of education.

5-190. SOCIOLOGY OF EDUCATION. (3 cr, §Soc 5-953) Clark
Advanced studies in social aspects of education including the school as a socialization process, the social structure of education, the role of school in social change.

5-191. PROFESSIONALIZATION AND TEACHING. (3 cr)
Process, social history, and ideology; role of teacher organizations; forms of militancy; comparison with professionalism in other occupations.

5-192. SOCIOLOGICAL STUDIES IN HIGHER EDUCATION. (3 cr)
Advanced studies in social aspects of higher education; socialization of students, comparative institutional organization, role structure; emphasis on theory and empirical research.

5-200, 5-201, 5-202. INTERCULTURAL EDUCATION: INDIAN AMERICANS. (3 cr per qtr; prereq 5-200 for 5-201...5-201 for 5-202)
Application of Indian historical material, contemporary research findings, and planned programs of educational change to the development of an integrated approach to college and public school curriculum redesign in Indian history and culture; preparation for consultative work with in-service teachers in the development of teaching materials.

5-205. INTERCULTURAL EDUCATION: WORKSHOP IN URBAN SOCIAL SIMULATIONS. (3 cr) Harkins
Analyses of operation of the city as a social system; use of simulation gaming techniques to study urban institutions and processes with emphasis on formal education.

5-210. APPLIED SOCIAL SCIENCE AND EDUCATIONAL FUTURES. (3 cr)
Application of social sciences in their academic and applied dimensions to formal education, including a social-scientific and systems orientation toward communities; emphasis on short-range social and educational planning, near-present to a few years hence.

5-211. SOCIAL PLANNING AND EDUCATIONAL FUTURES. (3 cr)
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.

5-212. EDUCATION IN FUTURE SOCIAL SYSTEMS. (3 cr)
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.

8-221, 8-222, 8-223. SEMINAR: 20TH-CENTURY EUROPE. (3 cr per qtr [total 9 cr]; prereq ‡)
Europe and North Atlantic community in the 1960's. Some significant trends in western Europe viewed in the context of western European relations within the Atlantic area and with nonwestern European nations.

8-231. SEMINAR: COMPARATIVE AND INTERNATIONAL EDUCATION. (3 cr)
Research reports on cross-national and cross-cultural developments in education and methods of investigating these developments.

8-232. SEMINAR IN COMPARATIVE EDUCATION: EDUCATION AND NATIONAL DEVELOPMENT. (Cr ar; prereq ‡)
Special topics announced by the department.

8-241.° PROBLEMS: HISTORY AND PHILOSOPHY OF EDUCATION. (Cr ar; prereq ‡) Beck, Bagley, Clark, Corcoran, Harkins
For graduate students interested in research and original work in these areas.

8-242. SEMINAR: EDUCATIONAL PHILOSOPHY. (3 cr; prereq ‡) Beck, Bagley
For advanced students; critical study and discussion of special problems.

8-255. SEMINAR: EUROPEAN AND AMERICAN EDUCATIONAL THOUGHT: 16th AND 17th CENTURIES. (3 cr; prereq 5-155 or ¶5-155 or ‡)
Analysis and interpretation of primary source materials of 16th- and 17th-century educational thought and practice in western Europe, principally England.

8-256. SEMINAR: EUROPEAN AND AMERICAN EDUCATIONAL THOUGHT: 17th CENTURY. (3 cr; prereq 5-155 or 8-255 or ‡)
Analysis and interpretation of primary source materials of 17th-century educational thought and practice in western Europe and the American colonies.

8-257. SEMINAR: EUROPEAN AND AMERICAN EDUCATIONAL THOUGHT: LATE 17th AND 18th CENTURIES. (3 cr; prereq 8-256 or ‡)
Analysis and interpretation of primary source materials of 17th- and 18th-century educational thought and practice in western Europe and the American colonies.

8-290. ADVANCED SOCIOLOGY OF EDUCATION. (3 cr; prereq 5-190 or Soc 5-953 or ‡) Clark
Analysis of a contemporary critical socio-educational problem; choice of problem varies from quarter to quarter.

8-296/8-297/8-298†. SEMINAR: AMERICAN SOCIAL AND EDUCATIONAL HISTORY. (3 cr per qtr [total 9 cr], §Hist 8-357, §Hist 8-358, §Hist 8-359; prereq 8-296 for 8-297...8-297 for 8-298)
Source materials: historical criticism and analysis applied to the study of social and educational forces in history; individual research projects.

Mathematics Education (MthE)

5-101. WORKSHOP: ELEMENTARY SCHOOL MATHEMATICS. (3 cr; not open to majors in mathematics education; prereq ‡) Jackson, Post, Stochl
Modern trends, methods, and materials used to convey mathematical ideas.

5-102. WORKSHOP: MATHEMATICS EDUCATION. (1-9 cr [max 9 cr])
Analyzes issues, materials, and instructional techniques focusing on a single current topic of particular relevance to secondary school and college mathematics teachers.

5-301. INSTRUCTIONAL LEADERSHIP IN ELEMENTARY SCHOOL MATHEMATICS. (3 cr; not open to majors in mathematics education; prereq ‡) Jackson, Post, Stochl
Current trends in methods, materials, content, and evaluation; program development and research; intended for supervisors and principals.

5-311. TEACHING AND SUPERVISION OF MATHEMATICS IN THE ELEMENTARY SCHOOL. (3 cr; prereq Elem 3-391 or ‡) Jackson, Post, Stochl
Present practices and trends in methods, evaluation, and diagnosis; objectives, psychology, and philosophy related to improvement of instruction.

5-312. TEACHING AND SUPERVISION OF MATHEMATICS IN THE SECONDARY SCHOOL. (3 cr; prereq mathematics tchg exper or ‡) David C Johnson, Donovan Johnson
Methods, materials, and curriculum development; principles of learning; review of research; preparation and evaluation of tests, units, and materials of instruction.

5-321. MATERIALS LABORATORY FOR ELEMENTARY SCHOOL MATHEMATICS INSTRUCTION. (3 cr; prereq 5-311 or Elem 3-391 or ‡) Jackson, Post, Stochl
Printed and programmed materials, audio-visual aids, community resources; laboratory projects and techniques of using mathematical devices and instruments.

5-322. MATERIALS LABORATORY FOR SECONDARY SCHOOL MATHEMATICS INSTRUCTION. (3 cr; prereq 5-312 or ‡) David C Johnson, Donovan Johnson
Sources and types of materials, laboratory projects and techniques of using mathematics devices and instruments, visual aids, and community resources.

5-331. CURRENT DEVELOPMENTS IN ELEMENTARY SCHOOL MATHEMATICS INSTRUCTION. (3 cr; prereq 5-311 or ‡) Jackson, Post, Stochl
Contemporary literature, trends, and experimentation with content; criteria for program evaluation.

5-332. NEW CONTENT AND METHODS IN SECONDARY SCHOOL MATHEMATICS INSTRUCTION. (3 cr; prereq 5-312 or ‡) David C Johnson, Donovan Johnson
Trends and experimentation with content; special programs for the gifted and slow learner; methods in mathematics; program evaluation.

5-345. MATHEMATICS FOR GIFTED CHILDREN. (3 cr; prereq 5-311 or Elem 3-391 or ‡) Jackson, Post, Stochl
Curriculum and methods of instruction for academically talented children; development of enrichment units; source material for teachers.

5-355. MATHEMATICS FOR SLOW LEARNING CHILDREN. (3 cr; prereq 5-311 or Elem 3-391 or ‡) Jackson, Post, Stochl
Units of instruction emphasizing mathematical concepts essential for vocational competence; experimental materials and methods designed to improve performance of low achievers.

5-366. COMPUTER-ASSISTED MATHEMATICS INSTRUCTION. (3 cr; prereq 5-311 or 5-312 or SeEd 3-365 or ‡) David C Johnson
Role of the computer in a mathematics department: its contribution to learning concepts, problem solving, and computational skill; consideration of various types of equipment and languages, programming of problems, instructional materials.

8-500. THEORY AND CLASSICAL RESEARCH IN MATHEMATICS EDUCATION. (3 cr; prereq 5-311 or 5-312 or ‡) Jackson, David C Johnson, Donovan Johnson, Post, Stochl
Critical review of research and relevant theoretical formulations; criteria for appraising research methods, educational implications.

8-570. RESEARCH IN MATHEMATICS EDUCATION. (3 cr; prereq 8-500 or ‡) Jackson, David C Johnson, Donovan Johnson, Post, Stochl
Current issues, problems, and findings in curriculum, gradation of subject matter, methods and materials of instruction; criteria for evaluating research.

8-590. SEMINAR: MATHEMATICS EDUCATION. (0-3 cr; prereq ‡) Jackson, David C Johnson, Donovan Johnson, Post, Stochl
Problems of mathematics instruction at levels of kindergarten through junior college; provides opportunity to develop proposals and design models for empirical research.

8-680. INTERNSHIP: MATHEMATICS EDUCATION. (3-9 cr)
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.

8-980.* PROBLEMS: MATHEMATICS EDUCATION. (Cr ar; prereq 8-500 or 8-570) Jackson, David C Johnson, Donovan Johnson, Post, Stochl
Surveying the most recent literature, designing and preparing research reports on special problems.

Music Education (MuEd)

5-111. BIBLIOGRAPHY. (4 cr) Turrentine
Sources, materials, and techniques.

5-112. RESEARCH TECHNIQUES. (4 cr)
Methods and techniques employed in investigating and reporting of music education problems; review of current significant research.

5-115. TESTS AND MEASUREMENTS. (4 cr; prereq ‡) Turrentine
Principles of music aptitude and achievement testing; current status of music testing; survey of existing published tests in music.

5-211. PHILOSOPHIES OF MUSIC EDUCATION. (4 cr) Borg
Analysis and interpretation of philosophies in music and education; objectives, trends, curriculum, evaluation.

5-212. COMPARATIVE MUSIC EDUCATION. (4 cr; prereq ‡) Caswell
Study, performance, and analysis of music; unique methods of instruction, roles of creative and performing musicians in elementary and secondary school music teaching in selected countries.

5-214. PSYCHOLOGICAL FOUNDATIONS. (5 cr; prereq ‡) Caswell
Analysis and interpretation of psychologies of music and education as applied to the teaching of music.

5-217. HISTORICAL FOUNDATIONS OF MUSIC EDUCATION. (4 cr; prereq ‡) Turrentine
Analysis and interpretation of important elements in modern music teaching derived from the past.

5-221. MUSIC AND THE HUMANITIES IN THE SECONDARY SCHOOLS. (4 cr; prereq Mus 1-506, 1-603 or ‡)
Teaching music as part of the humanities emphasis in high schools; methods and music materials appropriate to the humanities.

5-231. SUPERVISION AND ADMINISTRATION OF ELEMENTARY MUSIC. (4 cr; prereq major or minor in music or music education) Borg, Caswell
Analysis and evaluation of instructional techniques; supervisory and administrative techniques; readings; new trends.

5-232. SUPERVISION AND ADMINISTRATION OF SECONDARY SCHOOL MUSIC. (4 cr; prereq major or minor in music or music education)
Evaluation of materials, scheduling and teaching of required and elective courses; individual and group lessons; ensembles; extracurricular activities.

5-305. GENERAL MUSIC IN ELEMENTARY AND JUNIOR HIGH SCHOOLS. (4 cr; prereq 3-011 or ‡) Borg
Open to music education and nonmusic majors. Methods, materials, and problems in teaching general music classes; emphasis on music literature.

5-306. TEACHING MUSIC LITERATURE. (4 cr; prereq 3-011 or 3-302 or ‡) Borg
Principles, methods, and materials for teaching music history (appreciation) in grades K-12.

5-308. TEACHING MUSIC READING. (4 cr; prereq 3-011, 3-302 or ‡)
Objectives, materials, research, teaching procedures and evaluation; class and individual projects; emphasis on general music class approach.

5-311. MUSIC FOR EXCEPTIONAL CHILDREN. (4 cr; prereq 3-011 or ‡) Borg
Trends; methods and materials for a functional program of singing, playing, rhythm, listening, and creative activities for mentally and physically handicapped and gifted pupils.

5-322. INSTRUMENTAL MUSIC IN THE GENERAL MUSIC CLASSROOM. (4 cr; prereq Mus 1-001 or equiv; music or music education major)
Beginning and intermediate class and small group recorder instruction; methods and materials for teaching recorder, capped and uncapped Renaissance reed instruments and Studio 49 (Orff Schulwerk) melodic and percussion instruments; factors in combining these instruments with voices and keyboard instruments.

5-421. SELECTION, CONDUCTING OF CHORAL MATERIALS. (4 cr; prereq sr) Caswell
Student conducting with class as performing ensemble; criteria for selecting choral and combined choral and instrumental materials; rehearsal techniques.

5-431. ADVANCED TOPICS: VOCAL MUSIC. (4 cr; prereq ‡) Caswell
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.

5-441. READING AND STYLISTIC INTERPRETATION OF CHORAL MUSIC. (4 cr; prereq 5-431 or ‡) Caswell
Defining means of teaching choristers to read and interpret music of representative periods and styles of compositions.

5-504. ADVANCED STRING INSTRUMENT TECHNIQUES. (4 cr; prereq B.S. in music education or ‡)
Research reports, lecture-demonstrations; performance by class members and by school-age laboratory groups.

5-505. STRING TEACHING SEMINAR. (4 cr; prereq 3-650 or ‡)
Survey and evaluation, through group and individual projects, of recently developed string teaching techniques.

5-514. ADVANCED WIND AND PERCUSSION TECHNIQUES. (4 cr; prereq B.S. in music education or ‡) Turrentine
Research reports, practical performances, and lectures.

5-534. ADVANCED PERCUSSION TECHNIQUES. (4 cr)
Contemporary approaches to teaching percussion in the elementary, junior high, and high school with emphasis on performing techniques; playing of teaching materials, solo and ensemble repertoire.

5-581. SELECTION OF INSTRUMENTAL MATERIAL I. (4 cr) Turrentine
Analytical survey of solo and smaller wind chamber music and its use in the teaching of instrumental music on the precollegiate level.

5-582. SELECTION OF INSTRUMENTAL MATERIALS II. (4 cr) Turrentine
Analytical survey of larger wind chamber and band music and its use in the teaching of instrumental music on the precollegiate level.

5-591. NEW DIMENSIONS IN INSTRUMENTAL MUSIC EDUCATION. (4 cr)
Study of instrumental music through analysis, performance, listening, and composition; evaluative procedures; curriculum structure and design; scheduling.

5-801. INFLUENCE OF MUSIC ON BEHAVIOR. (4 cr)
Methods and principles of the behavioral and biological sciences as they relate to the art of music.

5-804. MUSIC IN THERAPY. (4 cr; prereq 5-801)
Application of methods and principles of music therapy through observation, research, and case studies.

5-970. INDEPENDENT STUDY. (1-4 cr; prereq consent of adviser and △) Borg, Caswell, Turrentine
Independent study project organized by the student in consultation with the appropriate instructor.

8-281/8-282/8-283. SEMINAR: CURRICULUM DEVELOPMENT. (4 cr per qtr; prereq M.A. in music or music education for 8-281...8-281 for 8-282...8-282 for 8-283) Borg, Caswell, Turrentine
Development and evaluation of the music curriculum; needed research; 3-quarter elementary, junior high, senior high sequence.

8-990.* RESEARCH PROBLEMS. (4-12 cr; prereq knowledge of elem statistics) Borg, Caswell, Turrentine
Individual projects.

School of Physical Education

PHYSICAL EDUCATION (PE)

5-100. 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.

5-101. PHYSICAL EDUCATION ACTIVITIES FOR THE HANDICAPPED. (3 cr; prereq 5-100 or SpEd 5-101)
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.

5-102. PRACTICUM: PHYSICAL EDUCATION FOR THE HANDICAPPED. (3 cr; prereq 5-101 or ‡)
Opportunity for teaching in public school or community organization providing instruction for atypical individuals; includes seminar for review of current theory and exchange of ideas and problems.

5-110. SUPERVISION OF SCHOOL HEALTH AND PHYSICAL EDUCATION. (3 cr, §Hlth 5-110; prereq ‡) Jaeger, Slocum
Functions; adaptations of accepted procedures for observation, guidance, and training of teachers.

5-111. PHYSICAL EDUCATION FACILITIES. (3 cr) Anderson, Jaeger
Planning of areas and facilities for physical education and athletics with special emphasis on current trends and problems in the field.

5-112. PHYSICAL EDUCATION EQUIPMENT. (3 cr) Anderson, Jaeger
Selection, purchase, and maintenance of athletic equipment and supplies with opportunity to investigate selected equipment in depth.

5-120. ADVANCED KINESIOLOGY. (3 cr; prereq undergrad kinesiology or ‡) Serfass, Stoner, Wilson
Principles of mechanics applied to human movement, analysis of motor skills, application to individual projects.

5-121. CONTRIBUTIONS OF BASIC SCIENCE TO PHYSICAL EDUCATION. (3 cr; prereq ‡) Serfass, Wilson
Recent research in related physical sciences; applications in selected areas.

5-122. APPLIED PHYSIOLOGY. (3 cr; prereq PubH 3-386 or Phsl 3-051 or equiv) Alexander, Serfass
Application of concepts in human physiology to exercise physiology, sports training, and physical activities with particular reference to respiratory and cardiovascular systems.

5-123. ANALYSIS OF MOVEMENT IN GYMNASTICS. (3 cr; prereq 3-111, 3-174 or 3-322 or ‡)
Scientific principles of body mechanics and training relating to teaching, analysis, and development of advanced performance techniques.

5-130. MOTOR LEARNING AND HUMAN PERFORMANCE. (3 cr; prereq 3-113 or ‡)
Mechanisms of human motor skill learning; emphasis on theories of motor learning and control of movement, motor memory, and individual differences.

5-150. TEACHING ELEMENTARY SCHOOL PHYSICAL EDUCATION. (3 cr; prereq tchg certificate or ‡)
Principles, techniques, and procedures in developing basic motor skills, physical fitness, and sports skills.

5-151. CURRICULUM. (3 cr) Young
For students without previous experience in curriculum; objectives, content, organization, evaluation, and trends.

5-152. CURRICULUM DEVELOPMENT. (3 cr; prereq 5-151 or equiv) Young
Trends, issues, and problems at selected levels of interest: elementary, secondary, junior college; for experienced teachers.

5-160. TESTS AND MEASUREMENT IN PHYSICAL EDUCATION. (3 cr; prereq ‡) Alexander, Shick, Stoner
Place and limitations of measurement; construction and interpretation of evaluative procedures.

5-170. FOUNDATIONS OF PHYSICAL EDUCATION. (3 cr)
Establishment of guidelines for individual and group professional action; examination of pertinent social forces, educational philosophies, and general ethics.

5-255. INTRAMURALS-EXTRAMURALS. (4 cr) Anderson, Mueller
Analysis and interpretation of philosophies of men's and women's programs; principles, objectives, and techniques of program development.

5-350. SEMINAR: TEACHING PHYSICAL EDUCATION IN COLLEGES AND UNIVERSITIES. (1 cr per qtr [max 3 cr]; prereq ‡)
Required of physical education teaching associates, assistants, part-time instructors, and open to graduate students having college teaching as their goal; emphasis on improvement of instruction.

5-620. PRACTICUM: PREVENTION AND CARE OF ATHLETIC INJURIES. (3 cr; prereq ‡)
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.

5-695. PRACTICUM: INTRAMURALS-EXTRAMURALS. (3-5 cr; prereq 5-255) Anderson, Mueller
Theory and application of principles in developing programs including supervised experiences in program operation.

5-700. WORKSHOP: DANCE IN EDUCATION. (2 or 4 cr per qtr, max 12)
History, principles, instructional techniques, and materials for teaching dance in schools and recreational agencies. Topic and credit will vary with each offering.

5-980. INTRODUCTION TO RESEARCH. (3 cr; prereq ‡) Alexander, Shick, Stoner, Wilson
Methods and design for research in health, physical education, and recreation.

5-983. READINGS: PHYSICAL EDUCATION. (1-3 cr; prereq ‡)
Independent study under tutorial guidance.

8-110. ADMINISTRATION: GENERAL PRINCIPLES AND PROCEDURES. (3 cr) Jaeger
Operation and management of physical education and athletic programs in schools, colleges, and universities.

8-111. INTERSCHOLASTIC ATHLETICS ADMINISTRATION. (3 cr; prereq 8-110) Bird, Jaeger
Principles and procedures in the management of school athletic programs for boys and girls; state high school athletic associations; regulations, finances, issues, trends, research.

8-112. INTERCOLLEGIATE ATHLETICS ADMINISTRATION. (3 cr; prereq 8-110) Bird, Jaeger
Principles and procedures in the management of college and university athletic programs for men and women; NCAA, AAU, and regional leagues; regulations, recruitment and subsidization, finances, issues, trends, research.

8-113. COLLEGE PHYSICAL EDUCATION ADMINISTRATION. (3 cr; prereq 8-110) Jaeger
Principles and procedures in the management of physical education programs in colleges and universities.

8-120. KINESIOLOGY: PHOTOGRAPHIC AND CINEMATOGRAPHIC ANALYSES. (3 cr; prereq 5-120, ‡) Serfass, Stoner, Wilson
Application of techniques; verification of development of mechanically efficient movement patterns.

8-121. KINESIOLOGY: ELECTROMYOGRAPHIC ANALYSIS. (3 cr; prereq 5-120, ‡) Serfass, Stoner, Wilson
Application of techniques; verification or development of mechanically efficient movement patterns.

8-150. PROFESSIONAL PREPARATION OF PHYSICAL EDUCATION TEACHERS. (3 cr; prereq 5-151 or equiv) Jaeger, Young
Current needs, issues, trends, curriculum patterns and standards; for experienced teachers.

8-310. SEMINAR: PHYSICAL EDUCATION. (1-9 cr; required of Ed.D. interns, open to M.A. and Ph.D. students; prereq △)
Critical study, supervised planning of field work experience, and special problems under guidance of adviser.

8-320. SEMINAR: KINESIOLOGY. (3 cr; prereq 8-120 or 8-121 or ‡) Serfass, Stoner, Wilson
Application of one or more analyses techniques to an individually selected problem.

8-330. SEMINAR: MOTOR LEARNING AND HUMAN PERFORMANCE. (3-9 cr, max 9; prereq 5-130 or ‡)
Advanced reading and discussion of research on specialized topics dealing with human performance and motor skills learning.

8-381. LABORATORY RESEARCH TECHNIQUES. (1-3 cr; prereq 5-980 or ¶5-980) Alexander, Serfass, Stoner
Demonstration and student participation in laboratory procedures involving assessment of exercise parameters.

8-980.* RESEARCH PROBLEMS. (3 cr; prereq 5-980, PsyF 5-110 or ‡)
Designing, reporting on individual problems; required of all M.A. and Ph.D. candidates.

8-981.* RESEARCH PROBLEMS. (Cr ar; prereq 8-980 or ‡)
Individual problems.

8-985. SEMINAR: CONTEMPORARY PROBLEMS. (3 cr; prereq 5-980, ‡) Alexander, Stoner
Individual presentation and class discussion of contemporary problems selected by class members.

RECREATION AND PARK ADMINISTRATION (Rec)

5-130. RECREATION AND PARK AREAS AND FACILITIES. (5 cr; prereq 1-520 or ‡) Giles
Introduction to the basic principles of planning community facilities; effective application of standards in facility planning, design, and construction.

5-140. RECREATION PROGRAMMING. (5 cr; prereq 1-520 or ‡)
Principles of program planning and leadership in all aspects of recreation.

5-150. PRINCIPLES AND PRACTICES OF RECREATION ADMINISTRATION. (5 cr; prereq 5-130, 5-140, or ‡) Chapman
Introduction to basic principles of administration and their application to successful administrative practices in various recreational settings.

5-160. CONSERVATION OF NATURAL RESOURCES. (2 cr; prereq 3-150) Chapman
Importance and relation to recreation and outdoor education.

5-170. CAMP ADMINISTRATION. (3 cr; prereq 1-540, ‡) Chapman, Ostrander
Prepares qualified personnel for responsibilities.

5-180. INDUSTRIAL RECREATION. (3 cr; prereq ‡)
History, scope, place, and relationship of management-employee recreation.

5-190. COMMERCIAL RECREATION. (3 cr; prereq 5-130 or ‡)
Survey of the scope and development of profit-making recreation agencies, facilities, and services; consideration of standards, business procedures, financing, and legal status.

5-200. SCHOOL RECREATION. (3 cr) Chapman
Principles of organizing and conducting school-sponsored recreation programs.

5-210. INTRODUCTION TO THERAPEUTIC RECREATION. (3 cr; prereq ‡) Weiss
General field as background for the recreation leader, hospital administrator, and other personnel.

5-220. PROGRAMMING: THERAPEUTIC RECREATION. (3 cr; prereq ‡) Weiss
Recreation service to the ill, disabled, and other special populations.

5-230. RECREATION FOR THE MENTALLY RETARDED. (3 cr; prereq 5-210, 5-220, or ‡) Chapman, Weiss
Characteristics and special needs in relation to recreation programs; consideration of skills and techniques for work with retarded persons in institutions and in the community.

5-240. RECREATION FOR THE AGING. (3 cr; prereq ‡) Weiss
Examination of leisure problems of the aging citizen; modification of program activities; investigation of community resources; trends and developments in recreation planning.

5-250. FINANCING PUBLIC RECREATION. (3 cr)
Overview of the methods of financing public recreation, including the legal basis, current practices and procedures, and fiscal policies.

5-550. COLLEGE UNIONS. (3 cr; prereq 5-150, 8-120 or ‡) Zander
Administration, organization, and programming in college unions.

5-980. INTRODUCTION TO RESEARCH. (3 cr, §PE 5-980; prereq ‡) Chapman, Weiss
Basic techniques; emphasis on social research methodology; survey of present status of recreation and park research.

5-983. READINGS: RECREATION. (1-3 cr; prereq sr honor, grad, M.Ed. or ‡)
Independent study under tutorial guidance.

8-120. FOUNDATIONS OF RECREATION. (3 cr; prereq M.Ed., adult special or grad)
Investigation of the historical, sociological, and educational bases of the recreative use of leisure in contemporary society.

8-310. SEMINAR: RECREATION AND PARK ADMINISTRATION. (1-9 cr; required of Ed.D. interns, open to advanced M.A. and Ph.D. students; prereq △)
Critical study, supervised planning of field work experience, and special problems under guidance of an adviser.

8-370. SEMINAR: ADMINISTRATIVE PROBLEMS IN THERAPEUTIC RECREATION. (3 cr; prereq 5-150 or equiv) Chapman, Weiss
Examination of organizational patterns, legal aspects, interdepartmental relationships; discussion and case study approach.

8-380. SEMINAR: ADMINISTRATIVE PROBLEMS IN RECREATION AND PARKS. (3 cr; prereq 5-150 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.

8-620. PRACTICUM: COLLEGE UNIONS. (3-9 cr; prereq 12 grad cr in recreation)
Supervised experiences in program operation; administrative and supervisory duties.

8-630. PRACTICUM: THERAPEUTIC RECREATION. (3-9 cr; prereq 12 grad cr in recreation)
Supervised experiences in program operation; administrative and supervisory duties.

8-640. PRACTICUM: PUBLIC RECREATION AND PARKS. (3-9 cr; prereq 12 grad cr in recreation)
Supervised experiences in program operation; administrative and supervisory duties.

8-980.* RESEARCH PROBLEMS. (3 cr; prereq 5-980, PsyF 5-110 or ‡) Chapman
Designing, reporting on individual problems; required of all M.A. and Ph.D. candidates.

8-981.* RESEARCH PROBLEMS. (Cr ar; prereq 8-980 or ‡) Chapman
Individual problems.

SCHOOL HEALTH EDUCATION (Hlth)

5-100. DRIVER EDUCATION I. (4 cr, §SeEd 5-100; prereq △)
Materials and methods for driver education, building a plan for driver education for a specific school; behind-the-wheel training. Valid Minnesota driver's license required.

5-101. DRIVER EDUCATION II. (4 cr, §SeEd 5-101; prereq 5-100, △)
Second of three courses to meet Minnesota certification requirements after September 1, 1966.

5-110. SUPERVISION OF SCHOOL HEALTH AND PHYSICAL EDUCATION. (3 cr, §PE 5-110; prereq ‡) Jaeger, Slocum
Functions; adaptations of accepted procedures for observation, guidance, and training of teachers.

5-120. ROLE OF THE SCHOOL HEALTH EDUCATOR IN HEALTH APPRAISAL. (3 cr) Slocum
Role of school medical and dental advisers, nurse, teachers, and other school personnel in protection and maintenance phases.

5-130. SAFETY EDUCATION. (4 cr)
Scope and nature of the accident problem in our society; study of curricular areas leading to accident prevention.

5-140. ADMINISTRATION OF THE SCHOOL HEALTH PROGRAM. (3 cr) Slocum
Coordination of total program; health supervision and guidance; relationships between public schools and governmental health organizations and agencies; evaluation; guidance in the solution of individual professional problems.

5-150. CURRICULUM: FAMILY LIFE AND SEX EDUCATION IN THE SECONDARY SCHOOLS. (3 cr) Slocum
An in-depth study of concepts and appropriate materials for teaching in the junior and senior high schools.

5-300. CONTEMPORARY PROBLEMS IN SCHOOL HEALTH EDUCATION. (3 cr) Slocum
Instructional and individual problems.

5-350. FAMILY LIFE AND SEX EDUCATION IN THE ELEMENTARY SCHOOLS. (3 cr)
Research on sexual behavior of the pre-adolescent child; terminology, appropriate content, and effective methods for teaching.

5-400. TOPICS: EDUCATIONAL ASPECTS OF DRUG USE AND ABUSE. (3 cr, §PubH 5-032; prereq sr in education, cert tchr, or school nurse)
Basic background information on alcohol and other drugs and chemicals with emphasis on curriculum concepts, teaching methodology, materials and referral procedures appropriate for elementary, junior, and senior high school.

5-402. DEATH EDUCATION IN CONTEMPORARY SOCIETY. (3 cr, §PubH 5-040; prereq educ sr, cert tchr, school nurse, mortuary science major, ‡)
Basic background information on concepts and attitudes toward death, grief, and bereavement with emphasis on instructional aspects for the elementary and secondary schools; role of the school in suicide prevention.

5-602. THE DRIVER SIMULATOR. (4 cr, §SeEd 5-602; prereq 5-100, tchr in service, ‡)
Working with the simulator program to improve, expand, and reduce the cost of conventional driver education.

5-981. PROBLEMS. (Cr ar; prereq ‡)
Focus on teaching school health education.

5-983. READINGS: HEALTH EDUCATION. (1-3 cr; prereq ‡) Slocum
Independent study under tutorial guidance.

8-310. SEMINAR: SCHOOL HEALTH EDUCATION. (1-9 cr; required of Ed.D. interns, open to advanced M.A. and Ph.D. students; prereq △)
Critical study, supervised planning of field work experience, and special problems under guidance of adviser.

8-980.* RESEARCH PROBLEMS. (3 cr; prereq PE 5-980, PsyF 5-110 or ‡)
Designing, reporting on individual problems; required of all M.A. and Ph.D. candidates.

8-981.* RESEARCH PROBLEMS. (Cr ar; prereq 8-980 or ‡)
Individual problems.

Secondary Education (SeEd)

5-105. AUDIO-VISUAL MATERIALS IN EDUCATION. (3 cr) Pearson
Characteristics, advantages, limitations, and practical classroom use of audio-visual materials of nonprojected and projected types. Practice in operation of audio-visual equipment.

5-106. COORDINATING AN AUDIO-VISUAL EDUCATION PROGRAM. (3 cr; prereq 5-105 or ‡) Pearson
Criteria for equipment, facilities, and materials; in-service training of teachers; problems in schools or industry.

5-107. RADIO AND TELEVISION IN EDUCATION. (3 cr; prereq 9 cr in education) Pearson
Production, techniques of classroom use, selection of equipment, teaching appreciation, and the administration of radio and television in the schools.

5-108. NONPROJECTED AUDIO-VISUAL MATERIALS AND EQUIPMENT LABORATORY. (3 cr; prereq 5-105 or ¶5-105) Pearson
Planning and making nonprojected materials for audio-visual education; use of materials and equipment.

5-109. PROJECTED AUDIO-VISUAL MATERIALS AND EQUIPMENT LABORATORY. (3 cr; prereq 5-105 or ¶5-105) Pearson
Planning and making projected materials for audio-visual education; use of materials and equipment.

5-110. APPLIED INSTRUCTIONAL MEDIA EVALUATION AND SELECTION. (3 cr; prereq 5-105)
Analysis of traditional and newer types of audio-visual materials; emphasis on selection applied to content, learning situations and technical quality; opportunity for students to follow subject area and grade-level interests.

5-112. FAMILY LIFE EDUCATION. (3 cr)
Sources and types of materials available; techniques of family life education, preparation, and evaluation of instructional materials.

5-113. PRINCIPLES OF SECONDARY SCHOOL CURRICULUM. (3 cr; prereq 3-155 or equiv) Kimpston
Concepts and basic principles; forces influencing curricular objectives, organization, and construction; evaluation and trends.

5-114. INTERDISCIPLINARY APPROACHES TO CURRICULUM. (3 cr) Kimpston
Rationale, status and trends, design, operation of curriculum of an interdisciplinary nature.

5-129. TRENDS AND ISSUES IN SECONDARY CURRICULUM. (3 cr; prereq 5-113 or equiv)
Research findings and analysis of current proposals at the national, state, and local levels.

5-131. INSTRUCTIONAL SIMULATIONS AND LEARNING GAMES: DEVELOPMENT AND CLASSROOM USE. (3 cr)
Background, development factors, subject-matter models, and procedures for use of materials; analysis of the value of such material.

5-150. INTRODUCTION TO SOCIAL STUDIES EDUCATION. (3 cr)
Advanced methods for social studies teachers; prerequisite to other graduate level courses in social studies education.

5-152. TECHNIQUES OF INSTRUCTION IN SOCIAL STUDIES. (3 cr; prereq 5-150)
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.

5-153. NEW PERSPECTIVES IN THE SOCIAL STUDIES. (1-3 cr [max 12 cr])
Issues, materials, and instructional techniques related to current topics of particular relevance to social studies teachers.

5-154. SOCIAL STUDIES WORKSHOP. (3-9 cr)
Minnesota Project Social Studies curriculum.

5-155. MATERIALS LABORATORY FOR SOCIAL STUDIES TEACHERS. (3 cr; prereq 5-150, 5-152)
Locating, developing, and using audio-visual materials, learning programs, and simulations for use in social studies classes.

5-156. PRACTICUM IN SOCIAL STUDIES INSTRUCTIONAL TECHNIQUES. (1 cr; prereq 5-150, 5-152)
Includes production of video tape episodes to demonstrate competency in use of materials and techniques of instruction; required for all M.A., M.Ed., and Ph.D. candidates.

5-167. ECONOMIC EDUCATION PROGRAMS. (1-3 cr; prereq Econ 1-002 or equiv or ‡) Lewis
Conceptual framework of economic education through analyzing its research, objectives, philosophy, scope, and curricular sequence.

5-169. STUDENT ACTIVITY PROGRAMS IN SECONDARY SCHOOLS. (3 cr; prereq 3-155)
Values, purposes, and practices in organizing, sponsoring, and evaluating student activity programs.

5-170. PROGRAMS AND PROCEDURES OF CURRICULUM DEVELOPMENT. (3 cr; prereq 5-113 or Elem 5-100) Goossen, Kimpston
Leadership in procedures; operational processes; major considerations in planning and organizing; interpersonal relationships; and evaluation of improvement programs.

5-171. TEACHER SELF-APPRAISAL OBSERVATION SYSTEMS. (3 cr)
Analyzing videotapes in classrooms using a variety of interaction analysis coding instruments as a means of understanding, selecting, and broadening classroom behavior; dimensions and directions of coding.

5-172. SUPERVISION OF SECONDARY INSTRUCTION. (3 cr; prereq 5-113)
Achievement of appropriate teaching expectations focusing on problems of personnel responsible for their improvement.

5-173. PREPARATION OF CURRICULUM MATERIALS. (1-12 cr)
Principles and procedures for the selection, development, and organization of curriculum materials including learning packages, teacher-made games and simulations, units, courses of study, and curriculum guides.

5-177. DIRECTING SECONDARY SCHOOL SPEECH ACTIVITIES. (3 cr; prereq Spch 1-101 or 1-102, 1-106 or ‡)
Philosophy, organization, and administration of extemporaneous speaking, oratory, interpretive reading, and debate.

5-189. MATERIALS AND CURRICULUM CONSTRUCTION IN MODERN LANGUAGES. (3 cr; prereq 5-385, ‡) Birkmaier, Lange
Curriculum development, preparation of units, testing techniques; materials for classroom, language laboratory, televised instruction, and programmed learning.

5-191. WORKSHOP: TEACHING OF FOREIGN LANGUAGES. (1-10 cr [max 10 cr])
Related specifically to the needs of the in-service teacher; topics, location, and duration will be highly flexible.

5-192. FOREIGN LANGUAGE WORKSHOP: DEVELOPMENT OF MATERIALS AND SHORT COURSES FOR INDIVIDUALIZED INSTRUCTION. (3-12 cr)
For foreign language teachers to develop and test new types of curriculum materials in French, German, Russian, or Spanish including independent study units, learning packages, minicourses, quarter courses, small group projects, and enrichment materials to be tried out with high school students, revised and published for the benefit of teachers of the state.

5-194. CURRICULUM DEVELOPMENT IN SECONDARY ENGLISH AND SPEECH. (3 cr; prereq 3-326 or equiv) Piché, Shroyer
Analysis and evaluation of curricula and trends; emphasis on articulation.

5-195. SOURCES FOR CURRICULUM DEVELOPMENT IN ENGLISH AND SPEECH. (3 cr; prereq 5-194 or ‡) Piché, Shroyer
Implications from anthropology, sociology, psychology, rhetoric, dialectology and dialect geography, mathematical linguistics, logic, and semantics.

5-321. TEACHING LITERATURE IN SECONDARY SCHOOLS. (3 cr; prereq 3-155 or jr-sr high school tchg exper)
Background for guidance in reading of secondary school students; services of information and theory in development of program of instruction in literature.

5-322. TEACHING RHETORIC AND COMPOSITION IN SECONDARY SCHOOLS. (3 cr) Piché
Contemporary directions in rhetorical theory and analysis of recent curriculum developments bearing on the teaching of oral and written composition.

5-323. TOPICS IN LANGUAGE AND THE TEACHING OF ENGLISH. (3 cr)
Psychological, linguistic, philosophical, sociological perspectives on language; cognitive and affective implications of language in discourse and in art; minority dialects, developmental aspects of language use, comparative grammatical systems and implications for English curriculum development.

5-340. TEACHING OF SPEECH. (3 cr; prereq Spch 1-101 or 1-102, 1-106 or ‡)
Methods and techniques of teaching speech in the high school classroom; social framework of spoken communication and responsibilities of the individual speaker.

5-344. TEACHING READING IN SECONDARY SCHOOLS. (3 cr; prereq 9 cr in education)
Procedures, objectives, and materials for teaching reading in subject-matter fields.

5-347. 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.

5-349. WORKSHOP: SECONDARY READING INSTRUCTION. (1-12 cr [max 12 cr]; prereq ‡)
Principles, instructional techniques, and materials for teaching reading in secondary schools. Each offering will focus on a single topic.

5-350. CURRENT DEVELOPMENTS IN ENGLISH AND SPEECH EDUCATION. (1-6 cr [max 6 cr])
New instructional approaches, new materials, current issues, and problems in English and language arts education focusing on a single topic or issue with each offering.

5-371. WORKSHOP: CURRICULUM LABORATORY PRACTICE. (0-3 cr per qtr; prereq 5-113 or Elem 5-100, ‡) Graduate staff
Analysis and construction of units, courses of study, and curricula according to needs, interests, level, and specialization.

5-382. TESTING AND EVALUATION IN FOREIGN LANGUAGE TEACHING AND LEARNING. (3 cr; prereq PsyF 5-120)
Standardized achievement, proficiency, aptitude, and attitude tests in foreign languages; building test items for cognitive, affective, and psychomotor domains; techniques for evaluating curricula and teaching practices.

5-385. TOPICS IN THE TEACHING OF FOREIGN LANGUAGES. (3 cr) Birkmaier, Lange
Classroom procedure for individualized instruction, new curricula, teaching of culture and literature, use of media, evaluation of teaching.

5-390. CURRENT DEVELOPMENTS IN SECONDARY SCHOOL SCIENCE TEACHING. (3 cr; prereq 3-356, 3-357, 3-358, or 3-352, or equiv undergrad courses or exper in tchg science) Gennaro
Curricula, methods, materials of instruction, evaluation.

5-391. METHODS AND MATERIALS FOR TEACHING PHYSICAL SCIENCE. (3 cr; prereq 3-356, 3-357, 3-358, or 3-352 or equiv) Boeck
Individualized instruction in laboratory techniques and equipment with application to classroom use.

5-392. METHODS AND MATERIALS FOR TEACHING BIOLOGICAL SCIENCES. (3 cr; prereq 3-356, 3-357, 3-358, or 3-352 or equiv) Gennaro
Individualized instruction in laboratory techniques and equipment with applications to classroom use.

5-393. METHODS AND MATERIALS FOR TEACHING EARTH SCIENCES. (3 cr; prereq 3-356, 3-357, 3-358, or 3-352 or equiv) Boeck
Individualized instruction in laboratory techniques and equipment with applications to classroom use.

5-394. WORKSHOP: SCIENCE EDUCATION. (1-12 cr [max 12 cr])
Analysis of issues, materials, and instructional techniques on current topics of relevance to secondary school and college science teachers; each offering to focus on a single topic for varying credit.

5-396. METHODS OF TEACHING ENGLISH AS A SECOND LANGUAGE. (3 cr; prereq Ling 5-001 or ‡)
Principles of selection, sequencing, and presentation of instructional materials at various grade levels.

5-404. LANGUAGE, CULTURE, AND EDUCATION. (3 cr, §Spch 5-404)
Psychological and social-psychological perspectives for the study of language-communication; dimensions of language variation (dialects, codes, registers); implications for program development and instructional practices.

5-670/5-671. INTERNSHIP: SUPERVISION OF SOCIAL STUDIES STUDENT TEACHERS. (2 cr for 5-670, 1 cr for 5-671; prereq ‡)
On-the-job supervision of social studies student teachers; coordinating seminar.

5-673. INTERNSHIP: COLLEGE TEACHING IN SOCIAL STUDIES EDUCATION. (1-3 cr; prereq 5-150, 5-152, 5-155, 5-156, 8-104, 8-801 and/or ‡)
Individual and group experience in planning, teaching, and evaluating a college course in social studies education.

5-674, 5-675, 5-676. CLINICAL METHODS AND PRACTICES IN SPEECH PATHOLOGY. (Cr ar; prereq CDis 5-502, 5-503, 5-504, ‡)
Case histories and analysis; testing and diagnosis of speech defects; techniques and work programs; practical clinical work.

5-697. PRACTICUM: TEACHING ENGLISH AS A SECOND LANGUAGE. (3 cr; prereq 5-396 or ‡)
Supervised observation and teaching of classes in English for students whose native language is not English.

8-104. CURRICULUM DEVELOPMENT IN THE SOCIAL STUDIES. (3 cr; prereq 5-150, 5-152)
Analysis of curriculum building process in the social studies.

8-188.* SEMINAR: RESEARCH IN SECOND LANGUAGE LEARNING AND TEACHING. (3 cr; prereq 5-385, 8-869, doctoral student)
Evaluation of research in foreign language education; implications for teaching and learning; needed research; designing an individual study.

8-194. STRATEGIES AND PROBLEMS OF INSTRUCTION IN ENGLISH. (3 cr; prereq 3-326 or equiv)
Analysis of instructional problems in English and speech programs designed for secondary schools.

8-322. SEMINAR: SECONDARY CURRICULUM AND INSTRUCTION. (1 cr per qtr [total 3 cr]; prereq 5-113) Kimpston, Birkmaier
Implications and problems resulting from innovations in staff utilization, student grouping procedures, paraprofessional personnel, flexible scheduling, and technological devices.

8-340. WORKSHOP: IMPROVEMENT OF INSTRUCTION. (1-4 cr)
For school principals, superintendents, and supervisors responsible for instructional program to develop understanding of problems, kindergarten through secondary school; programs for gifted and handicapped; courses of study, planning.

8-341. SEMINAR: ADVANCED STUDY IN SUPERVISION AND CURRICULUM DEVELOPMENT. (1 cr per qtr [total 3 cr]; prereq 5-113, 5-170, 5-172, or Elem 5-101) Birkmaier, Kimpston
Theory, models, and research design. *Fall:* Effects of social policies on curriculum. *Winter:* Theory and research in curriculum. *Spring:* Strategy of change and supervision theory.

8-362. RESEARCH IN SOCIAL STUDIES. (3 cr, §Elem 8-362; prereq 5-152, 8-104)
Critical review of research findings and relevant theoretical formulations of major studies; criteria for appraising research methods; educational implications.

8-364. SEMINAR: SOCIAL STUDIES EDUCATION. (3 cr; prereq M.A. or equiv)
Current issues and readings in literature of the social studies.

8-387. SEMINAR: FOREIGN LANGUAGE EDUCATION. (1-3 cr; prereq ‡) Birkmaier, Lange
Topics in curriculum development, second language learning, and teacher preparation.

8-642. FIELD PRACTICUM: SUPERVISION AND CURRICULUM DEVELOPMENT. (1-3 cr; prereq 5-113, 5-170, or Elem 5-101)
Experience through internships and field service.

8-801.* PROBLEMS: TEACHING SOCIAL STUDIES. (3-9 cr; prereq 5-150, 5-152, 5-156, 8-104 or ‡)
Individual research.

8-805.* PROBLEMS: AUDIO-VISUAL EDUCATION. (Cr ar; prereq ‡) Pearson

8-807.* PROBLEMS: RADIO-TELEVISION EDUCATION. (1-3 cr per qtr; prereq 5-107) Pearson
For students whose work in SeEd 5-107 has indicated an aptitude or interest in the field.

8-825.* PROBLEMS: SECONDARY SCHOOL SUPERVISION. (Cr ar; prereq ‡)
An individual problems course on improvement of instruction.

8-869.* INFORMATION SOURCES IN FOREIGN LANGUAGE TEACHING AND RESEARCH. (3 cr)
Identifying and retrieving information; classification structures for compiling special bibliographies; preparing research reports and theses.

8-870.* SEMINAR: CURRICULUM, LEARNING, AND TEACHING OF FOREIGN LANGUAGES IN ELEMENTARY AND SECONDARY SCHOOLS. (3 cr; prereq 8-869, PsyF 5-110, M.A. student)
Discussion of research problems in preparation for planning small scale studies.

8-871.* PROBLEMS: CURRICULUM CONSTRUCTION. (Cr ar; prereq ‡) Birkmaier, Boeck, Gardner, Donovan Johnson, Stochl, Chase, Dykstra, Humphrey, Lambert, Manning, Odland, Gennaro, David C Johnson, Kimpston, Lange
Individual research.

8-887.* RESEARCH FOUNDATIONS OF SECONDARY SCHOOL SCIENCE TEACHING. (3 cr) Boeck
Review and analysis of research with implications for the improvement of instruction in junior and senior high schools.

8-892. INTRODUCTION TO RESEARCH IN ENGLISH AND SPEECH EDUCATION. (3 cr; prereq 15 hrs of grad study incl 5-321 or 5-322, 5-194, or ‡) Piché, Shroyer
Review and analysis of representative, current research, and research procedures related to the teaching of English and speech.

8-895. READINGS IN ENGLISH AND MODERN LANGUAGE EDUCATION. (1-3 cr) Birkmaier, Kegler, Lange, Piché, Shroyer
Readings in high school English or modern language instruction.

8-896.* PROBLEMS: TEACHING ENGLISH. (Cr ar) Kegler, Chase, Dykstra
For those qualified to undertake individual research.

8-897. RESEARCH IN ENGLISH AND SPEECH EDUCATION. (1-3 cr [total 6 cr])
Analysis and evaluation of research.

8-936. FIELD STUDY IN GENERAL CURRICULUM. (6-9 cr; prereq ‡) Birkmaier, Gardner, Kimpston, Williams
Required for Specialist in Education Certificate in curriculum; investigation and analysis of educational programs, problems, issues, or developments; emphasis on concerns in specific school settings.

BUSINESS EDUCATION (BsEd)

5-100. RESEARCH AND METHODS IN TEACHING ACCOUNTING AND BUSINESS DATA PROCESSING. (3 cr) Hopkins
Recent trends and developments.

5-101. RESEARCH AND METHODS IN TEACHING TYPEWRITING AND SHORTHAND. (3 cr) McLean
Application of research findings to classroom methodology.

5-102. TEACHING THE BASIC BUSINESS SUBJECTS. (3 cr) Hopkins
Recent trends and developments in teaching general business, economic geography, marketing, business law, and consumer education.

5-103. CONSUMER EDUCATION IN SCHOOLS. (3 cr) Hopkins
Objectives, content, and curriculum organization at elementary and secondary levels.

5-104. OFFICE COORDINATION TECHNIQUES. (3 cr, §DE 5-105)
Problems in the cooperative program; guidance and selection; placing students in offices; job adjustments; developing and evaluation of the training program.

5-106. ORGANIZATION AND SUPERVISION OF BUSINESS EDUCATION. (3 cr; prereq ‡) Hopkins, McLean
Examination of evaluative criteria for business education departments, teacher selection and supervision, and organization of business education in the U.S.

5-107. MATERIALS AND METHODS IN OFFICE AND STENOGRAPHIC PROCEDURES. (3 cr) McLean
Recent research and developments in teaching office practice, clerical practice, and office machines.

5-108. CURRICULUM CONSTRUCTION IN BUSINESS EDUCATION. (3 cr; prereq SeEd 5-113) Hopkins, McLean
Curriculum problems; organization and preparation of teaching units.

5-110. BUSINESS EDUCATION PROGRAMS BEYOND HIGH SCHOOL. (3 cr) Hopkins, McLean
Determining objectives and curricula for junior/community college, vocational-technical school, adult education, and collegiate business programs.

5-111. MATERIALS AND METHODS FOR A SIMULATED OFFICE COURSE. (3 cr) Hopkins, McLean
Course organization; methods; development and evaluation of objectives and materials.

5-112. PROGRAM DEVELOPMENTS IN BUSINESS EDUCATION. (1-12 cr [max 12 cr]) Hopkins, McLean
Developments emerging from research and local, state, and national programs and projects.

5-113. PHILOSOPHY OF VOCATIONAL BUSINESS AND OFFICE EDUCATION. (3 cr) Hopkins, McLean
Philosophy, objectives, history, developments, and current practices.

8-100. RESEARCH PROCEDURES IN BUSINESS EDUCATION. (3 cr; prereq ‡) Hopkins, McLean
Research design, techniques; preparation of reports; criteria for appraising methods; critical analysis of research completed in business education.

8-300. SEMINAR: RESEARCH IN BUSINESS, DISTRIBUTIVE, AND ECONOMIC EDUCATION. (No cr; prereq doctoral student or ‡) Hopkins, Lewis, McLean
Planning and evaluation of research and individual projects.

8-600. INTERNSHIP: BUSINESS EDUCATION. (3-12 cr) Hopkins, McLean
In-service experience in a business education specialist role, supervised experience in communication, planning, decision making, materials, curriculum development, and supervising and working with people.

8-900.* PROBLEMS: BUSINESS EDUCATION. (Cr ar; prereq ‡) Hopkins, McLean
Investigations in field of student's interest.

Vocational Technical Education (VoEd)

AGRICULTURAL EDUCATION (AgEd)

5-010.* RURAL EDUCATION AND COMMUNITY LEADERSHIP. (3 cr, §1-010; prereq ‡) Swanson
Role of school in rural community, coordination of school with nonschool educational agencies; responsibility for community leadership.

5-021. EDUCATION THROUGH EXTENSION METHODS. (4 cr; prereq grad or ‡) Norenberg
Role of nonschool agencies in rural and agricultural education; methods and techniques of formal and informal instruction in nonschool and school educational programs.

5-023. EXTENSION METHODS FOR AGRICULTURAL PRODUCTION IN DEVELOPING COUNTRIES. (2 cr)
Extension methods to promote the rapid adoption of improved agricultural practices.

5-028. AGRICULTURAL EDUCATION IN THE SECONDARY SCHOOLS. (5 cr; prereq SeEd 3-155 or ¶3-155) Peterson
Fundamentals for teaching production agriculture and agri-business to secondary school students; use of home, farms, and business and community in structuring and implementing educational programs; FFA, orientation to careers, records of planning and performance; developing and utilizing teaching units.

5-032. HIGH SCHOOL CURRICULUM IN AGRICULTURE. (3 cr; prereq 10 cr in education) Peterson
Philosophy, organization, and administration of instruction in agriculture departments in secondary schools.

5-033. TECHNIQUES OF INSTRUCTION IN RURAL ELECTRIFICATION. (3 cr; prereq AgEn 5-020) Bear
Developing a program of instruction in electricity and rural electrification; teaching aids, units of instruction, job sheets, and demonstration facilities and materials for adult, young farmer, and high school classes.

5-034. PROCEDURES IN TEACHING AGRICULTURE. (3 cr; prereq ‡) Persons, Peterson, Marvin
New developments in methodology; assessment of innovations and procedures; consideration of various levels of instruction.

5-035. 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.

5-049. AGRICULTURAL EDUCATION FOR ADULTS. (5 cr) Persons
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.

5-051. ENTERPRISE ANALYSIS. (3 cr; prereq ‡) Marvin, Persons
Analyzing the farm business as a basis for identifying problems; planning learning experiences to improve farm management at the high school, young farmer, and adult levels.

5-052. FARM BUSINESS MANAGEMENT EDUCATION. (3 cr; prereq 5-049 or ‡) Persons
Administration, organization, and operation of farm business management education programs for adults; development and utilization of curriculum materials based on farm business record data.

5-061. PROGRAM PLANNING AND EVALUATION. (4 cr) Copa, Marvin
Developing a program of agricultural education in a community school, integration with total school program, administrative relationships, techniques and use of program evaluation in planning.

5-065. EVALUATION OF LOCAL VOCATIONAL EDUCATION PROGRAMS. (3 cr) Copa, Marvin
Procedures and instruments for assessing the effectiveness of programs for employment bound youth and adults.

5-066. POLICY AND PROGRAM DEVELOPMENT IN AGRICULTURAL EDUCATION. (3 cr)
Appraisal of the situation in local schools and plans for improving the program development process.

5-070. SUPERVISED FARM PRACTICE IN VOCATIONAL AGRICULTURE. (3 cr per qtr [total 9 cr]; prereq 10 cr in education or ‡) Staff
Selection, planning, supervising, and summarizing of individual farming programs; adaptation to meet needs of high school FFA students, young farmers, adults.

5-071. SUPERVISED OCCUPATIONAL EXPERIENCES IN AGRICULTURE. (3 cr)
Organization and administration of an occupation experience program in agriculture for high schools and area schools.

5-072. PRACTICUM: AGRICULTURAL BUSINESS AND INDUSTRY. (1-3 cr per qtr [max 9 cr]) McMillion
Observation, study, and experience in agricultural business and industry; application to educational programs in agriculture.

5-080. ORGANIZATION AND MANAGEMENT. (3 cr; prereq ‡) Staff
Administrative structure and function of subcollegiate programs.

5-084. 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.

5-085. CAREER DEVELOPMENT IN AGRICULTURE EMPLOYMENT. (3 cr) Staff
Methods and materials in teaching career development for agricultural industries.

5-090. INDEPENDENT STUDY. (1-3 cr) Staff
Topics may be chosen to permit study of areas within education or to supplement areas of inquiry not provided in the regular course structure.

5-128. 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.

5-129. CURRICULUM PLANNING. (3 cr; prereq 5-128 or ¶; non-agricultural education major and/or ‡)
Methods and procedures in planning a curriculum to teach within a specific subject matter area; curriculum construction in the subject matter field for use in native country setting.

8-001.° RESEARCH IN AGRICULTURAL EDUCATION. (Cr ar; prereq 15 cr in education) Staff
Selecting problems, preparing bibliographies, analyzing and interpreting data, and preparing manuscripts.

8-010. CURRENT ISSUES IN AGRICULTURAL EDUCATION. (Cr ar; prereq ‡) Staff
Problems related to local school programs.

8-020. SEMINAR: AGRICULTURAL EDUCATION. (Cr ar) Staff

8-081. SUPERVISION OF VOCATIONAL AGRICULTURE. (1-3 cr; prereq ‡) Staff
Objectives, functions, responsibilities of state and local supervision at the secondary level; role in teaching-learning process; supervisory activities; aids to effective supervision.

8-082. ORGANIZATION AND ADMINISTRATION OF EDUCATIONAL PROGRAMS IN AGRICULTURE. (3 cr per qtr [total 9 cr]; prereq ‡) Staff
Philosophy, purpose, and objectives at the national, state, and local levels.

8-091. FIELD PROBLEMS. (3 cr) Staff
Making investigations, gathering data, and formulating plans regarding agricultural education.

8-303. SEMINAR: GRADUATE STUDIES REVIEW. (1-3 cr)
Review of graduate studies in agricultural education being planned or recently completed.

DISTRIBUTIVE EDUCATION (DE)

5-100. ORGANIZATION AND ADMINISTRATION OF DISTRIBUTIVE EDUCATION. (3 cr) Ashmun, Klaurens, Meyer
Principles, practices, and legislation followed in developing cooperative vocational and adult programs under federal vocational acts; basic course for teacher-coordinators and vocational administrators.

5-105. COORDINATION TECHNIQUES. (2 cr) Ashmun, Klaurens, Meyer
Problems of coordinators in cooperative vocational education; guidance and selection; placing students in work stations, assisting job adjustments, developing training program.

5-106. COORDINATION TECHNIQUES IN COOPERATIVE DISTRIBUTIVE EDUCATION. (2 cr; prereq 5-105 or ¶5-105) Ashmun, Klaurens, Meyer
Application in secondary and post-secondary cooperative and project plan programs; certification course for distributive education teacher-coordinators.

5-110. CURRICULUM IN COOPERATIVE VOCATIONAL EDUCATION. (2 cr) Klaurens, Meyer, Ashmun
Planning, organizing, implementing, and evaluating a cooperative vocational education curriculum.

5-111. CURRICULUM IN COOPERATIVE DISTRIBUTIVE EDUCATION. (2 cr; prereq 5-110 or ¶5-110) Ashmun, Klaurens, Meyer
Application in secondary and post-secondary distributive education; certification course for distributive education teacher-coordinators.

5-115. POST-SECONDARY BUSINESS AND DISTRIBUTIVE EDUCATION. (3 cr) Ashmun
Determining needs, curriculum, facilities, admission practices, placement and follow-up of students, teacher qualifications, interorganizational relations in junior college and area technical school programs.

5-116. MATERIALS LABORATORY: POST-SECONDARY DISTRIBUTIVE EDUCATION. (3 cr; prereq ‡) Ashmun, Klaurens, Meyer
New methods of instruction; development of materials for distributive education programs in junior colleges and area vocational-technical schools.

5-120. BUSINESS AND DISTRIBUTIVE PROGRAMS FOR ADULTS. (3 cr) Ashmun
Selection and training of evening school instructors; planning and promoting evening school distributive education classes.

5-125. ISSUES AND TRENDS IN DISTRIBUTIVE EDUCATION. (3 cr; prereq ‡) Meyer
Identification, analysis, and discussion of recent issues and trends; review and synthesis of research.

5-300. MATERIALS AND METHODS IN COOPERATIVE VOCATIONAL EDUCATION. (2 cr) Ashmun, Klaurens, Meyer
Basic course for teacher-coordinators of cooperative vocational education programs.

5-301. MATERIALS AND METHODS IN COOPERATIVE DISTRIBUTIVE EDUCATION. (2 cr; prereq 5-300 or ¶5-300) Ashmun, Klaurens, Meyer
For teacher-coordinators of cooperative and project plan distributive education; certification course for distributive education teacher-coordinators.

5-305. TEACHING MERCHANDISE DISPLAY. (3 cr; prereq ‡) Klaurens
Materials and methods; practice in using equipment.

5-310. MATERIALS LABORATORY: DISTRIBUTIVE EDUCATION. (3 cr; prereq 3-303 or 5-300 or ‡) Ashmun, Klaurens, Meyer
Development of specific related vocational materials for distributive occupations, cooperative vocational education classes.

5-311. MATERIALS LABORATORY: FASHION MERCHANDISING. (3 cr; prereq 3-303, 5-300, or ‡, ¶HE 5-641)
Development of specific related materials for fashion merchandising in distributive education classes.

5-315. MATERIALS LABORATORY: OCCUPATIONAL ADJUSTMENT. (3 cr; prereq 3-303, 5-300 or ‡) Ashmun, Klaurens, Meyer
Development of general related vocational materials for all types of cooperative vocational education classes.

5-320. TEACHING DATA PROCESSING IN DISTRIBUTIVE EDUCATION. (3 cr; prereq 3-303 or 5-300 or ‡)
Implementation and application of electronic data processing principles, concepts, techniques, and materials for high school and post-high school distributive education programs.

5-330. TEACHING SUPERVISORY TRAINING. (3 cr) Ashmun, Klaurens, Meyer
Conducting short unit courses for store and office supervisors and improving on-the-job training in cooperative vocational education programs.

5-340. DISTRIBUTIVE EDUCATION YOUTH ORGANIZATIONS. (3-4 cr; prereq distributive education major) Ashmun, Klaurens, Meyer
Organization, administration, and operation of local, state, and national distributive education youth groups; lab assignment included for students registering for 4 credits.

5-400. PROGRAM DEVELOPMENTS IN DISTRIBUTIVE EDUCATION. (1-12 cr [max 12 cr]; prereq ‡) Ashmun, Klaurens, Meyer
Problems, practices, methodology, and relationships on topics of concern to distributive education personnel.

8-300. SEMINAR: RESEARCH IN BUSINESS, DISTRIBUTIVE, AND ECONOMIC EDUCATION. (No cr; primarily for doctoral degree candidates; prereq ‡) Meyer, McLean
Planning and evaluation of research and of individual projects.

8-600. INTERNSHIP: DISTRIBUTIVE EDUCATION. (3-9 cr) Ashmun, Klaurens, Meyer
Practical participation in supervisory or teaching positions; in-service experience in leadership role; includes a seminar-related project; required for Specialist in Distributive Education Certificate.

8-900.* PROBLEMS: DISTRIBUTIVE EDUCATION. (Cr ar; prereq ‡) Ashmun, Klaurens, Meyer
Individual research.

HOME ECONOMICS EDUCATION (HEEd)

5-106. COORDINATION TECHNIQUES IN HOME ECONOMICS OCCUPATIONAL EDUCATION. (2 cr; prereq DE 5-105 or ¶DE 5-105) Whiteford
Application in secondary and post-secondary cooperative and project plan programs; certification course for home economics teacher-coordinators.

5-111. CURRICULUM IN HOME ECONOMICS OCCUPATIONAL EDUCATION. (2 cr; prereq DE 5-110 or ¶DE 5-110) Whiteford
Application in secondary and post-secondary home economics education; certification course for home economics teacher-coordinators.

5-300. HOME ECONOMICS CURRICULUM. (3 cr; prereq 3-530, ‡) Wantoch
Examination of research and literature; development of units of study and programs at elementary and secondary level; production and evaluation of materials.

5-301. MATERIALS AND METHODS IN HOME ECONOMICS OCCUPATIONAL EDUCATION. (2 cr; prereq DE 5-300 or ¶DE 5-300) Whiteford
For teacher-coordinators of cooperative and project plan home economics education; certification course for home economics teacher-coordinators.

5-305. HOME ECONOMICS CURRICULUM: COLLEGE LEVEL. (3 cr; prereq ‡) Whiteford
Examination of research and literature; course and program development in higher education; analysis of current college programs; production and evaluation of curriculum materials.

5-310. METHOD IN TEACHING HOME ECONOMICS: THEORY AND TECHNOLOGY. (3 cr; prereq 3-530, ‡)
Derivation of theory for educational method from relevant research; application to the educational objectives; analysis of technology related to teaching method.

5-315. EVALUATION: THEORETICAL AND TECHNICAL ASPECTS. (3 cr; prereq 3-530, ‡) Brown
Collecting and interpreting evidence related to achievement of objectives, emphasizing higher levels of cognition and affective behaviors.

5-320. ADULT EDUCATION IN HOME ECONOMICS. (3 cr; prereq 3-315 or ‡) Ford
Planning a community program; teaching procedures; special problems. Planned for teachers and supervisors of adult education.

5-325. TRENDS IN HOME ECONOMICS EDUCATION. (3 cr; prereq 5-300 or 5-305) Staff
Current status, purposes, programs, content emphasis, research, problems, and issues in the field.

5-330. SPACE, EQUIPMENT, FURNISHINGS, AND MATERIALS FOR HOME ECONOMICS DEPARTMENTS. (3 cr; prereq 3-305, 3-600, HE 1-401)
Remodeling old and planning new departments, and equipping and furnishing them; review of research; investigation of problems.

5-335. HOME EXPERIENCES AND THE EXTENDED PROGRAM. (3 cr) Ford
Place and procedures in directing home experiences in the high school program; effective use of the period of extended employment of homemaking teachers in the vocational program.

5-400. WORKSHOP: HOME PLANNING AND FURNISHING. (4 cr)
Problems at high school and adult levels; use of new materials and techniques; group and individual projects to meet the needs and interests of experienced teachers.

5-405. WORKSHOP: CHILD DEVELOPMENT AND HUMAN RELATIONS. (4 cr)
Recent emphasis on growth and guidance of individuals; materials and techniques for high school and adult levels to attain better understanding.

5-410. WORKSHOP: FOODS AND NUTRITION. (4 cr)
Problems in teaching at high school and adult levels; use of new materials and techniques; group and individual projects for experienced teachers.

5-415. WORKSHOP: MATERIALS FOR INSTRUCTION. (1-4 cr; prereq grad or tchr in service)
Problem in selection and use of new materials for instruction in home economics.

5-420. WORKSHOP: ADULT EDUCATION. (4 cr)
Procedures in teaching adults; planning the program; use of new materials and techniques; group and individual problems for experienced teachers.

5-425. WORKSHOP: HOME EXPERIENCE AND EXTENDED EMPLOYMENT. (4 cr)
Methods of using the extended period of employment effectively; techniques for selection, execution, and evaluation of home experiences; group or individual problems for experienced teachers.

5-430. WORKSHOP: CONTEMPORARY PROBLEMS IN HOME ECONOMICS EDUCATION. (4 cr; prereq ‡)
Integration of FHA experiences into on-going home economics education programs; group and individual problems of experienced teachers.

5-500. PROSEMINAR: HOME ECONOMICS EDUCATION. (2 cr; required of all new grad students) Brown
Relation of processes and standards of rational thought to professional competence and goals of graduate program of study.

5-600. PRACTICUM: ADULT EDUCATION. (3 cr; prereq ‡) Ford
Individual field assignments under supervision.

5-900. READINGS IN HOME ECONOMICS EDUCATION. (1-3 cr; prereq ‡) Brown, Ford, Whiteford
Independent study under tutorial guidance.

8-300. RESEARCH METHODS. (3 cr; prereq 5-315, ‡) Brown
Methods of inquiry; descriptive and causal-comparative methods with attention to experimentation.

8-305. RESEARCH METHODS. (3 cr; prereq 8-300, 9 cr in history and philosophy of education or history or philosophy, ‡) Brown
Historical and philosophical methods applied to problems of meaning, validity, value, and conceptual structure.

8-500. SEMINAR: CURRICULUM DEVELOPMENT. (2 cr; prereq 5-300 or 5-305, 8-300) Brown, Whiteford
Examination of philosophical, descriptive, and experimental research pertinent to the development of a theory of curriculum.

8-505. SEMINAR: SUPERVISION OF STUDENT TEACHING. (2 cr; prereq Educ 5-184)
Examination of research pertinent to purposes, procedures, evaluation, and interpersonal relations.

8-510. SEMINAR: IMPROVEMENT OF INSTRUCTION IN ADULT EDUCATION. (2 cr; prereq 5-320 or ‡) Ford
Examination of research and literature.

8-515. SEMINAR: TEACHER EDUCATION. (2 cr; prereq 5-300, 8-300, Educ 8-285) Ford
Research related to problems of selection and education of teachers of home economics and family life education; development of a theoretical framework.

8-520. SEMINAR: HISTORY AND PHILOSOPHY OF HOME ECONOMICS EDUCATION. (2 cr; prereq 5-325, 8-305) Brown
Examination of sources of data to trace the meaning of home economics as a field of study; relation of developments in the field of intellectual forces in the society; examination of conceptual foundations. Emphasis during any quarter may be on any one of these three areas.

8-525. SEMINAR: ADMINISTRATION AND SUPERVISION OF HOME ECONOMICS PROGRAMS. (2 cr; prereq 5-320, 8-520 or ‡...EdAd 8-201 or EdAd 8-253 recommended) Ford, Whiteford
Application of research and theory of educational administration to clarify the role of leadership in home economics.

8-530.* SEMINAR: HOME ECONOMICS EDUCATION. (1 cr per qtr) Brown, Ford, Whiteford
Discussion and reports.

8-900.* PROBLEMS: HOME ECONOMICS EDUCATION. (1-9 cr; prereq 8-300, ‡) Brown, Ford, Whiteford
Independent study of current educational problems.

INDUSTRIAL EDUCATION (Ind)

5-300. VOCATIONAL EDUCATION SURVEYS. (3 cr; prereq 5-314 or 5-325 or equiv) Moss
Practices and techniques in the study of communities or areas for the establishment or improvement of vocational courses and facilities.

5-301. TESTS IN INDUSTRIAL SUBJECTS. (3 cr; prereq SeEd 3-155) Kavanaugh, Pucel, Smith
Application of principles of evaluation to shop and drawing subjects.

5-302. THE GENERAL SHOP. (3 cr)
Lectures only; purpose of general shop organization; types of shops, equipment; instructional materials and procedures, pupil personnel plans.

5-303. INSTRUCTIONAL AIDS. (3 cr; prereq 3-360 or 5-560 or equiv) Kavanaugh, Randleman, Pucel
Planning, construction, use.

5-305. CRITICAL ISSUES IN INDUSTRIAL EDUCATION. (3 cr) Bjorkquist, Kavanaugh, Moss, Randleman, Smith
Identification, analysis, and discussion of major current problems in the field.

5-306. INDUSTRIAL EDUCATION WORKSHOP. (3 or 6 cr; prereq tchg exper, ‡) Staff
Areas of concentration vary with each offering.

5-309. 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.

5-310. COORDINATION. (3 cr; prereq 3-330 or 5-325 or ‡)
Duties and responsibilities of coordinators in trade schools, part-time programs, and comprehensive high schools.

5-312. SUPERVISION OF INDUSTRIAL EDUCATION. (3 cr; prereq 3-330 or 5-314)
Principles of creative supervision; duties, organization for supervision.

5-314. ADMINISTRATION OF INDUSTRIAL EDUCATION. (3 cr; prereq 3-330 or ‡) Nelson
General and vocational phases; objectives, programs, and practices; laws, rulings, and standards for aid; significant literature.

5-320. VOCATIONAL GUIDANCE. (3 cr; prereq SeEd 3-155) Kavanaugh, Pucel
History of educational and vocational guidance movement; typical public school means and methods; types and uses of occupational information; duties of the counselor; organization and relationships.

5-325. PHILOSOPHY AND PRACTICE OF INDUSTRIAL EDUCATION. (3 cr, §3-330) Kavanaugh, Moss, Smith
History, objectives, development, and current practices of the field.

5-330. INDUSTRIAL COURSE CONSTRUCTION. (3 cr, §3-340) Kavanaugh, Smith
Principles and techniques; experience in planning, organizing, and building a teaching guide.

5-360. INDUSTRIAL INSTRUCTION. (3 cr; prereq 3-340, SeEd 3-155, ‡) Moss, Smith, Randleman
Concepts and techniques of instruction in the industrial arts, trade and industrial schools and classes, and training-within-industry programs.

5-400. INSTRUCTIONAL MATERIALS LABORATORY FOR NONMAJORS. (3 cr; prereq tchg exper or ‡) Staff
For students needing manipulative skills and craftwork activities in their teaching; individual and group projects.

5-401. WORKSHOP: OCCUPATIONAL EDUCATION PROGRAMS FOR HANDICAPPED. (3 cr; prereq ‡) Nelson
Examination of exemplary programs in occupational education; workshop sessions involving directors of model programs and other personnel.

5-600. INSTRUCTIONAL MATERIALS LABORATORY. (3-6-9 cr; prereq minor, tchg exper, or ‡) Staff
Laboratory and shop experiences with new materials, processes, and equipment; development of complementary instructional materials.

8-300. LITERATURE OF INDUSTRIAL EDUCATION. (3 cr; prereq ‡)
Professional literature, organizations, leaders, and movements in the field.

8-310. RESEARCH. (3 cr; prereq ‡) Moss, Pucel, Smith
Analysis of existing research; selection of problems; organization and presentation of projects.

8-700. SEMINAR: INDUSTRIAL EDUCATION. (No cr) Bjorkquist and staff
Required of all candidates for advanced degrees.

8-900, 8-901, 8-902.* RESEARCH PROBLEMS. (3-6-9 cr per qtr; prereq approval of candidacy) Bjorkquist, Kavanaugh, Moss, Nelson, Randleman, Pucel, Smith
Individual conferences.

VOCATIONAL EDUCATION (VoEd)

8-100. VOCATIONAL EDUCATIONAL TUTORIAL. (3-18 cr; prereq ‡)
Selected fundamental vocational education propositions.

ELECTRICAL ENGINEERING (EE)**

Professor

William T. Peria, *head*
Allen Nussbaum, *director of graduate study*
Vernon D. Albertson
LeRoy T. Anderson
William F. Brown, Jr.
J. Alex Carruthers
Paul A. Cartwright
Keith S. Champlin
Lorne M. Chanin
Robert J. Collins
Morton Hamermesh
K. S. P. Kumar
Robert F. Lambert
E. Bruce Lee
Lawrence Markus
Hendrik J. Oskam
Otto H. Schmitt
Belle A. Shenoi
William G. Shepherd
Aldert van der Ziel
Raymond M. Warner, Jr.
Gottfried K. Wehner

Associate Professor

Bernard V. Haxby, *associate head*
Fredric N. Bailey
Richard P. Halverson
James E. Holte
Jack H. Judy
Stephen J. Kahne
Richard Y. Kain
Sidney C. Larson
Thomas S. Lee
John H. Park, Jr.
Mahmoud Riaz
Alfons A. Tuszynski
Frederick M. Waltz

Assistant Professor

G. Benjamin Hocker
Lawrence L. Kinney
William P. Robbins
Gary Y. Robinson
Rolf Schaumann
Edwin C. Thiede

Prerequisites—Graduate work leading to the M.S. in electrical engineering and the Ph.D. degree is open to students who have shown exceptional scholarship and ability in accredited undergraduate curricula in electrical engineering or physics. Consideration will be given to students who have completed another curriculum in engineering, science, or mathematics, including sufficient pertinent subject matter that would qualify the student to carry forward a graduate program in electrical engineering. In some instances, additional preparatory studies may be stipulated.

Language Requirement—For the M.S. degree, none. For the Ph.D. degree, a reading knowledge of one foreign language, acceptable to the Electrical Engineering Graduate Committee, or satisfactory completion of the department's program in oral paper presentation.

Master's Degree—Offered under Plan A or under Plan B.

Doctor's Degree—Work leading to the Ph.D. degree is offered. Research programs are established and facilities are available in areas such as acoustics, biomedical engineering, circuit theory, communications systems, computer systems, control systems, electronics, magnetism, microelectronics, microwave devices, noise and fluctuation phenomena, plasma studies, power systems, quantum electronics, semiconductors, surface and sputtering studies, and interdisciplinary studies in urban systems, environmental problems, and information sciences.

The general requirements for the Ph.D. are outlined at the beginning of this bulletin. The written preliminary examination is conducted by the department for prospective doctoral students twice each year. Students who enter the department with the M.S. degree or who obtain departmental permission to bypass the M.S. degree must take and pass the examination during their first academic year in residence. All other students must take and pass the examination before the end of their second academic year in residence in the Graduate School.

** Professional degrees in engineering are administered by the Institute of Technology.

Courses Acceptable Only in Satisfaction of the Minor Requirement

5-000/5-001. LINEAR SYSTEM ANALYSIS. (4 cr per qtr; prereq 1-501, Math 3-061)
Development of time-invariant linear models for electrical, mechanical, thermal, and acoustic systems; analysis of the models in time and frequency domains. Applications of transform techniques to linear systems. Introduction to feedback systems. Analog computer simulation. Spectral analysis, correlation, noise, and sampling.

5-000/5-001. HONORS COURSE: LINEAR SYSTEM ANALYSIS. (4 cr per qtr; prereq △)

5-010/5-011. NETWORK SYNTHESIS. (4 cr per qtr; prereq 5-001 or ‡)
Description of linear networks in the time and frequency domains. Properties of two- and three-element-kind networks. Approximation and realization problems in network synthesis. Design of RC, RL, LC, and RLC networks to realize driving-point and transfer functions and their applications.

5-055. LINEAR ELECTRONIC CIRCUITS. (4 cr; prereq 3-051, 5-001 or ¶5-001)
Electronic functions, device limitations, and biasing stability; frequency effects in single-stage, cascaded, and tuned amplifiers; power amplifiers. Introduction to design considerations.

5-056. ELECTRONIC CIRCUITS LABORATORY. (1 cr; prereq 3-402, ¶5-055; 2 lab hrs per wk)

5-060/5-061. APPLIED ELECTRONICS I, II. (4 cr per qtr; prereq 5-050, 5-055)
Multistage amplifiers; broad-band, feedback, tuned transistor amplifiers, noise in amplifiers. Charge-control analysis of nonregenerative and regenerative switching circuits. Tuned power amplifiers and oscillators. Parametric amplifiers. Analysis and design including laboratory investigation of design.

5-100. ELECTROMAGNETIC FIELDS III. (4 cr; prereq 3-101)
Application of Maxwell's equations. Transmission lines. Wave propagation, antennas and radiation.

5-110/5-111. APPLICATIONS OF ELECTROMAGNETIC THEORY. (4 cr per qtr; prereq 5-100 or equiv)
Maxwell's equations, Poynting vector, propagation and reflection of plane waves. Transmission lines, wave guides, and resonant cavities. Radiation, interference, and diffraction. Other selected topics.

5-150. ELECTRICAL ENGINEERING MATERIALS. (4 cr; prereq 3-101, Phys 3-500)
Electric, magnetic, and dielectric properties of materials as related to devices used in electrical engineering.

5-160/5-161. PHYSICAL ELECTRONICS. (4 cr per qtr; prereq 3-050 or ‡)
Physical principles underlying devices used in electrical engineering; elementary quantum and statistical mechanics, semiconductor properties, electron emission from surfaces, special topics of current interest.

5-200/5-201. COMMUNICATIONS. (4 cr per qtr; prereq 5-001, Stat 3-092)
Theoretical and laboratory study of selected topics in electric communications. Spectral analysis; modulation theory and the effect of noise in modulation systems; multiplex systems, optimum filtering.

5-250/5-251. CONTROL SYSTEMS. (4 cr per qtr; prereq 5-001, Math 3-061, or ‡)
Analysis and applications of typical linear control elements, analysis and design of linear control systems in the frequency and time domains, using such techniques as Bode, Nyquist, and root-locus methods; analytic and graphical treatment of system stability.

5-300. ELECTROMECHANICS. (4 cr; prereq 3-101, 5-001 or ¶5-001)
Energy considerations in electromechanical devices; linear and nonlinear analysis of electromechanical energy converters; characteristics of specific rotary converter types obtainable from a generalized rotating machine.

5-301. ELECTROMECHANICS LABORATORY. (1 cr; prereq 3-402, ¶5-300)

5-310/5-311. ELECTRIC POWER SYSTEMS. (4 cr per qtr; prereq 5-001, 5-300)
Modern electric power system technology; response of rotating machines; complete electric power system: generation, transmission, distribution, and utilization. Balanced and unbalanced polyphase systems. Stability analysis of power systems. Digital computer applications to power system problems.

5-320/5-321. APPLIED ELECTROMECHANICS. (4 cr per qtr; prereq 5-001, 5-300, or ‡)
Theory and application of translational and rotational electromechanical converters; transducers, sensors, and machines. Formulation of dynamic equations and methods of solution. Properties of materials, consideration of limitations they impose on device performance.

5-330/5-331. DIRECT ENERGY CONVERSION. (4 cr per qtr; prereq 3-050, 5-100, ME 3-300)
Photoelectric, thermoelectric, thermionic, magnetohydrodynamic, and phase-change energy converters. Kinetic and transport properties of materials; interaction with electric, magnetic, thermal, and mechanical fields. Applications and limitations of typical converters.

5-350/5-351. PRINCIPLES OF COMPUTER ENGINEERING. (4 cr per qtr, §5-851/5-852; prereq 3-001 or 5-050 or ‡)
Boolean algebra and combination logic. Analysis and synthesis of sequential circuits. Design of digital systems and digital computers.

5-450. SPECIAL INVESTIGATIONS. (Cr ar [may be repeated]; prereq △)
Studies of approved topics, theoretical or experimental in nature.

Courses Acceptable in Satisfaction of Either Major or Minor Requirements

5-500. LINEAR NETWORK THEORY I. (3 cr; prereq 5-001 or equiv)
Properties and synthesis of the driving point and transfer functions of two- and three-element-kind networks. Theory of positive real functions.

5-501/5-502. LINEAR NETWORK THEORY II, III. (3 cr per qtr; prereq 5-500 or equiv)
Relationship between parts of network functions. Approximation theory. Design of filters and pulse networks. Properties of reciprocal and nonreciprocal N-port networks. Synthesis of one-port and two-port networks using gyrators.

5-503/5-504. LINEAR ACTIVE NETWORKS. (3 cr per qtr; prereq 5-500 or equiv, ¶5-501/5-502)
Network models of active devices. Analysis and synthesis of single-stage and cascaded amplifiers. Theory of feedback amplifiers and stability. Design of single-loop and multistage feedback amplifiers. Bandpass amplifiers.

5-550/5-551/5-552. SWITCHING AND DIGITAL CIRCUITS. (3 cr per qtr; prereq 5-050, 5-055, or ‡)
Transient response of junction diodes, bipolar, and field-effect transistors; large-signal models of semiconductor devices; bistable, monostable, and astable semiconductor circuits in discrete and microelectronic forms; phase-plane analysis of large-signal oscillators; digital logic circuits, comparison of discrete and integrated circuits; calculation of circuit response by approximate methods and by digital computer; verification of circuit solutions by laboratory examples and problems.

5-600/5-601/5-602. ELECTROMAGNETIC THEORY. (3 cr per qtr; prereq 5-100, 5-101 or equiv, grad standing or ‡)
Fields and waves with attention to mathematical formulation. Maxwell's equations and boundary value problems. Plane waves, transmission lines, wave guides, and resonators. Microwave networks. Inhomogeneous, anisotropic, and ionized media. Diffraction theory and optical resonators. Parametric systems.

5-650. DYNAMICAL METHODS IN ELECTRICAL ENGINEERING. (3 cr; prereq AEM 3-036 or equiv, Math 1-260 or ‡)
Lagrangian and Hamiltonian formulations of dynamics, with applications to electromagnetic systems. Lagrange's equations; dissipative forces; normal coordinates and small oscillations; Hamilton's equations; variational principles for discrete and continuous systems.

5-651. THERMODYNAMIC METHODS IN ELECTRICAL ENGINEERING. (3 cr; prereq 5-650 or ‡)
Basic thermodynamic concepts and laws, with special application to eletromagnetic 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.

5-652. STATISTICAL-MECHANICAL METHODS IN ELECTRICAL ENGINEERING. (3 cr; prereq 5-650 or ‡)
Classical and quantum-statistical mechanics, with application to materials and problems of electrical engineering. Statistical ensembles, phase space, Liouville's theorem, the canonical ensemble, the partition function. Classical and quantum statistics. Relation between statistical mechanics and thermodynamics. Classical and quantum calculations of susceptibilities.

5-653. INTRODUCTORY QUANTUM MECHANICS FOR ENGINEERS. (3 cr; prereq grad standing or ‡)
Principles of quantum mechanics for students with engineering background; intended as preparation for solid state materials or quantum electronics. Wave equation, operator formalism, angular momentum, perturbation theory.

5-660/5-661/5-662. SEMICONDUCTOR PROPERTIES AND DEVICES. (3 cr per qtr; prereq grad standing or ‡)
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 design.

5-700/5-701. INFORMATION THEORY AND CODING. (3 cr per qtr; prereq Stat 3-092 or ‡)
5-700: Binary arithmetic, logic; discrete information sources and channels, coding, the binary channel and Shannon's second theorem. 5-701: The continuous channel; error detection and correction codes, random coding; channels with feedback, the two-way channel.

5-702. STOCHASTIC PROCESSES AND OPTIMUM FILTERING. (3 cr; prereq grad in electrical engineering or ‡)
Stochastic processes, stationarity, independence, transformations of stochastic processes, ergodicity; correlation and power spectrum; the matched filter, the Wiener filter.

5-703. MODULATION SYSTEMS. (3 cr; prereq 5-702 or 5-753)
Mathematical models and effects of noise on modulation systems such as AM, FM, and PCM. Telemetry and space communication systems.

5-704. SIGNAL DETECTION AND ESTIMATION THEORY WITH APPLICATIONS. (3 cr; prereq 5-702 or ‡)
Risk theory approach to detection and estimation. Binary and multiple alternative detection of phase, frequency and epoch time of signal. Applications to current electronic systems.

5-750/5-751. SYSTEM ANALYSIS AND OPTIMUM CONTROL. (3 cr per qtr; prereq 5-001 or equiv or ‡)
5-750: Linear algebra and matrix differential equations; linear system representation; stability of linear systems via Lyapunov's Direct Method; structure of linear systems; controlability and observability, sensitivity analysis of linear systems. 5-751: Problem formulation and mathematical modeling; variational techniques and perturbation theory; mathematical programming; game theory; geometric theory of optimum control.

5-752. NONLINEAR SYSTEM DESIGN. (3 cr; prereq 5-750 or ‡)
Graphical, approximate, analytical and numerical techniques in nonlinear system analysis and design; stability of nonlinear systems. Use of computers in system design.

5-753. LINEAR STOCHASTIC SYSTEMS. (3 cr; prereq grad standing or ‡)
Random signals in linear systems; linear filtering, prediction and estimation; parameter estimation in identification problems; adaptive and learning systems.

5-800/5-801. POWER SYSTEM ANALYSIS. (3 cr per qtr; prereq 5-500 or equiv, 5-750, CICS 5-301 or ‡)
Matrix representation of large power systems. Formulation and modification of network matrices. Numerical and computer methods of solution. Applications to fault calculations, load-flow studies, stability studies and loss formulas.

5-851/5-852/5-853. DIGITAL COMPUTER SYSTEMS. (3 cr per qtr; prereq grad standing or ‡)
5-851: Boolean analysis and synthesis with practical logic circuits. Sequential circuit theory and practical design techniques. Switching hazards and races. 5-852: Digital systems design. Flow charts and bar charts. Clock generation and control. Interregister transfer control. Sequence counter design. 5-853: Digital computer design. Instruction classes and sequences. Memory systems. Digital arithmetic system design. Input-output techniques.

8-000/8-001/8-002.‡ ADVANCED TOPICS IN NETWORK THEORY. (3 cr per qtr; prereq 5-502, Math 5-572 or ‡ for 8-000...5-502, 5-750 or ‡ for 8-001 or 8-002)
8-000: Active RC network synthesis, sensitivity considerations. Analysis of distributed RC networks. Time-varying systems and networks. 8-001: Computer analysis of linear networks. Computer-aided design of lumped passive and active networks. Computer analysis of time-varying systems. 8-002: Selected topics in current literature.

8-090. ELECTRONICS SEMINAR. (Cr ar [may be repeated for cr]; prereq ‡)
Current literature; individual assignments.

8-100/8-101/8-102. PROBLEMS IN ELECTROMAGNETISM. (3 cr per qtr; prereq 5-602 or equiv, ‡)
Static electric and magnetic fields. Antennas, free-space transmission, refraction and diffraction phenomena, wave guides, and circuits.

8-110/8-111/8-112. PLASMA PHYSICS. (3 cr per qtr; prereq 5-652 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.

8-120/8-121/8-122. 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.

8-140. SEMINAR: PLASMA PHYSICS. (Cr ar [may be repeated for cr]; prereq ‡)
Current literature; individual assignments.

8-143. SEMINAR: MODERN OPTICS. (Cr ar [may be repeated for cr]; prereq ‡)
Current literature; individual assignments.

8-150/8-151. SOLID STATE PHYSICS. (3 cr per qtr; prereq 5-653 or ¶Phys 5-151/5-152 /5-153 or ‡)
(Same as Phys 8-221/8-222/8-223) Fundamental properties of crystals; dynamics of the lattice and of electrons in a periodic structure; effects of electric and magnetic fields on metals.

8-152. MAGNETIC PROPERTIES OF SOLIDS. (3 cr; prereq 5-652, 8-151 or ‡)
(Same as Phys 8-232) Properties of magnetic materials in relation to exchange interactions and elementary spin excitations.

8-153/8-154/8-155. PROPERTIES OF SEMICONDUCTORS. (3 cr per qtr; prereq 8-151, ‡)
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. Untilization of semiconductor properties in devices, especially devices of current importance.

8-156/8-157/8-158. FERROMAGNETISM AND RELATED PHENOMENA. (3 cr per qtr; prereq 5-652 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.

8-160/8-161/8-162. QUANTUM ELECTRONICS. (3 cr per qtr; prereq 5-652, 5-653, 5-602 or ‡)
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.

8-170/8-171/8-172. 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.

8-190. SEMINAR: QUANTUM ELECTRONICS. (Cr ar [may be repeated for cr]; prereq ‡)
Current literature; individual assignments.

8-191. SEMINAR: SURFACE PHYSICS. (Cr ar [may be repeated for cr]; prereq ‡)
Current literature; individual assignments.

8-200/8-201/8-202. TOPICS IN STATISTICAL THEORY OF COMMUNICATION. (3 cr per qtr; prereq 5-702 or 5-753, Math 5-331 or Stat 5-133, or ‡)
Optimum detection of signals in noise, estimation of signal parameters, sequential and adaptive techniques in detection and estimation. Recent advances in statistical communication theory. Selected special topics.

8-240. SEMINAR: COMMUNICATION. (Cr ar [may be repeated for cr]; prereq ‡)
Current literature; individual assignments.

8-250/8-251/8-252. 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.

8-253. LARGE-SCALE SYSTEM MODELS. (3 cr; prereq ‡)
Introduction to complex, multidisciplinary systems. Concepts useful in modeling of large systems; topological approaches; generalized network and bond graphs. Economic variables and models. Determination of variables and subsystem models. Examples from physical, economic, and business systems.

8-254. STRUCTURAL TECHNIQUES IN ANALYSIS AND CONTROL OF LARGE SCALE SYSTEMS. (3 cr; prereq ‡)
Use of structural information in the analysis and control of large systems. Structural features encountered in large systems. Partitioning, tearing, simplification, and aggregation as tools in analysis and control of interconnected and hierarchial systems.

8-255. CONTROL AND OPTIMIZATION IN LARGE-SCALE SYSTEMS. (3 cr; prereq ‡)
Goal setting in systems; utilities and preferences; decision analysis. Mathematical programming in complex systems; decomposition of programming and systems problems. Optimization and decision analysis in interconnected and hierarchial systems.

8-260/8-261/8-262. NONLINEAR SYSTEMS. (3 cr per qtr; prereq Math 5-512, ‡)
Nonlinear aspects of control systems: analytical and graphical methods of analysis and synthesis; stability studies via the method of Lyapunov; synthesis of dual-mode and relay control systems; nonlinear systems subjected to random input; nonlinear filtering and estimation and their application to optimal control synthesis.

8-290. SEMINAR: CONTROL THEORY. (Cr ar [may be repeated for cr]; prereq ‡)
Current literature; individual assignments.

8-291. SEMINAR: SYSTEM THEORY. (Cr ar [may be repeated for cr]; prereq ‡)
Current literature; individual assignments.

8-300/8-301/8-302. ADVANCED POWER-SYSTEM TOPICS. (3 cr per qtr; prereq 5-801 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.

8-340. SEMINAR: ELECTRIC POWER. (Cr ar [may be repeated for cr]; prereq ‡)
Current literature, individual assignments in the areas of power systems and electromechanics.

8-341. 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 which exploit these processes.

8-350. MODELS FOR COMPUTING MACHINES. (3 cr; prereq 5-851 or ‡)
Descriptions of finite-state machines, derivations of machines from descriptions and vice versa. Infinite-state machines with access constraints; push-down automata; turing machines. Relationships with recursive function theory and formal languages. Some emphasis on the relationships between the models and actual machines.

8-351. ADVANCED COMPUTER SYSTEMS. (3 cr; prereq 5-852 or ‡)
Currently existing and proposed computer systems. Modern systems design languages. Influence of user languages on systems design. Stack machines; syntax-free machines; highly parallel machines; the Holland machine and the Solomon computer. Selected topics in multiprogramming and multiprocessing techniques.

8-352. ADVANCED SWITCHING THEORY. (3 cr; prereq 5-851 or ‡)
Review of classical Huffman-Mealy-Moore sequential machine theory. Minimization of completely and incompletely specified machines. Linear sequential machines and binary sequence generators. Selected topics such as Hartmanis-Stearns partition theory, probabilistic automata, and various special automata.

8-450. SPECIAL INVESTIGATIONS. (Cr ar [may be repeated]; prereq △)
Studies of approved topics, theoretical or experimental in nature.

8-451. ADVANCED TOPICS IN ELECTRICAL ENGINEERING. (Cr ar [may be repeated]; prereq ‡)
Topics vary according to needs and available staff.

ENGLISH

Professor

William A. Madden, *chairman*
Chester G. Anderson
Bernard Bowron
John W. Clark
Thomas S. Clayton
Charles Foster
Chadwick Hansen
J. Dennis Hurrell
Joseph J. Kwiat
Andrew MacLeish
Robert E. Moore
Gordon W. O'Brien
William A. Rosendahl
James L. Scoggins
Martin Steinmann, Jr.
Mary Turpie
Leonard Unger
George T. Wright

Associate Professor

Edward M. Griffin, *director of graduate study*
Paul K. Alkon
Kent Bales
Margery S. Durham
Peter Firchow
David Haley
Calvin B. Kendall
Archibald I. Leyasmeyer
John J. McNally
Toni A. McNaron
Peter J. Reed
Martin Roth

Assistant Professor

Lonnie J. Durham
Phillip G. Furia
Arthur I. Geffen
Gordon Hirsch
J. Lawrence Mitchell
Francis Nye
Donald Ross
Robert D. Solotaroff
Charles J. Sugnet

The program outlined below represents a substantial change from the English department's former program. By fall, 1972, some additional changes may be instituted. For details, write the director of graduate study, 205 Main Engineering.

Prerequisites—For major work, not less than 28 quarter credits in English literature, 12 of which must be of upper division grade, including satisfactory courses in Chaucer, Shakespeare, and Milton. Students who have a good record in their 28 quarter credits in English literature but have not had courses in all three of the authors named may be allowed to make up some of those courses concurrently with their graduate program.

For minor work, not less than 18 quarter credits in English literature including a course in Shakespeare.

Candidates will ordinarily find it necessary to supplement their undergraduate work by a considerable amount of independent reading.

Before registering for their first quarter of graduate work, students should consult the director of graduate study for the department.

Special Regulation Regarding Examinations for the M.A. and the Ph.D. During the Summer Session—Written examinations for both the M.A. and the Ph.D. are ordinarily given, during the summer session, in the first term only. Oral examinations are given in neither term except for students who are certain that they will be neither in residence nor in the nearby area during the following fall quarter.

Additional information may be found in the following documents, obtainable in 205 Main Engineering: *Manual for Graduate Students in English, A Sample M.A. Examination, M.A. Examination Reading List, Annual List of 'Topics and Figures' Courses,* and the *English Department Bulletin.*

Requirements for the Degree of Master of Arts (Plan B)

Courses—45 credits; including at least 21 in courses in English listed under Language and Literature, and at least 18 in two or more "Related Fields," which *may* include Old and Middle English, American Literature, Composition, and The English Language, but *must* include at least two courses in one department other than the English department.

All candidates will take one quarter of seminar work, and a course in the English language or linguistics if they have not previously taken one.

Papers—Three 5,000-word papers. For details, refer to the *Manual for Graduate Students in English,* which is obtainable in 205 Main Engineering.

Examination—A written examination for the M.A. is given in the fall and spring quarters and in the first term of Summer Session (see Special Regulation above). A sample examination may be consulted in 205 Main Engineering.

Language—A reading knowledge of one of the following languages is required: Greek, Latin, French, German, or Italian. A candidate may, upon petition to the director of graduate study, satisfy the requirement with a language not on this list. The requirement may be satisfied in one of two ways, either by examination, or by completing at the college level at least 15 quarter credits in the language with a grade of A or 20 quarter credits with an average grade of B. There are special programs of course work satisfying the requirement in French, German, Italian, and some other languages. For details, consult the director of graduate study.

(Candidates with unusually thorough preparation may be permitted to follow the Plan A program, which calls for less course work and for the writing of a Master's thesis. For details, consult the director of graduate study in 205 Main Engineering.)

Requirements for the Degree of Doctor of Philosophy

Admission—All candidates will take a written Ph.D. qualifying examination. For students who have taken a Minnesota M.A., a high pass on the M.A. written examination satisfies this requirement.

Program—Candidates for the Ph.D. design their own programs with the help of a graduate adviser and the approval of the director of graduate study. On passing the Ph.D. qualifying examination, they should begin to construct a coherent and unified program of doctoral studies of which the logical last stage will be the preparation of a dissertation. For some students such a program will involve specialization in a particular area of study: students may choose, for example, to concentrate on Victorian studies and take courses not only in English but in history, political science, theology, and other relevant fields; or, they may choose to concentrate on the British or American literature of a specific period (probably not less than 150 years) and elect courses that will help them master it. Other students may choose a less concentrated kind of program and take courses over a broader spectrum of literary and humanistic studies but in some pattern that gives shape to the total program and permits a dissertation to emerge from it.

Courses—Each student's program will include the following (some of these requirements may be satisfied by the same course or courses; some will probably have been taken earlier):

1. Engl 8-011 (Introduction to Advanced Literary Study). This course should be taken during the first quarter of graduate study.
2. Two courses in literary criticism.
3. Three courses in English language or linguistics (courses in Old English literature and one course in Middle English literature exclusive of Chaucer may be used to satisfy this requirement).
4. Five quarters of seminar work.
5. A minor or "supporting program" of 20 credits, of which at least 8 will normally be taken outside the English Department. For details, consult the director of graduate study.

Examinations—In designing their program of studies with the help and approval of their adviser and of the director of graduate study (whom they should consult early in their residence), students will compile a list of 50-75 primary and secondary works drawn from the area of their doctoral studies, and it is on these works that their preliminary oral examination will be chiefly based, after which they will proceed to the writing of a dissertation. A final oral examination will be given to candidates on completion of their thesis and certification by their committee that it is ready for defense.

Language Requirement—The candidate is required to have a *thorough* reading knowledge of Greek, Latin, French, German, or Italian, or a demonstrated competence in two of these languages. Special exceptions may be made upon petition. A "thorough" reading knowledge ordinarily will be demonstrated by the candidate's taking and passing with a grade point average of at least 3.25 a minimum of twelve credits of course work *at the graduate level* (i.e., in courses 5-000 and above) in one of the appropriate language departments. Such courses may be included in the candidate's supporting program: see the director of graduate study for details.

The Graduate Minor in English

Prerequisites—Not less than 18 quarter credits in English literature, including a course in Shakespeare.

Candidates for the Master's degree (Plan A) taking a minor in English should consult the director of graduate study in the Department of English.

American Studies or Comparative Literature—Students interested in major work in these programs should see the American Studies and Comparative Literature sections in this bulletin.

Language and Literature (Engl)

5-111—5-117. SURVEY COURSES IN BRITISH LITERATURE. (4 cr each)

Historical surveys of important authors, intellectual currents, movements, conventions, genres, and themes. Lecture courses with emphasis on wide reading. No papers.

5-111. Old and Middle English Literature
No knowledge of Old English is required; some familiarity with Middle English would be helpful.

5-112. Sixteenth-Century Literature

5-113. Seventeenth-Century Literature

5-114. Eighteenth-Century Literature

5-115. Romantic Literature

5-116. Victorian Literature

5-117. Twentieth-Century Literature

5-151. THE EIGHTEENTH-CENTURY ENGLISH NOVEL. (4 cr)
Selected novels by such authors as Defoe, Richardson, Fielding, Smollett, Sterne, and Jane Austen.

5-152. THE NINETEENTH-CENTURY ENGLISH NOVEL. (4 cr)
Selected novels from the Romantic and Victorian periods by such authors as Scott, Dickens, the Brontës, Thackeray, Eliot, and Hardy.

5-153. THE TWENTIETH-CENTURY ENGLISH NOVEL. (4 cr)
Selected novels by such modern authors as Conrad, Ford, Joyce, Woolf, Lawrence, Forster, Cary, and Waugh.

5-171. MEDIEVAL, TUDOR, AND ELIZABETHAN DRAMA. (4 cr; prereq 3-241 or 3-242)
Mystery plays, moralities, interludes, academic and court plays; plays of Kyd, Marlowe, Lyly, Greene, and Peele.

5-172. JACOBEAN AND CAROLINE DRAMA. (4 cr; prereq 3-241 or 3-242)
Selected plays of Jonson, Tourneur, Webster, Middleton, Ford, and others.

5-173. RESTORATION AND EIGHTEENTH-CENTURY DRAMA. (4 cr; prereq 3-241 or 3-242)
The heroic play, tragedy, comedy of manners, and sentimental comedy.

5-174. DRAMA FROM ca. 1800 TO ca. 1920. (4 cr)
Beginnings of modern realism, naturalism, and expressionism in English and Continental drama.

5-175. DRAMA SINCE ca. 1920. (4 cr)
Survey of chief dramatists, English, American and Continental.

5-211f,w. OLD ENGLISH (ANGLO-SAXON). (5 cr)
Introduction to sounds and grammar with some prose reading. Relation to modern English stressed.

5-212w. READINGS IN OLD ENGLISH PROSE AND VERSE. (4 cr; prereq 5-211)
Critical reading of texts, and introduction to versification.

5-213s. BEOWULF. (4 cr; prereq 5-211)
Introduction to the Old English poem, with reading of considerable portions of text.

5-215. MAJOR TYPES OF MIDDLE ENGLISH LITERATURE. (4 cr; prereq 5-221)
Readings in Middle English, in romance, lyric, allegory, and devotional prose.

5-216. MAJOR FOURTEENTH-CENTURY POETS. (4 cr; prereq 5-221)
Readings in Gower, Langland, and the Pearl-poet.

5-221f,w,s. CHAUCER. (5 cr)
Readings of selections from *The Canterbury Tales,* with an introduction to grammar and literary forms of 14th-century English.

5-222w/5-223s. ADVANCED CHAUCER. (4 cr per qtr; prereq 5-221 or equiv)
Review of *The Canterbury Tales*; reading of the longer poems.

5-230. SPECIALIZED STUDIES IN RENAISSANCE LITERATURE AND CULTURE. (4 cr)
Topics will be specified in *Class Schedule.*

5-231. RENAISSANCE PROSE. (4 cr)
Readings in works of such authors as Elyot, Ascham, Hooker, Lyly, Sidney, Donne, Bacon, Burton, and Browne.

5-233. TUDOR AND ELIZABETHAN POETRY. (4 cr)
Readings in works of 16th-century poets, with attention to sonnet cycles.

5-243, 5-244. ADVANCED SHAKESPEARE I AND II. (4 cr per qtr; prereq 3-241 and 3-242)
Intensive study of a few plays. Courses are not strictly sequential.

5-247. SPENSER. (4 cr)
Readings in *The Faerie Queene, The Shepheardes Calendar, Amoretti,* and other poems.

5-253. JACOBEAN AND CAROLINE POETRY. (4 cr)
Readings in nondramatic poetry of earlier 17th century, commonly emphasizing works of Donne and Jonson and their successors.

5-255, 5-256. SEVENTEENTH-CENTURY PROSE AND POETRY TO 1660. (4 cr per qtr)

5-261f,w,s. MILTON. (4 cr)
Paradise Lost, Samson Agonistes, minor poems, *Areopagitica,* and often, although not always, *Paradise Regained.*

5-281. POPE. (4 cr)
Readings in poetry of Alexander Pope.

5-283. SWIFT. (4 cr)
Readings in prose and poetry of Jonathan Swift.

5-287. DR. JOHNSON AND HIS CIRCLE. (4 cr)
Johnson's major works and selected works by writers of the time whom he influenced; secondary emphasis on Boswell.

5-311f, 5-312w, 5-313s. ROMANTIC WRITERS. (4 cr per qtr)
Close examination of one, two, or three writers each quarter. Authors specified in *Class Schedule.*

5-331f, 5-332w, 5-333s. VICTORIAN WRITERS. (4 cr per qtr)
Close examination of one, two, or three writers each quarter. Authors specified in *Class Schedule.*

5-361s. POETRY OF W. B. YEATS. (4 cr)

5-363, 5-364. JAMES JOYCE. (4 cr per qtr)
Critical reading of the texts.

5-411, 5-412, 5-413. AMERICAN LITERATURE. (4 cr per qtr)
Historical survey of important authors, intellectual currents, movements, conventions, genres, and themes. Lecture course with emphasis on wide reading. 5-411: Beginnings through Hawthorne. 5-412: Thoreau and Melville through James. 5-413: Crane to present.

5-431f, 5-432w. AMERICAN POETRY. (4 cr per qtr)
Critical survey of American poetry from Anne Bradstreet to present; some attention to historical and intellectual backgrounds; emphasis upon major figures.

5-451w, 5-452s. AMERICAN NOVEL. (4 cr per qtr)
History of American novel from beginning to present.

5-455s. AMERICAN SHORT STORY. (4 cr)
Historical examination of American short story from 18th century to present.

5-471s. AMERICAN DRAMA. (4 cr)
Critical survey of American drama; primary emphasis upon American drama from 1914 to present; some representative American plays of the 18th, 19th, and early 20th centuries.

5-513, 5-514. EARLY AMERICAN LITERATURE. (4 cr per qtr)
Critical survey: emphasis upon principal writers and major cultural themes, from Puritans to Transcendentalists.

5-541w. EMERSON AND THOREAU. (4 cr)

5-543f. HAWTHORNE AND MELVILLE. (4 cr)

5-545s. WHITMAN AND MARK TWAIN. (4 cr)

5-547. HENRY JAMES. (4 cr)

5-561f. POETRY OF T. S. ELIOT. (4 cr)

5-591. ORIGINS OF AMERICAN NATURALISM. (4 cr)

5-593. BLACK WRITERS OF THE UNITED STATES. (4 cr)
Prose, poetry, and drama, with emphasis on writers of 20th century.

5-610. TWENTIETH-CENTURY WRITERS. (4 cr)
Authors vary from year to year, and will be specified in *Class Schedule*.

5-632. THE ROMANTIC TRADITION. (4 cr)

5-651, 5-652. TECHNIQUES OF POETRY. (4 cr per qtr)
Studies in sound, structure, style, and sense of poems.

5-671, 5-672. TECHNIQUES OF THE NOVEL. (4 cr per qtr)
Special studies in novels of late 19th and 20th centuries with particular regard to structure.

5-691f, 5-692w, 5-693s. FORM AND IDEA IN DRAMATIC LITERATURE. (4 cr per qtr; prereq 3-241...3-242 recommended)
Dramatic types, in chronological sequence; analytical reading of selected representative plays. 5-691: Tragic and religious drama (classical, medieval, Renaissance, and modern); theories of tragedy. 5-692: Comedy (classical, Renaissance, and modern); theories of comedy. 5-693: Experimental and nonrealistic drama.

5-711. CLASSICS OF LITERARY CRITICISM. (4 cr)
Foundations of classic critical theory and practice, with particular emphasis on Aristotle and Coleridge and attention to such authors as Plato, Horace, Longinus, Sir Philip Sidney, Dryden, Hume, Dr. Johnson, Arnold, and T. S. Eliot.

5-714. MODERN LITERARY CRITICISM. (4 cr)
Major texts and movements in modern literary criticism.

5-753. LITERATURE AND THE OTHER ARTS. (4 cr)
Informal, highly tentative exploration of possible relationships of literature to drama, music, painting and sculpture, and architecture: how they influence one another and how their aesthetic and social roles are similar and different. Readings in English and American literature and in aesthetic theory; recordings; gallery visits.

5-815s. HISTORY OF ENGLISH LANGUAGE. (4 cr)
Historical influences upon, and changes within, language as both popular and literary medium of communication.

5-821. OLD AND MIDDLE ENGLISH DIALECTS. (4 cr; prereq ‡)
Dialect differentiation in Old and Middle English, based upon phonemic-graphemic theory with some attention to generative theory; close textual analysis of dialect samples.

5-831. AMERICAN ENGLISH. (4 cr)
History of the English language in the United States; significant regional variations.

5-843. AMERICAN SOCIAL DIALECTS. (4 cr)
Social and class variation in American English, with emphasis upon dialects of the culturally disadvantaged, and their relation to standard English as a second dialect.

5-851f,w,s. STRUCTURE OF MODERN ENGLISH. (4 cr)
Introduction to three English grammars: traditional, structural, and transformational, with applications in study of social and regional variations.

5-871. LANGUAGE AND LITERATURE. (4 cr; prereq 5-851 or 8-851)
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; application to texts in prose and poetry.

5-873. SEMANTICS: SURVEY OF THEORIES OF MEANING. (4 cr)
Discussion of the relationship in English between semantics and syntax. Not a course in general semantics.

5-876. GRAMMAR AND RHETORIC. (4 cr)
Relationship between competence in English (described by a grammar—a syntax and semantics—of English) and effective performance (described by a rhetoric of English).

5-910 or 5-920. TOPICS IN ENGLISH AND AMERICAN LITERATURE. (4 cr)
Topics annually specified in *Class Schedule.*

5-940 or 5-950. FIGURES IN ENGLISH AND AMERICAN LITERATURE. (4 cr)
Figures annually specified in *Class Schedule.*

8-011. INTRODUCTION TO ADVANCED LITERARY STUDY. (4 cr)
Ends and methods of literary research, including professional literary criticism, analytical bibliography, and textual criticism, with particular atttention 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.

8-050. STUDIES IN SPECIAL SUBJECTS. (4 cr)
Topics annually specified in *Class Schedule.*

8-210 through 8-810. SEMINARS. (4 cr each)
Descriptive title given in *Class Schedule.*

8-210. Medieval Studies
8-220. Chaucer
8-230. Renaissance Studies
8-240. Shakespeare
8-250. Seventeenth-Century Studies
8-270. Eighteenth-Century Studies
8-310. Studies in the English Romantic Movement
8-330. Victorian Studies
8-510. Studies in Early American Literature
8-530. Studies in Nineteenth-Century American Literature
8-540. Authors of the American Renaissance
8-610. Studies in Twentieth-Century British and American Literature
8-650. Studies in Poetry
8-670. Studies in Prose Fiction
8-690. Studies in Drama
8-710. Studies in Criticism
8-750. Studies in Aesthetics
8-810. Studies in the English Language

8-970. INDEPENDENT READING. (1-15 cr ar; prereq ‡)

Composition (Comp)

5-101, 5-102, 5-103. WRITING OF FICTION. (4 cr per qtr; prereq submission of portfolio and ‡; P-N grading only)
Principles of composition in this art.

5-104, 5-105, 5-106. WRITING OF POETRY. (4 cr per qtr; prereq submission of portfolio and ‡; P-N grading only)
Principles of composition in this art.

5-107, 5-108. THE WRITING EXPERIENCE. (4 cr per qtr; prereq Comp 1-027 or ‡)
Courses intended for students who are likely to be called upon to teach creative writing at secondary or junior-college level, but have no experience in writing beyond Comp 1-027/1-028, and no experience at all of a workshop situation and social interactions in such a group.

8-201, 8-202, 8-203. GRADUATE SEMINAR: WRITING. (4 cr per qtr; prereq ‡)

ENGLISH AS A SECOND LANGUAGE

Professor
Betty W. Robinett, *director of program, director of graduate study*
Emma M. Birkmaier
Walter Lehn
Andrew MacLeish

Associate Professor
Dale L. Lange
Meri K. Lehtinen

Assistant Professor
Larry G. Hutchinson

The Program in English as a Second Language is an interdisciplinary program preparing teachers of English as a second language and leading to a Master's degree.

Prerequisites—An undergraduate major in English education, English, linguistics, or foreign language, or other preparation acceptable to the Committee on English as a Second Language.

Language Requirement—Knowledge, demonstrated by examination, of one language foreign to the student.

Master's Degree—Offered only under Plan B. Of the minimum 45-credit requirement, 31 credits are in specified courses, listed below. Before determining their electives, students should consult the director regarding relevance of these courses to their individual goals.

Minor—The minor comprises the required courses except Ling 5-701 and Ling 5-742 (a total of 23 credits).

All candidates must pass an oral examination.

Normally 1½ years will be required to complete the degree.

See listings of the respective departments for fuller information about course offerings.

Required Courses

Ling 5-001—Introduction to Linguistics
Ling 5-003—Applied Phonetics
Ling 5-701—Contrastive Linguistics
Ling 5-741, 5-742—Linguistic Description of Modern English
SeEd 5-396—Methods of Teaching English as a Second Language
SeEd 5-697—Practicum: Teaching English as a Second Language
Eng 5-843—American Social Dialects or Eng 5-831—American English or Eng 5-814—History of the English Language

In addition, for those who are not undergraduate majors in English, 8 credits of 19th- or 20th-century English or American literature.

Suggested Electives

Structure of a foreign language (not English)—See language department listings.

Anth 5-101—Principles of Cultural Anthropology
Ling 5-201, 5-202—Introduction to Syntax
Ling 5-751, 5-752—Applied Transformational Grammar
Ling 5-805—Psycholinguistics
Ling 5-821—Sociolinguistics
SeEd 5-189—Materials and Curriculum Construction in Modern Language Learning
SeEd 5-385—Advanced Course in the Teaching of Modern Languages
SeEd 8-188—Seminar: Research in Modern Language Learning
Spch 5-451—Intercultural Speech-Communication

ENTOMOLOGY, FISHERIES, AND WILDLIFE

Professor

Alexander C. Hodson, *head, director of graduate study*
Marion A. Brooks
Huai C. Chiang
Edwin F. Cook
Laurence K. Cutkomp
L. D. Frenzel, Jr.
Basil Furgala
Philip K. Harein
Herbert M. Kulman
William H. Marshall
Allan G. Peterson
Roger D. Price
A. Glenn Richards
Lloyd L. Smith, Jr.
John R. Tester
James C. Underhill
Franklin G. Wallace
Thomas F. Waters

Associate Professor

Edward B. Radcliffe

Assistant Professor

James M. Peek

Prerequisites—For admission, any B.A. or B.S. degree with a major in some zoological science is acceptable, but preference is given to students with a broad grounding in basic science courses.

Language Requirement—Reading knowledge of foreign languages is advised but not required for either the Master's or the Ph.D. degrees, except that for the Ph.D. degree, a reading knowledge of foreign languages must be acquired as part of the major program when such skill is needed to support the student's research objectives. Nonlanguage options will not be required.

Graduate Major Fields—Work leading to the Master's and Ph.D. degrees is offered in each of the following fields: entomology or fisheries or wildlife.

Master's Degree—Recommended under Plan A but Plan B may be accepted on an individual basis, at the option of the adviser and the advisory committee.

Doctor's Degree—It is recommended that candidates for the Ph.D. degree earn the Master's degree under Plan A.

Course 8-200 is required of all majors while in residence with the exception that students who have passed their preliminary oral examination may be exempt on approval of their advisors.

Entomology (Ent)

5-001, 5-002, 5-003. BASIC ENTOMOLOGY. (Cr ar [not more than 6 cr allowed for Master's program, and 9 cr for Ph.D. program]; majors must consult major advisers, others must consult dept head)

Provides a special arrangement for making up certain deficiencies in biological background.

5-020. FIELD ENTOMOLOGY. (5 cr; prereq Biol 1-002 or equiv; offered in Lake Itasca Biology Session)
The insect fauna in various natural habitats of the park and surrounding areas. Field trips, collection and classification of insects, as well as studies of general morphology, life histories, and habitats of local species under ecological conditions governing the distribution of insect fauna of the region.

5-022su. HOUSE AND GARDEN INSECTS. (3 cr; limited to 20 students; 6 lab hrs per wk) Price
Background in recognition and life history of commonly encountered Minnesota insects. Lectures and short field trips.

5-025. INSECT MORPHOLOGY. (5 cr; prereq 3-175 or ‡) Cook
Comparative studies of external and internal anatomy and histology of insects; phylogeny and function.

5-026. EMBRYOLOGY AND DEVELOPMENT OF INSECTS. (5 cr; prereq 5-025, Chem 3-302, ‡) Brooks
Reproductive behavior, embryology, and postembryonic development of insects.

5-027.° INSECT METABOLISM AND COORDINATION. (5 cr; prereq ‡...BioC 5-002 or MdBc 5-101 recommended) Richards
Homeostasis, permeability, circulation, metabolic systems and products, properties of muscles and nerves, sensation, behavior.

5-050.° FOREST ENTOMOLOGY. (4 cr; prereq forestry major or ‡) Kulman
Lectures and laboratory concerning ecology and population management of forest insects with heavy emphasis on tree factors and biological control.

5-130. AQUATIC ENTOMOLOGY. (5 cr; prereq 5-020, 3-175 or equiv or ‡; offered in Lake Itasca Biology Session)
Identification and biology of aquatic and littoral insects in all stages.

5-131. AQUATIC ENTOMOLOGY. (2 cr; prereq 5-020, 3-175 or equiv or ‡; offered 1973-74 and alt yrs) Cook
Identification and biology of aquatic and littoral insects in all stages.

5-133. INSECT TAXONOMY. (4 cr; prereq 3-175 or equiv) Price
Identification of taxa within the insect orders; use of taxonomic literature and catalogs; formation of an insect collection.

5-150. PRINCIPLES OF SYSTEMATIC ENTOMOLOGY. (2 cr; prereq 15 cr entomology or zoology; offered 1973-74 and alt yrs) Cook
Lectures on history of systematic entomology, the species concept and higher categories, systematic procedures and zoological nomenclature.

5-200. 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.

5-210.° INTEGRATED CONTROL. (4 cr; prereq 3-175 or equiv, ‡) Cook, Radcliffe
Suppression of insect, mite, and weed populations by integration of biotic agents; host plant resistance, artificial pest control measures and cultural practices. Principles of ecological approach to pest control. Laboratory work or independent study required. Laboratory work is concerned with identification of entomophagous insects, both those used in control programs and those naturally occurring.

5-215.° INSECTS IN RELATION TO PLANT DISEASES. (4 cr; prereq 5 cr entomology, 5 cr plant pathology or equiv, or ‡) Peterson, Wilcoxson
(Same as PlPa 5-215) Insect transmission and dissemination of plant pathogens; development of plant-insect relationships; habits of principal insect vectors—practical methods of control.

5-250.° PRINCIPLES OF ECONOMIC ENTOMOLOGY. (4 cr; prereq 15 cr zoology and entomology incl 1-005 or ‡; offered 1972-73 and alt yrs) Cutkomp
Methods and principles of insect control. Individual projects.

5-275. MEDICAL ENTOMOLOGY. (4 cr; prereq 15 cr incl 3-175 or equiv, or ‡) Price
Principal arthropods noxious to man and animals. Emphasis on those that serve as vectors of pathogenic organisms of man and animals.

5-400.° EXPERIMENTAL ECOLOGY. (3 cr; prereq 9 cr general biology or equiv, 3 cr animal or plant ecology, ‡; for companion lab course, see 8-300) Chiang
Experimental approach to study of environmental factors affecting animal populations.

5-425. SPECIAL LECTURES IN ENTOMOLOGY. (Cr ar; offered when feasible)
Lectures in special fields of entomological research given by a visiting professor.

5-500. PROBLEMS IN MICROTECHNIQUE. (Cr ar; prereq ‡) Brooks
Guidance for independent study of material of student's choice, with special reference to insects.

5-510. BIOLOGICAL MICROSCOPY. (4 cr; prereq 15 cr biological sciences, ‡; offered when demand warrants) Richards
Necessary elements of optics, use and limitations of various types of microscopes, interpretation of microscopical data. Laboratory; demonstration plus project in field of student's interest.

5-901, 5-902, 5-903.* ADVANCED WORK IN ENTOMOLOGY. (Cr ar; prereq ‡)
Library and laboratory research in various lines of entomology.

8-200x. SEMINAR. (1 cr per qtr)
Assigned topics dealing with some special fields of work of the department.

8-210.* CURRENT TOPICS IN FOREST ENTOMOLOGY. (1 cr; prereq 8-305, For 5-101, or ‡) Kulman
Lectures and group discussions of current problems and research. Visiting specialists will frequently participate.

8-300.* EXPERIMENTAL ECOLOGY LABORATORY. (2 cr; prereq 5-400 or ¶5-400) Chiang
Companion course of Ent 5-400.

8-305.* INSECT ECOLOGY. (3 cr; prereq 5-400 or ‡) Chiang
Dispersal, distribution, abundance, natural control, and related problems.

8-315. BIOLOGY OF IMMATURE INSECTS. (3 cr; prereq 3-175 or equiv) Cook, Price
Habits, habitats, life history and identification of immature insects.

8-323.* TOPICS IN INSECT PHYSIOLOGY. (Cr ar; prereq ‡) Richards
Lectures, discussions, and individual laboratory problems.

8-350.* INSECT MICROBIOLOGY. (5 cr; prereq ‡; offered 1973-74 and alt yrs or when demand warrants) Brooks
Relationships between insects and microorganisms; physiological, anatomical, and pathological aspects.

8-400. INSECTICIDES AND THEIR ACTION. (3 cr; prereq 15 cr incl 1-005 or equiv or ‡, inorganic and organic chemistry; offered 1973-74 and alt yrs) Cutkomp
Chemistry, physiological action, toxicology of insecticides.

8-405. INSECTICIDES LABORATORY. (2 cr; prereq 8-400 or equiv or ¶8-400; offered 1973-74 and alt yrs) Cutkomp
Research training in field of study discussed in Ent 8-400.

8-500, 8-501, 8-502, 8-503.* RESEARCH IN ENTOMOLOGY. (Cr ar) Brooks, Chiang, Cook, Cutkomp, Furgala, Harein, Hodson, Kulman, Peterson, Price, Radcliffe, Richards

Fisheries (FW)

5-103, 5-104, 5-105. BASIC FISHERY BIOLOGY. (Cr ar [not more than 6 cr allowed for the Master's program, and 9 cr for the Ph.D. program]; majors must consult major advisers, others must consult dept head)
Provides a special arrangement for making up certain deficiencies in biological background.

5-131. AQUATIC ENTOMOLOGY. (2 cr; prereq 5-020, Ent 3-175 or equiv or ‡; offered 1973-74 and alt yrs) Cook
Identification and biology of aquatic and littoral insects in all stages.

5-279. SPECIAL LECTURES IN FISHERIES. (Cr ar; offered when feasible)
Lectures in special fields of research given by a visiting professor.

5-280. SENIOR SEMINAR: FISHERIES. (1 cr)
Discussion and presentation of papers in fisheries and related subjects.

5-393, 5-394, 5-395.* ADVANCED WORK IN FISHERY BIOLOGY. (Cr ar; prereq ‡)
Library and laboratory research in various lines of fishery biology.

5-397su. ADVANCED WORK IN FISHERY BIOLOGY—ADVANCED WORK IN WILDLIFE BIOLOGY. (Cr ar; prereq ‡)
Library and laboratory research in various lines of fishery biology or wildlife biology.

5-400.* EXPERIMENTAL ECOLOGY. (3 cr; prereq 9 cr general biology or equiv, 3 cr animal or plant ecology, ‡; for companion lab course, see 8-300) Chiang
Experimental approach to study of environmental factors affecting animal populations.

5-451. ECOLOGY OF FISHERY POPULATIONS. (3 cr; prereq Ecol 3-001 or equiv, Zool 5-121, Ecol 5-812 or Geo 5-601, Math 1-142 or equiv, or ‡) Smith
Relationship of fishery populations to limnological conditions; factors influencing strength of year classes; influence of climatological factors on fish growth; species interaction as related to population structure; influence of natural and fishing mortality rates on structure and yield of exploited populations; fishery yield models.

5-452. FISHERY MANAGEMENT. (3 cr; prereq 5-451 or ‡) Smith, Waters
Fundamentals of population control; use of fishing regulations; habitat development; water quality control; use of artificial stocks for population maintenance; relationship between sport and commercial fisheries, including economic aspects; fundamentals of hatchery practice; pond management.

5-453.* TECHNIQUES OF FISHERY BIOLOGY. (3 cr; prereq 5-452 or ‡) Waters
Basic methods used in fishery research and management; lake and stream survey methods, mapping, chemical and biological sampling; methods of fish collection, use of nets and traps, fish toxicants, electrofishing; tagging and marking; methods of creel census.

5-454.* FISHERY ECOLOGY IN POLLUTED WATERS. (3 cr; prereq 5-451, Chem 1-004, 1-005, 1-006, Chem 3-100, 3-101; ‡) Adelman
Degrading water quality factors and influence on fish production. Fishery bioassay, setting of standards, and determination of criteria for aquatic organisms; administrative problems of pollution abatement. Biological effect of various pollutants on fish.

5-678. FISHERIES AND WILDLIFE ADMINISTRATION. (4 cr; prereq 3-050, 5-452, 5-552 or ‡) Marshall
Organization and function of federal and state agencies; laws and regulations; internal policies concerning personnel, budgets and financing, research management, law enforcement, and public education.

8-200x. SEMINAR. (1 cr per qtr)
Assigned topics dealing with some special fields of work of the department.

8-300.* EXPERIMENTAL ECOLOGY LABORATORY. (2 cr; prereq 5-400 or ¶5-400) Chiang
Companion course of 5-400.

8-364, 8-365, 8-366, 8-367.* RESEARCH IN FISHERY BIOLOGY. (Cr ar) Smith, Waters

8-448/8-449.*† FISHERY BIOLOGY. (3 cr per qtr; prereq 5-453, Ent 5-400, Stat 5-021 or equiv or ‡; offered 1972-73 and alt yrs or when demand warrants) Smith
Methods and theory of fishery biology; age and rate of growth, populations, mortality, and harvest; indices of productivity.

8-451.* PRODUCTION BIOLOGY OF FISHERY ENVIRONMENTS. (3 cr; prereq 5-453, Ent 5-400 or Ecol 3-001, Stat 5-021 or ‡; offered 1972-73 and 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.

Wildlife (FW)

5-106, 5-107, 5-108. BASIC WILDLIFE BIOLOGY. (Cr ar [not more than 6 cr allowed for the Master's program, and 9 cr for the Ph.D. program]; majors must consult major advisers, others must consult dept head)
Provides a special arrangement for the making up of certain deficiencies in biological background.

5-278. SPECIAL LECTURES IN WILDLIFE. (Cr ar; offered when feasible)
Lectures in special fields of research given by a visiting professor.

5-281. SENIOR SEMINAR: WILDLIFE. (1 cr)
Discussion and presentation of papers in wildlife and related subjects.

5-393, 5-394, 5-395.* ADVANCED WORK IN FISHERY BIOLOGY. (Cr ar; prereq ‡)

5-397. ADVANCED WORK IN WILDLIFE BIOLOGY. (Cr ar; prereq ‡)
Library and laboratory research in various lines of wildlife biology.

5-400.* EXPERIMENTAL ECOLOGY. (3 cr; prereq 9 cr general biology or equiv, 3 cr animal or plant ecology, ‡, for companion lab course, see 8-300) Chiang

5-551. WILDLIFE ECOLOGY AND MANAGEMENT I. (4 cr; prereq 3-277, Zool 5-076, Zool 5-077, or Zool 5-834, Ecol 3-001, Ent 5-400 or Ecol 5-817, AnSc 1-300 or Zool 5-104 or ‡)
Discussion of population characteristics and the factors affecting them. Natality, recruitment, and mortality rates, density and behavior. Role of these factors in relation to proper management of populations stressed.

5-552. WILDLIFE ECOLOGY AND MANAGEMENT II. (5 cr; prereq 5-551, Ecol 5-014 or Ecol 5-814, Bot 3-131) Peek
Principles and concepts pertaining to relationships between wildlife populations and their habitats; habitat requirements and relationships of important game species; relationships to land use and land management practices; habitat evaluation and management.

5-678. FISHERIES AND WILDLIFE ADMINISTRATION. (4 cr; prereq 3-050, 5-452, 5-552 or ‡) Marshall
Organization and function of federal and state agencies; laws and regulations; and internal policies concerning personnel, budgets and financing, research management, law enforcement, and public education.

8-200x. SEMINAR. (1 cr per qtr)
Assigned topics dealing with some special fields of work of the department.

8-300.* EXPERIMENTAL ECOLOGY LABORATORY. (2 cr; prereq 5-400 or ¶5-400) Chiang
Companion course of 5-400.

8-377, 8-378, 8-379, 8-380.* RESEARCH IN WILDLIFE BIOLOGY. (Cr ar) Frenzel, Marshall, Peek, Tester

8-574.* WILDLIFE MANAGEMENT: UPLAND GAME. (3 cr; prereq 5-552, Zool 5-077 or 5-834, or ‡; offered 1973-74 and alt yrs) Marshall
Survey of upland game, bird management problems in North America.

8-575.* WILDLIFE MANAGEMENT: WATERFOWL. (3 cr; prereq 5-552, Zool 5-077 or 5-834, or ‡; offered 1972-73 and alt yrs)
Life histories, ecology, and management of North American waterfowl.

8-576. WILDLIFE MANAGEMENT: BIG GAME. (5 cr; prereq ‡; offered 1973-74 and alt yrs) Peek
Comprehensive survey of the ecology and principles of management of major North American big game mammals, based on review and discussion of original literature.

Students may also want to consider the following courses, offered by other departments:

For Entomology

EBB 5-029—Population Ecology
Zool 5-144—Parasitic Protozoa
Zool 5-146—Experimental Parasitology
Zool 5-169—Physiological Ecology

For Fisheries

Zool 5-121—Ichthyology
Zool 5-169—Physiological Ecology

For Wildlife

EBB 5-029—Population Ecology
Zool 5-169—Physiological Ecology

ENVIRONMENTAL HEALTH (PubH)

Professor

Richard G. Bond, M.S., M.P.H., *director*
Conrad P. Straub, M.C.E., Ph.D., *director of graduate study*
Velvl W. Greene, Ph.D.
George S. Michaelsen, M.S.
Theodore A. Olson, Ph.D.
Harold J. Paulus, Ph.D.
Irving Pflug, Ph.D.

Associate Professor

Donald E. Barber, M.P.H., Ph.D.
Rexford Singer, M.S.
Lee D. Stauffer, M.P.H.

Assistant Professor

Knowlton J. Caplan, M.S.
Orlando R. Ruschmeyer, Ph.D.
Donald Vesley, Ph.D.

Prerequisites—A Bachelor's degree from an acceptable institution preferably with a major in engineering or in one of the biological or physical sciences. If preparation appears to be inadequate, certain additional courses may be required.

Language Requirement—Optional with the division head and determined by career plans of individual. For the Master's degree, knowledge of a foreign language may be required, or at the discretion of the adviser, no language may be required but substitution must be clearly identified in additional academic work. For the Ph.D. degree, at the discretion of the adviser, the requirement may be met by reading knowledge of two foreign languages, one foreign language and additional course work, or no language and additional defined course work.

Master's Degree—Offered under both Plan A and Plan B. All candidates for this degree must take PubH 5-151, 5-159 and 8-002. It is generally expected that candidates will include PubH 5-002, 5-330, 5-405, and either 5-161 or 5-700 in either their major or one of the related fields.

Doctor's Degree—The course work will be adapted to the needs of the individual student and will take cognizance of the several fields of specialization within environmental health (air pollution, environmental biology, hospital engineering, injury control, occupational health, radiological health, water hygiene). Candidacy for the Ph.D. degree implies the completion of a Master's degree or equivalent in environmental health or related fields. Minors will be chosen from a fundamental discipline appropriate to the student's previous academic training and individual needs.

Note—For descriptions of the following courses, see the Public Health section of this bulletin.

5-150. TOPICS: ENVIRONMENTAL HEALTH. (Cr ar; prereq ‡) Staff

5-151.° ENVIRONMENTAL HEALTH. (3 cr; prereq ‡) Bond and staff

5-153.° INSTITUTIONAL ENVIRONMENTAL HEALTH. (3 cr; prereq hospital administration student or ‡, 5-002) Michaelsen, Bond

5-159.° SEMINAR: ENVIRONMENTAL HEALTH. (Cr ar; prereq ‡) Olson

5-161.° ADMINISTRATION OF ENVIRONMENTAL HEALTH PROGRAMS. (3 cr, §5-154; prereq ‡) Bond

5-170. TOPICS: ENVIRONMENTAL BIOLOGY. (Cr ar; prereq ‡) Staff

5-171.° ENVIRONMENTAL MICROBIOLOGY. (3 cr; prereq 5-151, MicB 3-103 or ‡) Greene

5-172. ENVIRONMENTAL MICROBIOLOGY LABORATORY. (2 cr, §5-233; prereq ¶5-171, ‡) Greene, Vesley

5-177. ENVIRONMENTAL BIOLOGY. (3 cr; prereq ‡) Olson, Ruschmeyer

5-178. VECTORS AND PARASITES IN HUMAN DISEASES. (3 cr; prereq ‡) Olson, Ruschmeyer

5-179. PUBLIC HEALTH BIOLOGY—FIELD INVESTIGATIONS. (3 cr; prereq ‡) Olson, Ruschmeyer

5-180. TOPICS: AIR POLLUTION. (Cr ar; prereq ‡) Staff

5-181. INTRODUCTION TO THE AIR POLLUTION PROBLEM. (3 cr; prereq ‡) Paulus

5-182. AIR POLLUTION CONTROLS AND SURVEYS. (3 cr; prereq 5-181 or ‡) Paulus

5-183. PROBLEMS OF AIR POLLUTION CONTROL. (Cr ar; prereq 5-181, ‡) Paulus

5-184. AIR ANALYSIS I. (3 cr; prereq 5-211 or 5-181, 5-183, ‡) Paulus

5-185. AIR ANALYSIS II. (3 cr; prereq 5-184) Paulus, Caplan

5-190. TOPICS: INJURY CONTROL. (Cr ar; prereq ‡) Michaelsen, Scheffler

5-191. PRINCIPLES AND METHODS OF INJURY CONTROL. (Cr ar; prereq ‡) Michaelsen, Scheffler

5-192. HOSPITAL SAFETY. (3 cr; prereq ‡) Michaelsen, Scheffler

5-193. CHEMICAL LABORATORY SAFETY. (1 cr; prereq ‡) Scheffler

5-194. OCCUPATIONAL SAFETY. (2 cr; prereq ‡) Michaelsen, Scheffler

5-200. TOPICS: RADIOLOGICAL HEALTH. (Cr ar; prereq ‡) Staff

5-201. MEASUREMENT AND APPLICATION OF IONIZING RADIATION. (3 cr [lect and lab], 2 cr [lect only]; prereq ‡) Barber, Jonas

5-202. ENVIRONMENTAL RADIOACTIVITY. (3 cr; prereq ‡) Barber, Straub

5-203. LOW-LEVEL RADIOACTIVITY MEASUREMENTS. (3 cr; prereq ‡) Barber

5-207. RADIATION PROTECTION CRITERIA FOR HOSPITALS. (2 cr; prereq ‡) Barber, Wollan

5-209. SEMINAR: HEALTH PHYSICS. (1 cr; prereq ‡) Barber

5-210. TOPICS: OCCUPATIONAL HEALTH. (Cr ar; prereq ‡) Staff

5-211.° INDUSTRIAL HYGIENE ENGINEERING. (3 cr; prereq ‡) Caplan, Michaelsen

5-212. VENTILATION CONTROL OF ENVIRONMENTAL HAZARDS. (3 cr; prereq 5-211, ‡) Caplan

5-213. PUBLIC HEALTH ASPECTS OF TOXIC PRODUCTS. (2 cr; prereq ‡) Caplan

5-214. AGRICULTURAL OCCUPATIONAL HEALTH. (3 cr; prereq 5-211 or ‡) Caplan

5-215. ENVIRONMENTAL TOXICOLOGY. (3 cr; prereq 5-181 or 5-211, ‡) Caplan, Long

5-216. HEALTH ASPECTS OF AIR CONTROL IN HOSPITALS. (2 cr; prereq ‡) Michaelsen

5-220. TOPICS: FOOD SANITATION. (Cr ar; prereq ‡) Staff

5-221. INSTITUTIONAL FOOD PROTECTION PROGRAMS. (2 cr; prereq ‡) Bond, Jopke

5-222.° FOOD SANITATION. (3 cr; prereq 5-002, ‡) Olson

5-230. TOPICS: INSTITUTIONAL ENVIRONMENTAL HEALTH. (Cr ar; prereq ‡) Staff

5-231.° ENVIRONMENTAL HEALTH AND SAFETY IN HEALTH CARE FACILITIES I. (4 cr; prereq ‡) Michaelsen, Greene, Vesley

5-232.° ENVIRONMENTAL HEALTH AND SAFETY IN HEALTH CARE FACILITIES II. (4 cr; prereq ‡) Michaelsen, DeRoos

5-233.° ENVIRONMENTAL HEALTH AND SAFETY IN HEALTH CARE FACILITIES III. (4 cr; prereq ‡) Michaelsen, Vesley

5-239. HOSPITAL ENGINEERING PROBLEMS. (Cr ar; prereq ‡) Michaelsen, and visiting lecturers

5-241. ENVIRONMENTAL HEALTH ASPECTS OF WATER SUPPLY SYSTEMS. (3 cr; prereq ‡) Straub, Singer

5-244. ENVIRONMENTAL HEALTH ASPECTS OF WASTE, WATER SYSTEMS. (3 cr; prereq ‡) Straub, Singer

8-002. FIELD OBSERVATION OF SELECTED PUBLIC HEALTH PRACTICES. (Cr ar; prereq ‡) Staff

8-150. RESEARCH: ENVIRONMENTAL HEALTH. (Cr ar) Staff

8-170. RESEARCH: ENVIRONMENTAL BIOLOGY. (Cr ar; prereq ‡) Olson, Greene

8-180. RESEARCH: AIR POLLUTION. (Cr ar; prereq ‡) Paulus

8-190. RESEARCH: INJURY CONTROL. (Cr ar; prereq ‡) Michaelsen

8-200. RESEARCH: RADIOLOGICAL HEALTH. (Cr ar; prereq ‡) Barber

8-201.° RADIATION DOSIMETRY. (3 cr; prereq ‡) Barber

8-202. RADIATION DOSIMETRY LABORATORY. (1 cr; prereq ¶8-201) Barber

8-208. FIELD PRACTICE IN RADIOLOGICAL HEALTH. (Cr ar; prereq ‡) Barber

8-210. RESEARCH: OCCUPATIONAL HEALTH. (Cr ar; prereq ‡) Michaelsen

8-211. HEALTH SURVEY OF MANUFACTURING PROCESSES. (2 cr; prereq 5-211, ‡) Caplan

8-218. FIELD PROBLEMS IN OCCUPATIONAL HEALTH. (3 cr; prereq 5-211, 5-212, or ¶5-213, ‡) Caplan

8-220. RESEARCH: FOOD SANITATION. (Cr ar; prereq ‡) Pflug

8-230. RESEARCH: INSTITUTIONAL ENVIRONMENTAL HEALTH. (Cr ar; prereq ‡) Michaelsen, Greene

8-246. GROUNDWATER DEVELOPMENT. (Cr ar; prereq grad engr, ‡) Bond, Singer, staff and visiting lecturers

8-247. FIELD WORK IN GROUNDWATER DEVELOPMENT. (Cr ar; prereq grad engr, 8-246) Bond, Singer, staff and visiting lecturers

8-248. WATER QUALITY INVESTIGATION AND RESEARCH TECHNIQUES. (6 cr; prereq ‡) Olson, Odlaug, Ruschmeyer

8-249. WATER QUALITY RESEARCH. (6 cr; prereq ‡) Olson, Odlaug, Ruschmeyer

EPIDEMIOLOGY (PubH)

Professor

Leonard M. Schuman, M.D., M.S., *chairman, director of graduate study*
R. K. Anderson, D.V.M., M.P.H.
Lawrence H. Meskin, D.D.S., M.S.D., M.P.H., Ph.D.

Associate Professor

Stanley L. Diesch, D.V.M., M.P.H.

Assistant Professor

James H. Stebbings, Jr., Sc.D.

Lecturer

Henry Bauer, Ph.D.

Prerequisites—Specialized training in epidemiology is offered to qualified graduates in medicine, dentistry, and veterinary medicine. Other students with adequate background in biological or physical sciences or with demonstrated competence in investigative work may be admitted. Since positions in the program are relatively limited, selection of candidates is competitive with respect to background of instruction and experience presented.

Language Requirement—For the Master's degree, knowledge of a foreign language may be waived on recommendation of the adviser. For the Ph.D. degree, the requirement is reading knowledge of two foreign languages or of one foreign language and option of a special research technique or a collateral field of knowledge. Acceptable languages are: Danish, French, German, Japanese, Norwegian, Russian, Spanish, or Swedish.

Minor—For the Master's degree, 9 credits selected by the minor adviser on the basis of the candidate's field of study.

For the Ph.D. degree, PubH 5-375 and 23 additional credits selected by the minor adviser on the basis of the candidate's field of major study.

Master's Degree—Offered under both Plan A and Plan B. All candidates for this degree must take PubH 5-375.

Doctor's Degree—Applicants for the degree in epidemiology will usually present a degree in medicine, dentistry, or veterinary medicine; others with adequate background in the biological or physical sciences or with demonstrated competence in investigative work may be accepted. Students majoring in epidemiology will offer a minor in a related field.

Note—Graduate study in epidemiology is also offered at the Mayo Graduate School of Medicine of the University of Minnesota. See the bulletin, *Graduate Programs in the Health Sciences.*

For descriptions of the following courses, see the Public Health section of this bulletin.

5-300. COMPARATIVE MEDICINE AND PUBLIC HEALTH. (2 cr; prereq 5-002, ‡) Diesch

5-330.* EPIDEMIOLOGY I. (3 cr; prereq 5-375, 5-407, 5-405, or 5-450/5-451, ‡) Schuman, Stebbings

5-331. FUNDAMENTALS OF BIOSTATISTICS. (3 cr) Visiting lecturers

5-332. FUNDAMENTALS OF EPIDEMIOLOGY. (3 cr) Visiting lecturers

5-335.* EPIDEMIOLOGY II. (3 cr; prereq 5-330) Schuman

5-336. INFECTIOUS DISEASE EPIDEMIOLOGY. (3 cr; prereq basic epidemiology and biostatistics) Visiting lecturers

5-337. SEROLOGIC EPIDEMIOLOGY. (2 cr; prereq basic epidemiology and biostatistics) Visiting lecturers

5-340. EPIDEMIOLOGIC SURVEY METHODS. (3 cr; prereq 5-330, 5-407 or equiv, ‡) Schuman, Stebbings

5-341. HEALTH SURVEY METHODS. (2 cr; prereq basic epidemiology and biostatistics) Visiting lecturers

5-342. PUBLIC HEALTH BACTERIOLOGY. (Cr ar; prereq MicB 5-232, MicB 5-216, ‡) Bauer

5-345. EPIDEMIOLOGY OF CANCER. (3 cr; prereq basic epidemiology and biostatistics, 5-357 or ¶5-357) Schuman and visiting lecturers

5-346. EPIDEMIOLOGY OF CARDIOVASCULAR DISEASES. (3 cr; prereq basic epidemiology and biostatistics, 5-357 or ¶5-357) Visiting lecturers

5-347. EPIDEMIOLOGY OF MENTAL DISORDERS. (2 cr; prereq basic epidemiology and biostatistics) Visiting lecturers

5-348. EPIDEMIOLOGY OF NEUROLOGIC DISEASES. (2 cr; prereq basic epidemiology and biostatistics) Visiting lecturers

5-349. EPIDEMIOLOGY OF CHRONIC RESPIRATORY DISEASE. (Cr ar; prereq ‡)

5-350. EPIDEMIOLOGIC BASIS FOR HEALTH SERVICES, PLANNING, AND EVALUATION. (2 cr; prereq 5-330, 5-332 or equiv, 5-407, 5-331 or equiv) Visiting lecturers

5-355. GENETICS AND EPIDEMIOLOGY. (3 cr; prereq basic epidemiology and biostatistics) Visiting lecturers

5-356. POPULATION DYNAMICS. (2 cr; prereq basic epidemiology and biostatistics)

5-357. SELECTED STATISTICAL TOPICS IN EPIDEMIOLOGY. (3 cr; prereq basic epidemiology and biostatistics) Visiting lecturers

5-358. RADIATION EPIDEMIOLOGY. (2 cr; prereq basic epidemiology and biostatistics and advanced statistics) Visiting lecturers

5-365. EXPERIMENTAL EPIDEMIOLOGY. (Cr ar; prereq 5-335, 5-407 or 5-450 or equiv, ‡)

5-370. APPLIED EPIDEMIOLOGY. (Cr ar; prereq 5-330, 5-407 or 5-450 or equiv, ‡) Staff

5-375. BIOLOGICAL BASES OF HEALTH AND DISEASE. (3 cr; prereq course in microbiology or ‡) Schuman

5-379.* TOPICS IN EPIDEMIOLOGY. (Cr ar; prereq ‡) Staff

5-380.* APPLIED HUMAN NUTRITION. (3 cr; prereq ‡) J Anderson, Grande, Stief

5-386. PUBLIC HEALTH ASPECTS OF CARDIOVASCULAR DISEASE. (3 cr; prereq ‡) Blackburn, Grande, and staff

5-407. VITAL STATISTICS I. (3 cr) Bearman
For description see main Biometry section of this bulletin.

5-450/5-452/5-454. BIOMETRY I, II, III. (3 cr per qtr; prereq Math 1-111 or ‡, ¶5-451/5-453/5-455) Bartsch
For description see main Biometry section of this bulletin.

5-451/5-453/5-455. BIOMETRY LABORATORY I, II, III. (2 cr per qtr; prereq ¶5-450/5-452/5-454) Bartsch
For description see main Biometry section of this bulletin.

5-612. HUMAN GENETICS AND PUBLIC HEALTH. (3 cr) Schacht

5-651. PHILOSOPHY AND CONCEPTS OF PREVENTIVE DENTISTRY. (3 cr; prereq ‡) Meskin

8-330. RESEARCH: EPIDEMIOLOGY. (Cr ar)

8-340.* EPIDEMIOLOGY OF NONCOMMUNICABLE DISEASES. (3 cr; prereq 5-330) Schuman, Stebbings

8-341. EPIDEMIOLOGY OF SELECTED CHRONIC DISEASES. (2 cr; prereq basic epidemiology and biostatistics) Visiting lecturers

8-379. SEMINAR: EPIDEMIOLOGY. (Cr ar; prereq ‡) Schuman, Stebbings

FAMILY PRACTICE AND COMMUNITY HEALTH (FPCH)

For information on staff, program, and courses, see the bulletin *Graduate Programs in the Health Sciences.*

FLUID MECHANICS

SUBCOMMITTEE:

Professor

Ephraim M. Sparrow (Mechanical Engineering), *chairman, director of graduate study*
Ernst R. G. Eckert (Mechanical Engineering)
Arnold G. Fredrickson (Chemical Engineering)
Thomas S. Lundgren (Aerospace Engineering and Mechanics)
James B. Serrin, Jr. (Mathematics)
Edward Silberman (Civil Engineering)
Hans F. Weinberger (Mathematics)

This group, together with the following, may serve as graduate advisers for this area:

Professor

Neal R. Amundson (Chemical Engineering)
Rutherford Aris (Chemical Engineering)
Abraham S. Berman (Aerospace Engineering and Mechanics)
Perry L. Blackshear (Mechanical Engineering)
Richard J. Goldstein (Mechanical Engineering)
Helmut G. Heinrich (Aerospace Engineering and Mechanics)
Herbert S. Isbin (Chemical Engineering)
Daniel D. Joseph (Aerospace Engineering and Mechanics)
Stephen Prager (Physical Chemistry)
William E. Ranz (Chemical Engineering)
L. Edward Scriven (Chemical Engineering)

Associate Professor

Charles J. Scott (Mechanical Engineering)
Charles C. S. Song (Civil Engineering)
Theodore A. Wilson (Aerospace Engineering and Mechanics)

Degrees—The program in fluid mechanics leads to the Master's and Ph.D. degrees. Work in fluid mechanics can also be taken for a minor in a Ph.D. program.

Master's Degree—Offered under Plan A and Plan B.

Doctor's Degree—The program in fluid mechanics leads to the Ph.D. degree.

Prerequisites—Candidates for the M.S. or Ph.D. programs in fluid mechanics will normally have completed undergraduate work in one of the related fields of: aerospace engineering, chemical engineering, civil engineering, mathematics, mechanical engineering, or physics. Admission to the program must be approved by the Graduate School on recommendation of the Fluid Mechanics Subcommittee, which will consider any applicant whose scientific and engineering training is adequate to carry on this program.

Approval of Program—The candidate's tentative program will be planned with the aid of an adviser selected from those listed who will supervise the thesis investigation. The Fluid Mechanics Subcommitee will consider the program and transmit it to the Graduate School with recommendations. Approval and appointment of a thesis committee will be handled as usual.

Major Program—The course work in the major should normally be selected from those courses in science and engineering that are particularly relevant to the various fields of interest in fluid mechanics. As it is the intent of this program to provide opportunity for broad training, it is desirable that at least 9 credits of 8-000 series courses be selected from not less than three of the several graduate majors listed.

Minor or Supporting Program—Any reasonable collection of courses that support the major program of study in fluid mechanics and that have been approved by the thesis adviser and the director of graduate study are acceptable.

Language Requirement—A candidate must satisfactorily meet the language requirements of the department of which the thesis adviser is a member.

For course descriptions, see sections on Aerospace Engineering and Mechanics, Chemical Engineering, Civil Engineering, Mechanical Engineering, and Mathematics.

AEM 5-200. KINEMATICS AND DYNAMICS OF FLUID FLOW. (4 cr, §CE 3-400; prereq mathematics including vector calculus; 3 lect and 3 recitation hrs per wk)

AEM 5-201. SHOCK WAVES AND COMPRESSIBLE FLUID FLOW. (4 cr; prereq 5-200; 3 lect and 2 rec hrs per wk)

AEM 5-202. INCOMPRESSIBLE BOUNDARY LAYER THEORY. (4 cr; prereq 5-200; 3 lect and 2 rec hrs per wk)

AEM 5-204. INCOMPRESSIBLE POTENTIAL FLOW. (4 cr; prereq 5-200 or ‡)

AEM 5-206. AERODYNAMICS OF LIFTING SURFACES. (4 cr; prereq 5-200)

AEM 5-220. INTERMEDIATE INVISCID FLOW. (4 cr; prereq 5-200 or ‡)

AEM 5-240. RAREFIED GAS DYNAMICS. (4 cr; prereq 5-201 or ‡)

AEM 5-241. HIGH SPEED GAS DYNAMICS. (4 cr; prereq 5-201)

AEM 5-242. ONE-DIMENSIONAL GAS DYNAMICS. (3 cr; prereq 5-202)

AEM 5-270. TURBULENCE AND ATMOSPHERIC FLUID DYNAMICS. (4 cr; prereq some background in viscous flow, such as 5-202 or ‡)

AEM 5-290. INTRODUCTION TO MAGNETOHYDRODYNAMICS. (4 cr; prereq 5-200 or ‡)

AEM 8-201. FOUNDATIONS OF FLUID MECHANICS. (4 cr; prereq 1 yr undergrad fluid mechanics, ¶Math 5-457 or Math 5-571 or ‡)

AEM 8-202, 8-203. INVISCID FLUID MECHANICS. (4 cr; prereq 8-201 or ‡)

AEM 8-207. INSTABILITY OF FLOW OF VISCOUS FLUIDS. (3 cr; prereq 8-201 or ‡)

AEM 8-208. NONLINEAR THEORIES OF HYDRODYNAMIC STABILITY. (3 cr; prereq 8-207 or ‡)

AEM 8-209. ROTATING FLUIDS. (3 cr; prereq background in fluid mechanics especially boundary layer theory)

AEM 8-210/8-211. VISCOUS FLUID MECHANICS. (3 cr; prereq 8-201 or ‡)

AEM 8-216. THEORY OF TURBULENCE. (3 cr; prereq 5-680, Math 5-211 or equiv or ‡)

AEM 8-217. APPLICATIONS OF TURBULENCE THEORY. (3 cr; prereq 8-216 or equiv or ‡)

AEM 8-230/8-231/8-232. TRANSONIC AND HYPERSONIC FLOW. (3 cr per qtr; prereq 8-203)

AEM 8-240. PERTURBATION METHODS IN FLUID MECHANICS. (3 cr; prereq 8-202 or ‡)

AEM 8-250/8-251/8-252. MAGNETOFLUIDDYNAMICS. (3 cr per qtr; prereq 8-203 or Phys 5-012)

AEM 8-280. INTERNAL RAREFIED GAS FLOW. (3 cr; prereq 5-240 or ‡)

AEM 8-285/8-286. SELECTED TOPICS IN RAREFIED GAS DYNAMICS. (3 cr for 8-285, 1 to 3 cr for 8-286; prereq 5-240, 8-201 or ‡)

ChEn 5-102. PRINCIPLES OF CHEMICAL ENGINEERING. (4 cr; prereq 5-101)

ChEn 8-101. INTERMEDIATE FLUID MECHANICS. (3 cr; prereq 5-103, ‡)

ChEn 8-102. PROBLEMS IN FLUID MECHANICS. (3 cr; prereq 8-101)

ChEn 8-103. TENSORS AND FIELD THEORY WITH APPLICATIONS TO CONTINUUM MECHANICS. (3 cr; prereq 8-201)

ChEn 8-104. BOUNDARY AND INTERFACE MECHANICS. (3 cr; prereq 8-103; offered 1972-73 and alt yrs)

ChEn 8-105. PRINCIPLES AND APPLICATIONS OF RHEOLOGY. (3 cr; prereq 8-101, 8-103, or ‡; offered 1973-74 and alt yrs)

ChEn 8-106. ADVANCED TOPICS IN FLUID MECHANICS AND TRANSPORT PROCESSES. (3 cr; prereq 8-101, 8-103)

ChEn 8-601/8-602/8-603. MOLECULAR THEORY OF TRANSPORT PROCESSES. (3 cr per qtr; prereq ‡)

CE 5-401. WATER RESOURCES ENGINEERING. (5 cr; prereq 3-400 or AEM 5-200 or ‡)

CE 5-402. HYDRAULIC ANALYSIS. (4 cr; prereq 5-401 or ‡)

CE 5-405. HYDROLOGY. (4 cr; prereq 5-401 or ‡)

CE 5-410. OPEN CHANNEL HYDRAULICS. (4 cr; prereq 3-400, 5-401 or ‡)

CE 5-420. INTRODUCTION TO WATER RESOURCES MANAGEMENT. (4 cr)

CE 5-435. INTERMEDIATE FLUID MECHANICS WITH APPLICATIONS. (4 cr; prereq 3-400)

CE 5-505. MANAGEMENT OF THE AQUATIC ENVIRONMENT. (4 cr; prereq ‡)

CE 8-400.* HYDRAULIC TRANSIENTS. (3 cr; prereq 5-401 or ‡) Song

CE 8-431/8-432/8-433. HYDRODYNAMICS OF THE BOUNDARY LAYER. (3 cr per qtr; prereq 5-435 or ‡) Silberman

CE 8-430. LAKE, RESERVOIR, AND OCEAN HYDRODYNAMICS. (3 cr; prereq 3-400 or equiv)

CE 8-435, 8-436, 8-437. SPECIAL TOPICS IN HYDRODYNAMIC THEORY. (3 cr per qtr; prereq 8-433 or ‡; offered when demand warrants) Staff

CE 8-410.* FLUID TURBULENCE. (3 cr; prereq 5-435; offered when demand warrants) Silberman

CE 8-412.* MECHANICS OF SIMILITUDE AND DIMENSIONAL ANALYSIS. (3 cr; prereq 5-401) Anderson

CE 8-413.* MECHANICS AND SEDIMENT TRANSPORT. (3 cr; prereq 5-410 or ‡)

CE 8-415.* WATER POWER. (3 cr; prereq 5-405) Ripken

CE 8-416. HYDRAULIC PUMPS AND TURBINES. (3 cr; prereq 3-400 or ‡) Ripken

CE 8-417. HYDRAULIC MEASUREMENTS. (3 cr; prereq 3-400 or ‡) Ripken

CE 8-420. WATER RESOURCES SYSTEMS. (4 cr; prereq 5-420, some background in computer use)

CE 8-421.* INCOMPRESSIBLE POTENTIAL FLOW. (3 cr, §AEM 5-204; prereq 5-435 or ‡) Silberman, Song

CE 8-422.* INCOMPRESSIBLE BOUNDARY LAYER FLOW. (3 cr, §AEM 5-201; prereq 5-435 or ‡) Silberman, Song

CE 8-425.* GROUNDWATER HYDRAULICS. (3 cr; prereq 3-400 or ‡) Hayden

CE 8-497/8-498/8-499.* ADVANCED HYDRAULIC LABORATORY. (2 cr per qtr; prereq ‡)

Math 5-441. MATHEMATICAL THEORY OF FLUID FLOW. (4 cr; prereq 3-231 or 5-602, 5-568 or 5-572)

Math 8-430/8-431/8-432. MATHEMATICAL THEORY OF FLUID DYNAMICS. (3 cr per qtr; prereq 5-602, 5-573, or ‡)

Math 8-433. MATHEMATICAL ASPECTS OF BOUNDARY LAYER THEORY. (3 cr; prereq 5-602, 5-573 or ‡)

ME 5-344. THERMODYNAMICS OF FLUID FLOW. (4 cr; prereq CE 3-400, ME 3-301 or equiv)

ME 5-443.* TURBOMACHINERY. (3-5 cr; prereq 3-301 or equiv)

ME 8-326. BOILING HEAT TRANSFER AND MULTIPHASE FLOW. (3 cr; prereq 5-342 or ‡)

ME 8-331.* CONVECTION. (3 cr; prereq 8-330) Eckert

ME 8-333.* ADVANCED THEORY OF HEAT TRANSFER. (3 cr; prereq 5-342)

ME 8-350.* ADVANCED FLUID THERMODYNAMICS. (3 cr; prereq 5-344, 8-310 or ‡) Ibele

ME 8-370/8-371/8-372.* MAGNETOHYDRODYNAMICS. (3 cr per qtr; prereq 5-340 or AEM 5-202, Math 5-403 or ‡) J Anderson

FOOD SCIENCE AND INDUSTRIES (FScI)

Professor

Elmer L. Thomas, *acting head*
Francis F. Busta, *director of graduate study*
C. Eugene Allen
Charles V. Morr
Howard A. Morris

Associate Professor

William M. Breene
Theodore P. Labuza

Assistant Professor

Larry L. McKay
Gary A. Reineccius
John R. Rosenau
Sita R. Tatini
David R. Thompson

Prerequisites—Superior students having a B.S. or B.A. degree from an accredited college or university with a major in any physical science-oriented or biological science-oriented field may be considered as having the necessary prerequisites. However, if preparation appears to be inadequate, certain additional courses may be required.

Major and Minor—Students working toward the M.S. or Ph.D. degrees may emphasize chemistry, process engineering, physics, or microbiology of food products. It is suggested that students present a minor in one of the following fields: chemistry (analytical), biochemistry, chemical engineering, industrial engineering, microbiology, physiology, public health, economics, or business administration.

Language Requirement—At the discretion of the adviser.

Master's Degree—Offered under Plan A. Plan B may be followed with adviser's approval.

Doctor's Degree—Work leading to the Ph.D. degree is offered.

5-100. SEMINAR: FOOD INDUSTRIES LITERATURE. (2 cr; prereq Rhet 1-002, 3-551) Manning
Selected topics. Food literature. Preparation of bibliographies. Student presents papers and reports on assigned subjects and reviews scientific investigations in food industries.

5-120.* FOOD MICROBIOLOGY. (3 cr for lect, 2 cr for lab [lect taken separately by ‡]; prereq MicB 3-103) Busta, McKay
Relationship of environment to occurrence, growth, and survival of microorganisms in foods; evaluation of microbiological quality of dairy and food products; recognition and control of food-borne pathogens and food poisoning.

5-122.* SANITATION AND PROCESS MICROBIOLOGY. (3 cr for lect, 1 cr for lab [lect taken separately by ‡]; prereq 3-120 or 5-120 or ‡) Busta
Factors that influence control and destruction of microorganisms; chemical, physical, and microbiological principles in cleaning and sanitizing dairy and food processing equipment; inactivation of microorganisms and thermal process evaluation; microbiological fermentations and preservation methods; development of sanitation programs; microbiological standards for dairy and food products.

5-222. PRINCIPLES OF DAIRY PROCESSING I. (4 cr; prereq 3-120, 3-110, 3-132 or ‡) Thomas
Application of scientific principles to problems involved in processing of fluid and concentrated milk products. Physical and chemical properties of fluid milk systems and their control. Demonstrations of basic processing operations including heating, cooling, homogenization, evaporation, crystallization, and freezing.

5-310.* ADVANCED FOOD CHEMISTRY TOPICS. (4 cr; prereq sr or ‡) Morr
In-depth study of food chemistry and current food chemistry research topics.

5-311. SPECIAL PROBLEMS IN FOOD CHEMISTRY. (1-5 cr; hrs ar) Morr, Manning, Labuza
Laboratory or library research on problems related to chemistry, applied to foods or food processing.

5-320.* ADVANCED DAIRY AND FOOD MICROBIOLOGY. (4 cr; prereq sr, 5-122, or ‡) McKay, Tatini
Microbiology of food starter cultures; composition of starters, nutrition and metabolism, inhibitors in milk, strain association and compatibility, preservation and mass production, and bacteriophage in cheesemaking. Influence of food environments on spore formation, activation, germination, and resistance. Natural and microbial toxicants in foods; occurrence, techniques for monitoring their presence, and control.

5-321.* SPECIAL PROBLEMS IN DAIRY AND FOOD MICROBIOLOGY. (1-5 cr; prereq sr or ‡; hrs ar) Staff
Laboratory or library research on problems related to microbiology of dairy and food products.

5-350. FOOD FORMULATION, PRODUCT DEVELOPMENT. (4 cr; prereq Biom 1-010 or equiv) Morris
Application of concepts and techniques of experimental design to solution of food science problems. Case studies, computer programming and use.

5-360.* SENSORY TESTING OF FOODS: THEORY AND METHODOLOGY. (2 cr; 3 lab hrs per wk) Thomas
Fundamentals of flavor perception; sensory evaluation of properties of food products with emphasis on methodology and interpretation of test results.

5-380. FOOD PACKAGING. (3 cr; prereq Phys 1-020 or 1-050) Thomas
Lecture and demonstration of properties of various packaging materials and their uses in the food industry.

5-510. MUSCLE CHEMISTRY AND PHYSIOLOGY. (4 cr; prereq 1-300, BioC 1-302 or equiv ... AnSc 1-500 recommended) Allen
(Same as AnSc 5-510) Fundamental properties of muscle ultrastructure, chemistry, and physiology as they relate to muscle proteins, growth, contraction, energy metabolism, adaptive responses, rigor mortis, and conversion of muscle to meat.

5-512. MEAT CHEMISTRY AND PROCESSING. (4 cr; prereq 1-500, BioC 1-302) Addis
(Same as AnSc 5-512.) Meat proteins; effects of pH, salt, and temperature on hydration and emulsification; methods of fractionation. Meat preservation, effects of heat, freezing, curing; 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).

5-523.* PRINCIPLES OF DAIRY PROCESSING II. (3 cr; prereq 3-120, 3-110, 3-132) Morris
Manufacture of cheese and fractionated milk proteins with emphasis on application of chemical, microbiological, and physical principles.

5-530.* INDUSTRIAL PROCESSING OF FRUITS AND VEGETABLES. (4 cr; prereq 3-110, 3-120, 3-130 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, and freezing.

5-555.* FREEZING AND DEHYDRATION OF FOODS. (4 cr; prereq 3-135, 3-110, 5-120, or ‡) Labuza
Principles involved in processing, handling, and storage of frozen, dry, and intermediate moisture foods with emphasis on physical-chemical properties of water in foods.

5-561. SUPERVISED INDUSTRY PRACTICE. (4 cr; prereq 15 cr) Thomas
Practical training and experience in some operational phase of the dairy and food industries. Includes a minimum of 2 months' employment in an approved position and written reports.

5-571.* SPECIAL PROBLEMS IN FOOD MANUFACTURING. (1-5 cr; prereq sr or ‡; hrs ar) Staff
Individual laboratory or library research on chemical, physical, and engineering problems involved in processing and utilization of food products.

5-581.* INTERNATIONAL FOOD TECHNOLOGY. (4 cr; prereq sr; hrs ar) Morris, Thomas
Independent study of food processing problems and developments throughout the world. Relation of food technology to adequate feeding of peoples of the world will be emphasized.

8-205x.* GENERAL SEMINAR. (1 cr) Staff
Review of literature and discussion of research problems and developments related to dairy and food chemistry, microbiology, and physics.

FORESTRY

Professor

Frank H. Kaufert, *dean*
Richard A. Skok, *associate dean, director of graduate study*
Kenneth E. Winsness, *director of undergraduate programs*
Arnett C. Mace, Jr., *head, Forest Biology*
John G. Haygreen, *head, Forest Products*
Frank D. Irving, *head, Forest Resources Development*
Bruce A. Brown, *director, Cloquet Forestry Center*
Egolfs V. Bakuzis
Henry L. Hansen
Ralph L. Hossfeld
Jay M. Hughes
Lawrence C. Merriam, Jr.
Merle P. Meyer
Edward I. Sucoff

Associate Professor

Robert W. Erickson
Douglas J. Gerrard
Roland O. Gertjejansen
Hans M. Gregersen
Alvin R. Hallgren
Harold Scholten
John C. Tappeiner II
Robert D. Thompson

Assistant Professor

Timothy B. Knopp
Carl A. Mohn
Joseph J. Ulliman

Prerequisites—The prerequisites for entering the master of forestry program may be either an undergraduate degree program in forestry or completion of a 4-year undergraduate college degree including college-level courses in algebra, inorganic chemistry, physics, and 2 quarters of college biology. Applicants for admission to study for the master of science degree or the Ph.D. degree are expected to have completed Bachelor's or advanced degrees in forestry or in related sciences as dictated by the major field of specialization. Consideration will be given to students who have included in their undergraduate college curriculum sufficient pertinent subject matter to qualify them to undertake graduate work with specialization in the forest sciences or in the forest products area.

Master of Forestry Degree—Students will fulfill the general requirements for the master of science degree under Plan B. This program is designed to meet the needs for professional study by qualified students primarily interested in administration and professional work in forest resources development. For completion of the M.F. degree, the following courses or their equivalent must have been completed in the undergraduate program or during the student's graduate studies.

FBio 1-100—Dendrology (4 cr)
FBio 3-101—Forest Ecology (3 cr)
FBio 5-100—Silviculture (4 cr)
FRD 3-204—Statistical Methods in Forestry (4 cr)
FRD 5-200—Aerial Photo Interpretation (3 cr)
FRD 5-212—Forest Economics (4 cr)
FRD 5-213—Forest Management and Administration (5 cr)
FRD 5-215—Forest Mensuration (3 cr)
FRD 5-230—Forest Fire (2 cr)
FRD 5-232—Management of Recreational Lands (3 cr)
FRD 5-237—Forest Meteorology and Hydrology (4 cr)
FW 3-050—Principles of Fisheries and Wildlife Management (3 cr)
Ent 5-050—Forest Entomology (4 cr), or
PlPa 3-050—Forest Pathology (4 cr)
1 quarter of forestry field camp experience

Master of Science Degree—Students will fulfill the general requirements of the master of science degree under either Plan A or Plan B, to be decided jointly with their adviser. The student's program of study is determined in consultation with the adviser and subject to approval by the College of Forestry's Graduate Study Committee and a Unit Committee of the Graduate School. The foreign language requirement for Plan A is waived unless the adviser and the Graduate Study Committee of the College of Forestry deem it necessary for the student's program.

Doctor's Degree—Work leading to the Ph.D. degree is offered under the general requirements for that degree. A program of study may be developed to include either a specific minor subject or a coherent supporting subject program.

Each student pursuing a Ph.D. program in forestry shall elect, in consultation with the adviser and with approval of the school's Graduate Study Committee, either (a) a foreign language, (b) a special research technique, or (c) a collateral field of knowledge as a supplement to the major and minor (or supporting program) course work.

Research Facilities—The Cloquet Forestry Center, the Forestry and Biological Station at Lake Itasca, and the forest products and forest science laboratories on the St. Paul Campus are available to students for the development of requisite problem and thesis research.

Forest Biology (FBio)

5-100. SILVICULTURE. (4 cr; prereq FBio 1-100, 3-101...Soil 1-122, or ‡) Scholten
Introduction to the silvicultural systems, intermediate cuttings, and related practices. Forest regeneration problems and techniques.

5-101. FIELD SILVICULTURE. (5 cr; prereq FBio 5-100; given at Cloquet) Tappeiner
Lectures and field work in relation to timber stand improvement projects, stand examinations and prescriptions, seeding and planting, and related silvicultural practices.

5-102.° REGIONAL SILVICULTURE. (3 cr; prereq FBio 5-100 or ‡) Hansen
Forest regions of North America emphasizing silvical, historical, geographic, economic, and other determinants of forest management. Topics and field trips on special problems of current forestry concern.

5-103.° ADVANCED FOREST TREE BIOLOGY. (3 cr; prereq ‡) Sucoff
Treatment of current applications and research in forest tree biology.

5-104. FOREST METEOROLOGY AND HYDROLOGY. (4 cr; prereq Itasca...Soil 1-122...Geo 1-001, or ‡) Mace
Analysis of effects of climate on the forest ecosystem and components of the hydrologic cycle. Principles of managing the forest system including effects of climate and vegetation on soil moisture, timing of runoff and water quantity and quality.

5-115. FOREST BIOLOGY SEMINAR. (1 cr; prereq grad, or 5-401, or ‡) Staff
Presentation of research proposals, plans, progress, and results.

5-150.° PRINCIPLES OF SILVICS. (3 cr; prereq sr, FBio 5-100, 5-101, or ‡) Hansen
Survey of classical concepts and contemporary developments in ecology as related to forestry. Discussion group format.

5-151.° MULTIPLE-USE SILVICULTURE. (3 cr; prereq sr...FBio 5-100, or ‡) Hansen
Ecomanagement of forest areas with special emphasis on aesthetic, wildlife, and other nontimber values.

5-152.° FOREST GENETICS. (3 cr; prereq ‡) Mohn
Heredity and variation of important forest-tree species; applications of genetic principles in tree improvement.

5-153.° ADVANCED FOREST HYDROLOGY. (3 cr; prereq 5-104 or ‡) Mace
Recent literature relating to management of the forested watershed. Methods of analyzing research data.

8-100.° RESEARCH PROBLEMS: SILVICULTURE. (Cr ar) Bakuzis, Brown, Hansen, Scholten, Tappeiner

8-101.° RESEARCH PROBLEMS: FOREST-TREE PHYSIOLOGY. (Cr ar) Sucoff

8-102.° RESEARCH PROBLEMS: FOREST-TREE GENETICS. (Cr ar) Mohn

8-103.° RESEARCH PROBLEMS: FOREST HYDROLOGY. (Cr ar) Mace

8-104.° FOREST ECOSYSTEMS. (3 cr) Bakuzis
Structure, dynamics and productivity of forest ecosystems. Models and classification of ecosystems, theory and application.

Forest Products (ForP)

5-300.* FUNDAMENTAL WOOD PROPERTIES I: WOOD FLUID RELATIONSHIPS. (3 cr; prereq ForP 1-302) Erickson
Discussion of wood permeability and fluid movement above and below the fiber saturation point. Adsorption, hysteresis, swelling, and dimensional stabilization.

5-301. FUNDAMENTAL WOOD PROPERTIES II: PHYSICAL PROPERTIES. (4 cr; prereq ForP 5-300) Hossfeld
Strength, time-strain relationships, heat transfer, and electrical properties. Lectures and demonstrations.

5-302. FUNDAMENTAL WOOD PROPERTIES III: WOOD CHEMISTRY. (3 cr; prereq Chem 3-301, 3-302) Hossfeld
Chemical composition, reactions, and analysis of wood, wood components, and derivatives.

5-303. FUNDAMENTAL WOOD PROPERTIES IV: WOOD DETERIORATION AND PRESERVATION. (4 cr; prereq ForP 1-301) French, Kaufert
Wood deterioration by bacteria, fungi, insects, marine organisms, fire, and weathering. Lectures, reading discussion, arranged laboratories, and reports.

5-304.* WOOD PROCESSING I: DRYING AND IMPREGNATION TECHNOLOGY. (3 cr; prereq ForP 5-300, 5-303 or ‡) Erickson
Air drying, kiln drying and specialized drying techniques. Treatment of wood for increased decay, fire, and weather resistance. Laboratory.

5-305. WOOD PROCESSING II: PULP AND PAPER TECHNOLOGY. (4 cr; prereq ForP 5-300, 5-301, or ‡) Gertjejansen
Pulping processes; fiber refining and processing; manufacture of paper; fiber and paper properties; recycling of paper; and water intake and effluent treatments. Lecture and laboratory.

5-306. WOOD PROCESSING III: MANUFACTURING PROCESSES. (3 cr; prereq ForP 1-301) Haygreen
Manufacturing of wood-based products considered from systems point of view. Input requirements, machinery selection, methods of economic comparison. Field trip.

5-307. WOOD PROCESSING IV: FIBERBOARD AND PARTICLEBOARD TECHNOLOGY. (3 cr; prereq ForP 5-305) Gertjejansen
Design, manufacture, properties, and application of fiberboards and particleboards. Adhesives and their application in the board industry. Lectures and a laboratory research project.

5-310. ADVANCED PULP AND PAPER TECHNOLOGY. (4 cr; prereq ForP 5-305) Gertjejansen
Refiner action and fiber morphology; rheological properties of wet webs and paper; chemistry of internal additives; coating technology.

5-311.* MANUFACTURED HOUSING SYSTEMS. (4 cr; prereq ‡) Haygreen
Development and principles of manufactured housing systems. Analysis of wood-frame construction technology. Strength and related properties of wood and wood based materials as related to design. Material and design optimization. Analysis of plant layout.

5-350. WOODY TISSUE MICROTECHNIQUE. (2 cr; prereq ForP 1-302) Hossfeld
Use of sliding and rotary microtomes, hand sectioning, maceration, differential staining, and special techniques in preparation of woody tissue for microscopic study. Laboratory.

5-351.* MOISTURE RELATIONS IN WOOD. (3 cr; prereq ForP 5-300) Hossfeld
Moisture movement in wood related to microphysical and chemical structure and its influence on development of stress during drying and subsequent use.

5-352.* ADVANCED WOOD PRESERVATION. (3 cr; prereq ForP 5-303, 5-304) Kaufert
Factors governing toxicity, permanence, and effectiveness of wood preservatives to fungi, insects, and marine borers. Fire retardant and treatments. Permeability of wood, penetration of preservatives, and heat transfer.

5-353. ADVANCED WOOD CHEMISTRY. (2 cr; prereq ForP 5-302...Chem 3-100, 3-101 or equiv; offered when feasible) Hossfeld
Laboratory problems in analysis of wood constituents and in techniques of their isolation and purification.

5-355.* MECHANICAL BEHAVIOR OF WOOD. (3 cr; prereq AEM 1-015, 3-016) Haygreen
Orthotropic nature of wood; elastic and inelastic behavior; effect of moisture, temperature, and time. Some consideration of plywood, particleboard, and fiberboard properties.

5-356. ADVANCED FOREST PRODUCTS MARKETING. (3 cr; prereq ForP 3-303) Thompson
Lectures and case studies of retail, wholesale manufacture, and market analysis research of forest products business.

5-358.* PULP AND PAPER TECHNOLOGY: SPECIAL TOPICS. (2 cr; prereq ForP 5-310 or ‡) Gertjejansen
Laboratory problems in properties of wood fiber, paper, and paper products.

8-300.* RESEARCH PROBLEMS: FOREST PRODUCTS ENGINEERING. (Cr ar) Erickson, Haygreen, Hossfeld, Gertjejansen, Kaufert.

8-301.* RESEARCH PROBLEMS: FOREST UTILIZATION. (Cr ar) Erickson, Gertjejansen, Haygreen, Hossfeld, Kaufert, Thompson

Forest Resources Development (FRD)

5-090. INTRODUCTION TO RESEARCH. (3 cr; prereq sr or ‡) Hossfeld
Research philosophy, objectives, problem development, analytical principles, and presentation, illustrated by situations in forestry.

5-200. AERIAL PHOTO INTERPRETATION. (3 cr; prereq ¶5-215 or ‡) Meyer, Ulliman
Use of aerial photographs; preparation of planimetric and vegetative type maps. Photo interpretation and application to resource management. Lectures and laboratory.

5-202. FOREST INVENTORY AND PHOTOGRAPHIC INTERPRETATION. (4 cr; prereq FRD 3-204, 5-200, 5-215, AgEn 1-400; given at Cloquet) Gerrard, Ulliman
Type delineation, area measurement, map construction, cruise design, and timber measurement using aerial photos.

5-210. MULTIPLE USE. (5 cr; prereq AgEc 1-020; given at Cloquet) Brown and staff
Elements and interrelationships of forest administration, management, utilization, engineering, hydrology, and recreation. Lectures, field trips, and problems.

5-212. FOREST ECONOMICS. (4 cr; prereq AgEc 1-020 or ‡) Gregersen
Examination of the United States and world forest resource supply and consumption relationships; forest products industries and wood products users characteristics; aggregate and firm capital use theory for long period production processes; market systems for principal forest products; macro problems of the forest economy; and decision-making in micro forest economic situations. Lectures and problems.

5-213. FOREST MANAGEMENT AND ADMINISTRATION. (5 cr; prereq FRD 3-204, 5-212 ...¶FBio 5-100 or ‡) Irving
Inventory, regulation, and continuous production of timber. Economic analysis production problems. Organization and administration of forestry enterprises.

5-230. FOREST FIRE. (2 cr; prereq FBio 1-100 or ‡) Sando
Fire behavior, effects, control, and use.

5-231.* RANGE MANAGEMENT. (4 cr; prereq FRD 5-237...Biol 1-011, or ‡) Meyer
Grazing animal production on forest and open range lands; relationship to other land uses.

5-232. MANAGEMENT OF RECREATIONAL LANDS. (3 cr) Merriam
Recreational use of the forest and associated land and water. Policy problems arising from recreational demands.

5-233.* PRINCIPLES OF OUTDOOR RECREATION DESIGN AND PLANNING. (4 cr; prereq FRD 5-232) Knopp
(Same as Hort 5-010) 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.

5-234. FOREST PROTECTION. (2 cr; prereq FRD 5-230 or ‡; given at Cloquet) French, Irving, Kulman
Field exercises in the behavior, effects, control, and use of fire. Identification and ecology of forest disease and insect problems.

5-238. TIMBER HARVESTING. (2 cr; prereq jr, sr, or ‡) Hallgren
Principles and general methods of logging in different forest regions of the United States, and modifications required by forest management.

5-250.° FOREST POLICY. (3 cr; prereq sr or ‡) Irving, Skok
Public and private forest policies in the United States. Forest policies of other nations. Analysis of current policy issues. Lectures and reports.

5-251.° ADVANCED FOREST ECONOMICS. (3 cr; prereq FRD 5-212 or ‡) Gregersen, Skok
Economics of forest resource development and forest products.

5-252. REMOTE SENSING OF NATURAL RESOURCES. (4 cr; prereq sr, FRD 5-200 or ‡) Meyer
Photogrammetric systems, flight planning, contracting, contract inspection; advanced photo interpretation, mapping and measurement problems. Laboratory.

5-253.° ADVANCED FOREST MENSURATION. (3 cr; prereq 3-204, 5-215, Stat 5-022, or ‡) Applications of statistical and advanced mensurational methods in analysis and interpretation of forestry data and forest survey sampling methods. Lectures and laboratory.

5-254.° ADVANCED FOREST MANAGEMENT AND ADMINISTRATION. (3 cr; prereq sr or ‡; offered 1972-73 and alt yrs) Irving
Traditional and contemporary forest management concepts and practices. Administrative science applications in technical organizations concerned with forest land management.

5-256. PLANNING, CONTROL IN FORESTRY. (3 cr; prereq sr, FRD 5-212, 5-213, or ‡; offered 1973-74 and alt yrs) Hughes
Analysis of forest management objectives and their relationship to forestry planning concepts including systems analysis, and the control of significant biological and economic variables in forest production alternatives.

5-257.° RECREATIONAL LAND POLICY. (3 cr; prereq FRD 5-232 or ‡) Merriam
Discussion and analysis of policy issues affecting the use and management of lands devoted entirely or in part to recreational objectives.

5-258.° OUTDOOR RECREATION ECONOMICS. (3 cr; prereq FRD 5-232, 5-257...AgEc 1-020, or ‡) Hughes
The role of economic analysis in outdoor recreation; analysis of alternative methodologies for valuation and choice problems, including both supply and demand aspects; discussion and analysis of major trends and issues. Lectures, readings, discussions, reports.

5-259.° RECREATION LAND AMENITIES AND THE USER. (3 cr; prereq FRD 5-232 and ‡) Knopp
Concepts and management of parks, forests, and other recreational areas for recreation visitors. The role of interpretive education, user preference in relation to administrative objectives. Principles of area management, individual and group influences. Lecture, discussion, reports, reading.

5-260.° ADVANCED MANAGEMENT OF RECREATIONAL LANDS. (3 cr; prereq FRD 5-232...Ecol 3-004 or ‡) Hansen, Merriam
Discussion of relationship of man as recreationist to the natural environment. Principles of manipulation of plant and animal communities for outdoor recreation objectives. Lectures, reading, discussion, reports. Field trips.

5-261.° FORESTRY AND ECONOMIC DEVELOPMENT. (3 cr; prereq sr or grad student... FRD 5-212 or ‡) Gregersen
The role of forestry and forest industries in economic development explored through application of economic theory and through case studies with emphasis on low income countries of the world. Sector programming and project planning techniques are discussed as they relate to forestry development.

8-103.° RESEARCH PROBLEMS: FOREST HYDROLOGY. (Cr ar) Mace

8-200.° RESEARCH PROBLEMS: FOREST MANAGEMENT. (Cr ar) Brown, Hallgren, Hughes, Irving

8-201.° RESEARCH PROBLEMS: FOREST ECONOMICS. (Cr ar) Gregersen, Hughes, Skok

8-202.° RESEARCH PROBLEMS: FOREST MEASUREMENTS. (Cr ar) Gerrard, Meyer, Ulliman

8-203.° RESEARCH PROBLEMS: FOREST RECREATION. (Cr ar) Hansen, Hughes, Knopp, Merriam

8-204.° RESEARCH PROBLEMS: FOREST POLICY. (Cr ar) Gregersen, Hallgren, Hughes, Irving, Merriam, Skok

8-205.° RESEARCH PROBLEMS: REMOTE SENSING AND PHOTOGRAMMETRY. (Cr ar) Gerrard, Meyer, Ulliman

FRENCH AND ITALIAN

Professor

Armand A. Renaud, *coordinator of graduate study*
Peter W. Lock
Arshi Pipa
Joseph L. Waldauer

Associate Professor

F. R. P. Akehurst
Lawrence C. Mantini

Assistant Professor

Peter H. Robinson, *chairman*
George H. Bauer
Harry Baxter
Ronald L. Chastain
Tom Conley
Henry E. Kalb
Margaret A. Mack
Thomas D. O'Donnell
Marilyn Schneider

Instructor

Stephen B. Davidson
Eileen B. Sivert

Prerequisites—For major work, 45 upper division credits or equivalent in the major field (French or Italian) of which at least 25 credits must be in literature courses. Candidates will ordinarily find it necessary to supplement their undergraduate work by a considerable amount of independent reading. Lists of required and recommended readings are available from the departmental secretary.

Language Requirement—Candidates for the Master's degree must have a reading knowledge of at least one modern 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). Candidates for the Doctor's degree must have a knowledge of Latin equivalent to at least 2 years of high school Latin. The language requirement may be satisfied in any of the following methods:

a. Two languages: one Romance language and one appropriate research tool.
b. Higher proficiency in a language suitable as a research tool.
c. A special research technique.
d. Any bilaterally agreed solution.

Master's Degree—Offered under both Plan A and Plan B in French and Italian. There is also a Master's degree with a double major in French and Italian.

Doctor's Degree—Offered in both French and Italian.

Before registering for their first quarter of graduate work, students should consult the coordinator of graduate study in their major. They are to familiarize themselves with the special requirements of the department, which include submitting a provisional (departmental) program for the M.A. during the second quarter of residence; Ph.D. candidates must file a provisional program within 2 quarters after obtaining an M.A. degree at this University, or during the second quarter of residence if accepted to work directly toward the doctorate. Detailed information, mimeographed, is available from the departmental secretary and is also posted on the graduate bulletin board of the department.

Comparative Literature—For information on this program see the Comparative Literature section of this bulletin.

French (Fren)

5-011. ADVANCED PROBLEMS IN FRENCH LANGUAGE. (5 cr; prereq major in French, ‡) Chastain
Troublesome aspects of the French language relating to grammar, usage, levels of expression, and pronunciation. Special emphasis on problems encountered by the native speaker of American English. Classroom contact with students enrolled in beginning and intermediate French classes by grad student teachers.

5-012. STYLISTICS. (5 cr; prereq 3-035 or ‡) Kalb
Structural and stylistic dimensions of literary works as they relate to language. Examples from a variety of genres and periods. Taught in French.

5-013. INTRODUCTION TO FORMAL ANALYSIS. (5 cr) Staff
Outstanding literary texts from Middle Ages to 20th century. Analysis of language, themes, and structure as a whole and in depth.

5-201/5-202/5-203. FRENCH LITERARY DOCTRINES FROM PLÉIADE TO THE PRESENT. (5 cr per qtr).

5-204/5-205/5-206. MOUVEMENT DES IDEES. (5 cr per qtr; prereq 3-501, 3-502, or ♯)
Designed primarily for graduate students. Taught in French.

5-207. OLD FRENCH. (5 cr; prereq 1 yr Latin or ♯)
Language course in preparation for reading medieval French texts in the original.

5-208. LITERATURE OF THE LATE MIDDLE AGES. (5 cr; prereq grad or 3-209 or above) Akehurst
Poetry, narrative prose, and chroniclers from around the period of the Hundred Years War. Charles d'Orleans, Villon, Christine de Pisan, Antoine de la Sale, Commynes, *Quinze Joyes, Cent Nouvelles, nouvelles,* etc.

5-219. HUMANISM AND ITALIANISM IN THE LITERATURE OF THE 16TH CENTURY. (5 cr; prereq 3-209 or above) Renaud, Pipa.
Systematic study of aspects of Italian civilization of the 14th-15th-16th centuries that lead to the French Renaissance and the Humanistic trends. Principally French and Italian literary works, but also some paraliterary works.

5-259. L'ENCYCLOPÉDIE. (5 cr; prereq 3-209 or above) Mack
Genesis of the Encyclopédie; analysis of its major articles and ideas.

5-261. ROMANTIC POETRY. (5 cr; prereq 3-209 or above)

5-262. SYMBOLIST POETS: VERLAINE, MALLARMÉ, RIMBAUD. (5 cr; prereq 3-209 or above) Robinson
Selected works, representing different aspects of symbolism. Taught in French.

5-269. FRENCH ROMANTICISM. (5 cr; prereq 3-209 or above) Lock

5-271. PROSE POETRY OF THE 19TH CENTURY. (5 cr; prereq 3-209 or above) Robinson
Prose poems of Baudelaire, Rimbaud, Mallarmé, and Lautréamont.

5-272. POST-SYMBOLIST POETS: LAFORGUE, CORBIERE, SAINT-POL ROUX, HENRI DE REGNIER. (5 cr; prereq 3-209 or above) Robinson
Poetry between symbolism and surrealism.

5-275. HUYSMANS AND VILLIERS (DE L'ISLE-ADAM): THE REACTION. (5 cr; prereq 3-209 or above)
Late 19th century literature through study of the reaction to Realism and Naturalism in the works of Huysmans, Villiers de l'Isle-Adam and others.

5-281. EARLY 20TH-CENTURY POETRY: APOLLINAIRE, BRETON, ELUARD. (3 cr; prereq 3-209 or above) Kalb
Poetry as it emerged out of the "experiments" undertaken at the end of the 19th century that lead to Apollinaire's concept of poetry and to the surrealist movement.

5-301. MEDIEVAL LYRIC POETRY. (5 cr; prereq 5-207 or ♯) Akehurst
Origins, form, and content of lyric poetry from the trouvères to Villon.

5-303. MEDIEVAL FRENCH DRAMA. (5 cr; prereq 5-207 or ♯) Akehurst
History of medieval French theatre from origins to the Renaissance.

5-305. MEDIEVAL FRENCH ROMANCE. (5 cr; prereq 5-207 or ♯) Akehurst
The Roman Courtois, with emphasis on Chrétien de Troyes.

5-307. MEDIEVAL FRENCH ALLEGORY AND SATIRE. (5 cr; prereq 5-207 or ♯) Akehurst, staff
Use of satire and allegory in the French *Fabliaux,* the *Roman de Renart* and *Roman de la rose.*

5-309. MEDIEVAL FRENCH EPIC. (5 cr; prereq 5-207 or ♯) Akehurst, staff
Origins, form, and history of epic literature of French middle ages.

5-311. POETRY OF THE 16TH CENTURY AFTER SCEVE. (5 cr; prereq 3-209 or above) Renaud, staff
Concentrates on Ronsard and DuBellay but examines lesser poets of the Pléiade and the first baroque poets, including Sponde, DuBartas, Desportes, Chassignet.

5-312. RENAISSANCE POETRY BEFORE THE PLÉIADE. (5 cr; prereq 3-209 or above) Renaud, staff
From the Grands Rhétoriqueurs to Marot and Saint-Gelais to "l'ècole lyonnaise" with special attention to Scève.

5-313. RENAISSANCE-BAROQUE DRAMA (EXCLUSIVE OF CORNEILLE). (5 cr; prereq 3-209 or above) Renaud, staff
Dramatic genres, particularly tragedy, from Jodelle to Rotrou.

5-331. FRENCH POETRY FROM D'AUBIGNE TO LA FONTAINE. (5 cr; prereq 3-209 or above) Renaud, staff
Movement from baroque to classicism in the great verse creations of the 17th century.

5-333. COMEDY OF THE 16TH AND 17TH CENTURIES (EXCLUSIVE OF MOLIERE). (5 cr; prereq 3-209 or above) Renaud, Baxter
Rebirth of comedy during the Renaissance, its encounter with traditional comic genres of the Middle Ages, its elaboration into a new comedy blending the heritage of Greece, Rome, Italy, Spain and France itself.

5-335. THE NOVEL OF THE 17TH CENTURY. (5 cr; prereq 3-209 or above) Renaud

5-338. NONFICTION PROSE OF THE 16TH AND 17TH CENTURIES. (5 cr; prereq 3-209 or above)
Significant writings in prose other than the novel.

5-339. SHORT STORIES OF THE 16TH AND 17TH CENTURIES. (5 cr; prereq 3-209 or above) Renaud, Conley
Development of narrative techniques and variants of short stories in France during the 16th and 17th centuries.

5-354. DRAMA OF THE 18TH CENTURY. (5 cr; prereq 3-209 or above) Waldauer
Discussion of tragedy, *drame*, comedy.

5-355. NOVEL OF THE 18TH CENTURY. (5 cr; prereq 3-209 or above) Waldauer

5-358. GNOMIC LITERATURE OF THE 17TH-18TH CENTURIES. (5 cr; prereq 3-209 or above) Mack
Emergence of the genre in antiquity, the Middle Ages and the Renaissance, and analyses of a few great realizations, including those of La Rochefoucauld, La Bruyère, Chamfort, Vauvenargues.

5-361. PARNASSIAN POETRY: GAUTIER, LECONTE DE LISLE, HEREDIA. (5 cr; prereq 3-209 or above) Robinson
The Art for Art's Sake movement and the Parnasse.

5-363. 19TH-CENTURY DRAMA. (5 cr; prereq 3-209 or above) Lock, staff
Alexandre Dumas to Henry Becque and Maeterlinck, with special attention to Hugo.

5-367. 19TH-CENTURY DRAMA: MUSSET. (5 cr; prereq 3-209 or above) Lock, staff

5-368. SHORT STORIES OF THE 19TH CENTURY. (5 cr; prereq 3-209 or above) Lock
From Charles Nodier to Anatole France with particular attention to Villiers de l'Isle-Adam. See 5-467 for Flaubert and Maupassant.

5-380. THE FRENCH NOVEL IN THE 20TH CENTURY. (5 cr; prereq 3-209 or above) Bauer
Trends. Typical works selected.

5-381. CLAUDEL. (5 cr; prereq 3-209 or above) Kalb

5-382. VALÉRY AND THE HERITAGE OF SYMBOLISM. (5 cr; prereq 3-209 or above) Kalb
Thorough study of the poetry of Valéry with attention to the sources of his concept of poetry.

5-383. 20TH CENTURY FRENCH DRAMA TO EXISTENTIALISM. (5 cr; prereq 3-209 or above) Bauer
Main trends, themes, and dramatic theories from symbolist and surrealist drama to existentialism.

5-384. 20TH CENTURY FRENCH DRAMA: EXISTENTIALISM TO THE PRESENT. (5 cr; prereq 3-209 or above) Staff
Concentrates on Anouilh, Sartre, Camus, Genet, Ionesco, Beckett, Arrabal; also examines less well-recognized dramatists of the last decade.

5-391. RECENT FRENCH POETRY. (5 cr; prereq 3-209 or above) Kalb, staff
Several contemporary French poets.

5-395. NOVEL OF L'ENTRE-DEUX GUERRES. (5 cr; prereq 3-209 or above) Staff
Complements other courses on French novel of this century. Works of Bernanos, Jules Romains, Colette, Duhamel, Giono, Giraudoux, Martin du Gard and Saint-Exupéry.

5-396. EXISTENTIAL NOVEL. (5 cr; prereq 3-209 or above) Bauer
Stress upon novelists from 1930's to present whose work reveals concern for what Malraux calls "the human condition": Malraux, Céline, Sartre, Camus, Blanchot, and Beckett.

5-397. LE NOUVEAU ROMAN. (5 cr; prereq 3-209 or above) O'Donnell
Nathalie Sarraute, Alain Robbe-Grillet, Michel Butor, and others.

5-398. FRENCH FICTION OF THE LAST DECADE. (5 cr; prereq 3-209 or above) O'Donnell
Representative texts since 1960.

5-415. RABELAIS. (5 cr; prereq 3-209 or above) Conley, Davidson
Gargantua and *Pantagruel* in original text.

5-418. MONTAIGNE. (5 cr; prereq 3-209 or above) Renaud
The *Essais* studied in depth, partially in light of the *Journal de Voyage.*

5-434. BAROQUE TRAGEDY: CORNEILLE. (5 cr; prereq 3-209 or above) Renaud, Baxter
Plays both as unique creations and in perspective of the aesthetics of the period.

5-438. PASCAL. (5 cr; prereq 3-209 or above) Renaud, Davidson
Les Pensées. The literary originality of the *Provinciales* is also analyzed.

5-443. CLASSICAL COMEDY: MOLIERE. (5 cr; prereq 3-209 or above) Renaud

5-444. CLASSICAL TRAGEDY: RACINE. (5 cr; prereq 3-209 or above) Renaud

5-455. BAYLE AND FONTENELLE. (5 cr; prereq 3-209 or above) Mack
Major philosophical works; some clandestine texts of the early Enlightenment in France.

5-456. MONTESQUIEU. (5 cr; prereq 3-209 or above) Mack
Complete works studied for literary merit and significance as contributions to social and political thought.

5-457. ROUSSEAU. (5 cr; prereq 3-209 or above) Waldauer

5-458. VOLTAIRE. (5 cr; prereq 3-209 or above) Waldauer

5-459. DIDEROT. (5 cr; prereq 3-209 or above) Waldauer

5-461. BAUDELAIRE. (5 cr; prereq 3-209 or above) Robinson
Analysis of *Les Fleurs du Mal,* Baudelaire's major work as typical of his creative adventure.

5-462. RIMBAUD. (5 cr; prereq 3-209 or above) Robinson
Poetry and writings.

5-463. HUGO. (5 cr; prereq 3-209 or above) Staff

5-465. STENDHAL. (5 cr; prereq 3-209 or above) Lock

5-466. BALZAC. (5 cr; prereq 3-209 or above) Lock

5-467. FLAUBERT, MAUPASSANT, AND NARRATIVE TECHNIQUES. (5 cr; prereq 3-209 or above) Lock

5-471. MALARMÉ. (5 cr; prereq 3-209 or above) Robinson
Poetry and writings.

5-475. ZOLA, GONCOURT, AND THE NATURALISTIC NOVEL. (5 cr) Lock

5-485. MAURIAC AND THE CATHOLIC NOVEL. (5 cr; prereq 3-209 or above) Kalb, staff

5-486/5-487. PROUST. (5 cr per qtr; prereq 3-209 or equiv) Lock

5-488. GIDE. (5 cr; prereq 3-209 or above) O'Donnell

5-505. FRENCH ROMANCES OF THE MIDDLE AGES AND THE "LIBROS DE CABELLERIA" (5 cr; prereq at least one upper division course in the literature of France or Spain) Akehurst, Jones, staff
Taught in English.

5-509. ITALIAN AVATARS OF FRENCH MEDIEVAL EPICS: BOIARDO, ARIOSTO, TASSO. (5 cr; prereq at least one literature course in either French or Italian) Akehurst, Schneider, staff
Brief study of a number of French epics; selected readings in Boiardo's *Orlando Innamorato;* close study of Ariosto's *Orlando Furioso* and Tasso's *Gerusalemme Liberata.* Other works examined briefly. Taught in English.

5-511. IDEALISM IN POETRY OF ITALY AND FRANCE: DANTE TO D'AUBIGNE. (5 cr; prereq 1 course in literature of 1 of countries studied or ‡) Staff
Dante's transmutation of "l'amour courtois" through Petrarch, Bembo, Tansillo, Scève, Ronsard, Du Bellay, Desportes, D'Aubigné and others. Poetic uses of love and the beloved and the various concepts of poetry and the reality they reflect. Taught in English.

5-519. THE CONTINENTAL RENAISSANCE IN LITERATURE. (5 cr; prereq at least one upper division course in Italian, Spanish, French, or Portuguese literature and ‡) Renaud and staff
Origin and dissemination of ideas, attitudes, themes, and some literary genres, first in Italy, then in Spain, Portugal, and France. Taught in English.

5-523. INTERRELATION OF DRAMATIC LITERATURES OF FRANCE, ITALY AND SPAIN IN THE 16TH-17TH CENTURIES. (5 cr; prereq 1 course in literature of 1 of countries studied or ‡) Renaud and staff
Theatre of antiquity—revival and rejuvenation in Italy, spread to and from Spain and France where it took new forms and new spirit, return to Italy and France. Taught in English.

5-531/5-532/5-533. THE BAROQUE IN EUROPEAN LITERATURE: FRANCE, GERMANY, ITALY, PORTUGAL, SPAIN, WITH SOME ATTENTION TO HOLLAND AND ENGLAND. (5 cr per qtr; prereq at least one upper division course in the literature of France, Germay, Italy, Portugal, or Spain) Jones, Renaud, Weiss, and staff
The baroque in literature as it spreads through the European community. Italian baroque aesthetics and world view, then their modification. Taught in English.

5-538. NOVELLE, NOVELAS, AND NOUVELLES: FROM BOCCACCIO TO CERVANTES AND MME. DE LAFAYETTE. (5 cr; prereq at least one upper division course in French, Spanish, or Italian literature, ‡) Renaud, and staff
Boccaccio's tales, the evolution of narrative techniques in Italy, into Spain and France. Influence of the novelle-novela-nouvelle on the "first modern novel," *La Princesse de Clèves*, and on the realistic novel. Taught in English.

5-539. NARRATIVE TECHNIQUES AND THEMES IN THE LITERATURE OF FRANCE AND SPAIN FROM THE LIBRO DE BUEN AMOR TO GIL BLAS DE SANTILLANE. (5 cr; prereq at least one upper division course in French or Spanish literature and ‡) Renaud, staff
"Realistic" trends, including the picaresque, between the 14th and 18th centuries, with special attention to the 16th and 17th. Taught in English.

5-559. RISE OF ROMANTICISM: GERMANY, ENGLAND, FRANCE. (5 cr; prereq 1 upper division course in German, English or French literature)
Emergence of romanticism in Germany and British Isles; transformations and realizations in France. Taught in English.

5-561. POETIC THEORY OF 19TH CENTURY. (5 cr; prereq 3-209 or above) Robinson
Poetic theory of language, versification and aesthetics.

5-565. REALISM IN THE 19TH-CENTURY NOVELS OF FRANCE AND SPAIN. (5 cr; prereq at least one upper division course in French or Spanish literature, preferably in the 19th century, ‡) Staff

5-568. FRENCH SYMBOLISM AND ITALIAN HERMETICISM. (5 cr; prereq at least one pertinent course either in French or Italian literature or ‡) Pipa, Robinson
Poetry of Rimbaud, Mallarmé and Valéry, followed by that of Campana, Ungaretti and Montale.

5-569. NATURALISM IN THE FRENCH AND ITALIAN NARRATIVE. (5 cr; prereq at least one pertinent course either in French or Italian literature or ‡) Lock, Pipa
Flaubert, Maupassant, Zola and other naturalist writers, followed by that of Verga, Deledda, Fogazzarro and others.

5-575. NATURALISM IN FRENCH AND HISPANIC LITERATURES. (5 cr; prereq at least one upper division course in French or Spanish literature and ‡) Staff
Movement from preoccupations with material representation (realism) to a desire to represent human nature "as it really is," with concentration on the baser, more brutal, or special side. Pseudo-scientific approach to literature in the novels of France, Spain, and some Latin-American countries. Taught in English.

5-581. POETICS OF THE 20TH CENTURY. (5 cr; prereq 3-209 or above) Kalb
Innovations in versification, aesthetics, and doctrines.

5-589. STRUCTURAL RHETORICS APPLIED TO FRENCH WORKS. (5 cr; prereq grad standing or ‡)
Examination of rhetoric, especially the notions of "écart" and "degré zéro." Structural classification of classical rhetorical figures. Rhetoric as applied to other arts (stories, films, paintings). Use of figures of speech in modern French authors.

5-599. LITTÉRATURE FRANCAISE ET SOCIÉTÉ. (5 cr; prereq 3-209 or above)
Problems and methods of sociological literary criticism.

5-701/5-702. STRUCTURE OF MODERN FRENCH: PHONOLOGY, MORPHOLOGY, SYNTAX. (5 cr per qtr; prereq 3-015 or ‡) Mantini
Application of linguistics to study of present-day French.

5-900. TOPICS IN FRENCH LITERATURE. (5 cr; prereq 3-209 or above)

5-901. "LE DEUXIEME SEXE": WOMEN IN FRENCH LITERATURE. (5 cr; prereq 3-209 or above) Baxter
Women as literary object: misogyny to worship. Point of view in male and female authors. Social versus literary values.

8-202/8-203. FRENCH LITERATURE IN THE MIDDLE AGES: GRADUATE SURVEY. (5 cr per qtr; prereq 5-207) Akehurst

8-231/8-232/8-233. FRENCH SEMINAR: TOPICS IN 16TH- AND 17TH-CENTURY FRENCH LITERATURE. (3-5 cr per qtr) Renaud, Mack, staff

8-251/8-252/8-253. FRENCH SEMINAR: TOPICS IN 18TH-CENTURY FRENCH LITERATURE. (5 cr per qtr) Waldauer, Mack, staff

8-261/8-262/8-263. FRENCH SEMINAR: TOPICS IN 20TH-CENTURY FRENCH LITERATURE. (5 cr per qtr) Staff

8-281/8-282/8-283. FRENCH SEMINAR: TOPICS IN 20TH-CENTURY FRENCH LITERATURE. (3-5 cr per qtr)

8-291/8-292/8-293. FRENCH SEMINAR. (5 cr per qtr) Staff
Guided research in materials for which regular graduate courses do not offer adequate scope.

8-501. RESEARCH METHODS AND MATERIALS. (5 cr) Staff

8-701/8-702. HISTORY OF THE FRENCH LANGUAGE. (5 cr per qtr) Akehurst, staff

8-704/8-705. OLD PROVENCAL. (5 cr per qtr) Akehurst
Language and literature of the troubadours.

8-970. DIRECTED READINGS FOR GRADUATE STUDENTS. (3-5 cr) Staff

Italian (Ital)

Note—Most courses are offered alternate years or when feasible.

5-013. ITALIAN STYLISTICS. (5 cr)
Variety of literary works representing literary genres. Critical terminology; literary problems.

5-042. INTENSIVE READING OF MODERN ITALIAN NARRATIVE LITERATURE. (5 cr; prereq 3-041 or ‡)
Twentieth-century authors read and analyzed from both a linguistic and literary point of view. Sequence to 3-041.

5-219. HUMANISM AND ITALIANISM IN THE LITERATURE OF THE 16TH CENTURY. (5 cr; prereq 3-209 or above)
Systematic study of aspects of Italian civilization of the 14th-15th-16th centuries that lead to the French Renaissance and the Humanistic trends. Principally French and Italian literary works but also some paraliterary works.

5-321. CHIVALRIC POETRY: BOIARDO, ARIOSTO, TASSO. (5 cr) Staff

5-328. RENAISSANCE PROSE WRITERS: MACHIAVELLI, CASTIGLIONE. (5 cr) Staff

5-331. MODERN POETRY: GOZZANO TO QUASIMODO. (5 cr) Pipa, Schneider

5-384. MODERN DRAMA: PIRANDELLO TO FABBRI. (5 cr) Pipa, Schneider

5-385. MODERN NARRATIVE: SVEVO TO MORAVIA. (5 cr) Pipa, Schneider

5-401/5-402. DANTE: INFERNO, PURGATORIO, PARADISO. (5 cr per qtr) Pipa

5-409. DANTE'S MINOR WORKS. (5 cr) Pipa

5-411. PETRARCH. (5 cr) Staff

5-418. BOCCACCIO. (5 cr) Staff

5-451. PASCOLI AND D'ANNUNZIO. (5 cr) Staff

5-461. LEOPARDI AND MANZONI. (5 cr) Pipa, Schneider

5-568. FRENCH SYMBOLISM AND ITALIAN HERMETICISM. (5 cr; prereq at least one pertinent course either in French or Italian literature or ‡) Pipa, Robinson
Poetry of Rimbaud, Mallarmé and Valéry, followed by that of Campana, Ungaretti and Montale.

5-569. NATURALISM IN THE FRENCH AND ITALIAN NARRATIVE. (5 cr; prereq at least one pertinent course in French or Italian literature or ‡) Lock, Pipa
Analysis of Flaubert, Maupassant, Zola, and other naturalist writers, followed by that of Verga, Deledda, Pirandello, and others.

5-601/5-602/5-603. ITALIAN LITERATURE IN ENGLISH TRANSLATION. (5 cr per qtr) Schneider
Knowledge of Italian not required. For students with little or no knowledge of Italian but interested in contributions of Italians to European and world literature. Representative works from medieval times to present day examined by movement, genres, or themes.

5-609. DANTE (IN ENGLISH). (5 cr) Staff

5-701/5-702. ITALIAN LANGUAGE. (5 cr per qtr) Mantini

5-900. TOPICS IN ITALIAN LITERATURE. (5 cr; prereq 3-209 or above) Staff

8-201. ITALIAN SEMINAR: TOPICS IN MEDIEVAL LITERATURE. (3-5 cr) Pipa, Schneider

8-209. LITERARY CRITICISM. (5 cr) Pipa
Major Italian critics from De Sanctis to the present.

8-231. ITALIAN SEMINAR: TOPICS IN THE RENAISSANCE AND THE BAROQUE. (3-5 cr) Pipa, Schneider

8-281. ITALIAN SEMINAR: TOPICS IN MODERN LITERATURE. (3-5 cr) Pipa, Schneider

8-301. EARLY ITALIAN POETRY. (5 cr) Staff
From origins to the Dolce Stil Nuovo.

8-303. FORMS OF THE ITALIAN DRAMA. (5 cr) Staff
The sacred representation, the "commedia dell'arte," tragedy, comedy, the pastoral drama, the melodrama.

8-481. UNGARETTI AND MONTALE. (5 cr) Pipa
Reading and exegesis of works.

8-501. RESEARCH METHODS AND MATERIALS. (5 cr) Staff

8-583. MARXISM AND EXISTENTIALISM IN ITALIAN NARRATIVE AND DRAMA. (5 cr) Pipa
Reading and discussion of contemporary works in which the influence of Marxism and existentialism is more apparent.

8-701/8-702. HISTORY OF THE ITALIAN LANGUAGE. (5 cr per qtr) Mantini
History and development of the Italian language from early times.

8-711. ITALIAN PHILOLOGY. (5 cr) Mantini
Study of the Italian language through literary texts, especially early ones.

8-970. DIRECTED READINGS FOR GRADUATE STUDENTS. (3-5 cr) Pipa, Mantini, Schneider

Students of Italian may also wish to consider:

Fren 5-519—The Continental Renaissance in Literature

Fren 5-531/5-532/5-533—The Baroque in European Literature

Fren 5-538—Novelle, Novelas and Nouvelles

GENETICS

Professor

Frederick Forro (Genetics and Cell Biology), *head*
Robert K. Herman (Genetics and Cell Biology), *director of admissions*
Franklin D. Enfield (Genetics and Cell Biology), *director of graduate study*
Milton Alter (Neurology)
Dwight L. Anderson (Microbiology)
V. Elving Anderson (Genetics and Cell Biology)
Peter D. Ascher (Horticulture)
William J. Boylan (Animal Science)
Charles R. Burnham (Agronomy and Plant Genetics)
Richard S. Caldecott (Dean, College of Biological Sciences)
Jaroslav Cervenka (Genetics and Dentistry)
Ralph E. Comstock (Genetics and Cell Biology)
Verne E. Comstock (Agronomy and Plant Genetics)
David W. Davis (Horticulture)
David P. Fan (Genetics and Cell Biology)
Irving I. Gottesman (Psychology)
Daniel L. Hartl (Genetics and Cell Biology)
Robert E. Heiner (Agronomy and Plant Genetics)
Herbert W. Johnson (Agronomy and Plant Genetics)
Roger A. Kleese (Agronomy and Plant Genetics)
Jean W. Lambert (Agronomy and Plant Genetics)
Florian I. Lauer (Horticulture)
David J. Merrell (Zoology)
Robert Mullin (Horticulture)
Ronald L. Phillips (Agronomy and Plant Genetics)
Donald C. Rasmusson (Agronomy and Plant Genetics)
Sheldon C. Reed (Genetics and Cell Biology)
William E. Rempel (Animal Science)
Irwin Rubenstein (Genetics and Biology)
James C. Sentz (Agronomy and Plant Genetics)
Burton L. Shapiro (Dentistry)
Robert N. Shoffner (Animal Science)
D. Peter Snustad (Genetics and Cell Biology)
Leon A. Snyder (Genetics and Cell Biology)
Francis A. Spurrell (Veterinary Medicine)
Cecil Stushnoff (Horticulture)
Robert Touchberry (Genetics and Animal Science)
Huber R. Warner (Biochemistry)
Carl J. Witkop (Dentistry)
Val W. Woodward (Genetics and Cell Biology)
Charles W. Young (Animal Science)
Jorge J. Yunis (Laboratory Medicine)

Members of the graduate faculty in genetics represent many departments and several colleges within the University. Students wishing to earn the Master's or Ph.D. degree in genetics may choose a major adviser from among these members; all genetics major programs must be approved by the Graduate Subcommittee in Genetics.

Prerequisites—One year of college mathematics, chemistry through organic chemistry (physical chemistry highly recommended), college physics, and college biology. Students will be required to make up course deficiencies during their first year at the University.

Master's Degree—Offered under Plan A or Plan B.

Doctor's Degree—The Doctor's degree is a research degree but demands a general understanding of genetics as well as special competence in one of five major areas, i.e., cytogenetics, molecular genetics, population genetics, human genetics, and physiological and developmental genetics. Depending upon the special interest area of genetics, the student will be expected to gain competence in the appropriate related areas of science, e.g., physiology, chemistry, psychology, mathematics, statistics, etc.

Language Requirements—There are no specific language requirements for obtaining an advanced degree in genetics, but students requesting admission into the genetics program are urged to obtain a prior working knowledge of at least one language.

Note—The following list of courses includes those considered basic and which constitute the core of the genetics curriculum. Students will round out their programs with courses from the Department of Genetics and Cell Biology and other departments in consultation with their major adviser.

GCB 5-023s. GENETICS AND THE BIOLOGY OF POPULATIONS. (3 cr; primarily for secondary tchrs; prereq ¶3-022 or ‡)
Elementary development of basic concepts in population genetics and population biology. Population expansion and deterioration of the environment, analysis of gene frequency changes under natural and relaxed selection, genetic loads and reproductive excess, population genetics of quantitative characters, inbreeding, and the genetics of population isolates. Examples largely from human populations.

GCB 5-030f,w,s. LABORATORY: GENETICS. (2 cr; prereq 3-022, 5-022, Biol 3-032, or ‡)
Investigative approaches to analysis of genetic problems. Attention focused on given organism or related group of organisms which may differ from quarter to quarter.

GCB 5-031f,s. INTERMEDIATE GENETICS I. (3 cr; prereq 3-022 or Biol 3-032 and BioC 5-002 or 5-742, or ‡)
Mechanics of inheritance. Comparative organization of genetic material in procaryotic and eucaryotic organisms. The use of mutation, complementation, and recombination as operational criteria for genetic analysis.

GCB 5-032w. INTERMEDIATE GENETICS II. (3 cr; prereq 5-031)
Action of the gene in molecular, cellular, and organismal development. Mechanisms of storage of genetic information, modes of information transfer, and mechanisms of regulating these processes in various biological systems.

GCB 5-033s. INTERMEDIATE GENETICS III. (3 cr; prereq 3-022 or Biol 3-032...a course in genetics, course in biometry or statistics, or ‡)
Genetic variation in quantitative traits with special attention to fitness. Causes of change of equilibria in gene frequencies, heterosis and inbreeding depression, consequences of natural and artificial selection.

GCB 5-042f. POPULATION, QUANTITATIVE GENETICS. (3 cr; prereq 5-033...Stat 5-301 recommended)
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.

GCB 5-043s. HUMAN GENETICS. (3 cr; prereq 3-022 or Biol 3-032 or ‡)
Inherited characters in man, particularly in relation to medicine, with some reference to the relation of genetics in marriage and to social conditions.

GCB 5-044w. METHODS IN HUMAN GENETICS. (3 cr; prereq 5-043, PubH 5-450, ‡)
Methods for research in human genetics. Importance of appropriate statistical techniques. Use of genetic concepts in exploring new problems. Individual study of current problems and group discussion.

GCB 5-051w. INTERMEDIATE CELL BIOLOGY. (3 cr, §Biol 5-601; prereq ‡...introductory biochemistry and molecular genetics recommended)
Analysis of structure, replication, and function of general and specialized cells and their organelles at the microscopic and molecular level.

GCB 5-052s. QUANTITATIVE TECHNIQUES, CELL BIOLOGY. (3 cr; prereq ‡, calculus, introductory cellular or molecular biology and biochemistry recommended)
Use and detection of radioisotopes; theory and practice of analytical and preparative ultracentrifugation, chromatography, spectroscopy, and electron microscopy; tissue culture and subcellular particle fractionation.

GCB 5-062s. CELLULAR REGULATION. (3 cr; prereq ‡)
Control of biosynthesis and function of protein and nucleic acids; chromosome replication; cell cycle; differentiation in eucaryotic systems.

GCB 5-063s. THEORETICAL POPULATION BIOLOGY. (3 cr; prereq 5-033 or ‡, familiarity with differential and integral calculus)
Special emphasis on population genetic theory as related to problems of natural populations. Properties of finite populations, evolutionary cost and load, subdivided and fluctuating environments, fitness sets and optimization theory, population structure, competition and species packing, genetic methods of population control.

GCB 5-082s. MEMBRANES AND INTERFACES: PHYSICAL CHEMISTRY OF INTERFACES. (3 cr; prereq ‡)
Thermodynamics, statistical mechanics, electrical properties and experimental systems for study of interfaces. Isolation, dynamic properties, chemistry, and model systems of biological membranes. Cell surface and contact relations.

GCB 8-060f,w,s. CURRENT TOPICS. (2 cr; may be repeated for cr)
Several sections will be offered each quarter, each devoted to a different topic related to different areas (population genetics, extrachromosomal inheritance, cellular regulation) and advertised in advance.

GCB 8-900. SEMINAR. (1 cr per qtr [may be repeated for cr])

GCB 8-910. SEMINAR: GENETICS AND CELL BIOLOGY. (1 cr per qtr [may be repeated for cr])

GCB 8-990. RESEARCH. (Cr ar [may be repeated for cr])

Agro 8-230. CYTOGENETICS

Psy 5-134. INTRODUCTION TO BEHAVIORAL GENETICS

LMed 5-160. HUMAN CYTOGENETICS

LMed 5-161. HUMAN CYTOGENETICS LAB

LMed 5-162. HUMAN BIOCHEMICAL GENETICS

LMed 5-163. HUMAN BIOCHEMICAL GENETICS LAB

OPat 8-012. MEDICAL CYTOGENETICS

OPat 8-300. HUMAN DEVELOPMENTAL GENETICS I

Zool 5-171. GENETICS AND SPECIATION

GEO-ENGINEERING (GeoE)

Professor
Charles Fairhurst, *director of graduate study*

Associate Professor
W. David Lacabanne
Hans-Olaf Pfannkuch
Donald H. Yardley

Assistant Professor
Steven L. Crouch
Charles R. Nelson

Prerequisites—For major work, adequate preparation in undergraduate subjects and in the sciences fundamental to geo-engineering, in addition to general admission requirements. For minor work, the prerequisites to the courses to be pursued, and approval of the major department.

Language Requirement—For the Master's degree, none. For the Ph.D. degree, either (a) one foreign language selected from German, French, and Russian (other languages may be considered on petition); or (b) a special research technique. Students working toward the Ph.D. degree must show substantial progress toward completion of the language or the special research technique in their first year of residence.

Master's Degree—Either a Master's degree with departmental designation or an undesignated Master's degree is offered. Students who have a B.S. in geo-engineering have the option of obtaining either the designated or the undesignated M.S. degree. Students who have a B.S. degree in other fields (geology, physics, chemistry, etc.) may choose either (a) to make up deficiencies in the basic engineering curriculum and proceed normally to the designated M.S. degree, or (b) proceed directly to the undesignated M.S. degree.

Only Plan A will be allowed for students working toward an undesignated M.S. degree. Either Plan A or Plan B will be permitted for students working toward the M.S. degree with departmental designation.

Master of Geo-Engineering Program—The master of geo-engineering program is designed for students particularly interested in planning, design, operation, or management. The candidate should have a 2.50 GPA to enter the master of geo-engineering program.

Doctor's Degree—Work leading to the Ph.D. is offered.

5-180. GEOCHEMICAL EXPLORATION. (3 cr; prereq sr or ‡; 2 lab hrs per wk) Yardley
Geochemical principles and techniques involved in the search for orebodies. 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.

5-190. SELECTED TOPICS IN MINERAL EXPLORATION. (3 cr; prereq sr, grad; offered 1972-73 and alt yrs) Yardley
Exploration programming in relation to theories of ore genesis. Analysis of effects of contract and lease requirements on decision and planning. Statistical analyses in ore estimates. Case histories. Special problems.

5-210. ADVANCED ENGINEERING DESIGN. (Cr and hrs ar)
A design problem and report on some aspect of the geo-engineering field.

5-216. GEO-ENGINEERING AND ROCK MECHANICS I. (4 cr)
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. Elementary analysis of stress and strain in rock.

5-218. TUNNEL TECHNOLOGY. (3 cr; prereq 5-330 or ‡; offered 1973-74 and alt yrs) Yardley, Nelson
Tunneling systems, site problems. Analysis of stress and load. Design of linings and support. Materials handling. Planning. Special problems, case histories.

5-260/5-262. GEO-ENGINEERING ANALYSIS. (2 cr for 5-260, 3 cr for 5-262; prereq sr yr or ‡; 2 lab hrs per wk for 5-260, 6 lab hrs per wk for 5-262) Fairhurst, Yardley
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.

5-330. GEO-ENGINEERING AND ROCK MECHANICS II. (4 cr)
Design of blasting patterns and control of blast damage in rock, stress in room and pillar systems, foundations for structures, *in situ* stress measurements, disintegration and comminution.

5-332. DISINTEGRATION AND EXCAVATION OF ROCK. (4 cr; 3 lab hrs per wk)
Drilling, blasting, thermal fragmentation, crushers, and mills; methods of product classification.

5-334. ROCK MECHANICS. (4 cr; prereq 5-330 or ‡)
Mechanical behavior of jointed rock masses, rock slope stability, influence of ground water, rock bolting, field determination of rock properties, analog and digital computer simulation in rock mechanics.

5-437. COMPUTER APPLICATIONS IN GEO- AND MINERAL ENGINEERING. (4 cr)
Finite differences applications in ore reserve estimates, volume of fill, haulage heat transfer and fluid flow. Solution of linear equations, curve fitting, regression analysis and application of iterative methods to structural and ventilation analysis. Introduction to random numbers, simulation and computer models.

5-660. SPECIAL GEO-ENGINEERING PROBLEMS. (Cr and hrs ar; prereq sr or ‡) Staff
Literature survey, research work or design study in geo-engineering problems.

8-336. ANALYTICAL METHODS IN ROCK MECHANICS. (4 cr)
Development and application of methods of analysis in rock mechanics, including elasticity, finite elements and electrical analogs. Generation of appropriate mathematical models including material properties, loading and boundary conditions for different types of rock mechanics problems. Emphasis on obtaining practical engineering solutions using best method for given problem.

8-350/8-352. ADVANCED ROCK MECHANICS I, II. (3 cr per qtr; prereq AEM 5-580) Fairhurst
Analysis of stress and strain. Rock behavior under stress. Theories of rock failure in drilling and comminution. Folding and faulting; hydra-frac process. Original experimental investigation. Critical analysis of methods of rock testing. Model analysis.

8-601/8-602/8-603. SEMINAR: GEO-ENGINEERING. (Cr ar) Staff

8-604/8-605/8-606. SEMINAR: GEO-ENGINEERING. (Cr ar) Staff

8-612/8-613/8-614. GEO-ENGINEERING RESEARCH PROBLEMS. (Cr ar) Staff

GEOGRAPHY (Geog)

Professor
Ward J. Barrett, *chairman*
John R. Borchert
John F. Hart
Mei Ling Hsu
Fred E. Lukermann
Eugene C. Mather
Philip W. Porter
Joseph E. Schwartzberg
Yi-Fu Tuan
John W. Webb

Associate Professor
John S. Adams
Russell B. Adams
Dwight A. Brown
John G. Rice
Richard H. Skaggs

Assistant Professor
Anthony R. deSouza
Stuart R. Loomis
Earl P. Scott

Prerequisites—Geography majors are expected to have taken two introductory courses in physical, human, economic geography, similar to 1-401, 1-301, and 1-311, and at least seven upper division courses in systematic and regional geography, and also to have minor course work in the humanities or the biological, physical, or social sciences. For *minor work,* 12 credits in geography.

Master's Degree—Offered under both Plan A and Plan B.

Doctor's Degree—Consult the graduate faculty in drawing up a program of study leading to the Ph.D. degree.

Language Requirement—The use of foreign languages and research techniques is an integral part of a student's program. The graduate faculty (through its committee) will determine the requirements for each student working toward the M.A. or Ph.D. after submission of pertinent information by the adviser. Normally Ph.D. students will offer one foreign language or one research technique at a high level of proficiency. Certification of completion of the requirements will be granted on demonstration of competent use in course work.

Regional Studies

5-101. HISTORICAL GEOGRAPHY OF NORTH AMERICA. (4 cr)
Changing spatial ecology of North America from about 1500 to 1900, with special emphasis on the impact of European modes of living and settlement patterns, and the evolution of a distinctively American scene.

5-102. HISTORICAL GEOGRAPHY OF NORTH AMERICA. (4 cr or 6 cr with optional field trips in Minnesota and Wisconsin)
Modification of the American landscape since about 1900, with regard to several changes or revolutions, e.g., urban, agrarian, and transportation.

5-111.* EASTERN UNITED STATES. (4 cr) Hart
Regional analysis of physical and human resources east of the Great Plains.

5-112.* WESTERN UNITED STATES. (4 cr) Mather
Regional analysis of physical and human resources of western United States.

5-113.* CANADA AND ALASKA. (4 cr; prereq 10 cr or #) Mather
Regional analysis of physical and human geography; examination of both internal and external areal relationships.

5-131.* MIDDLE AMERICA. (4 cr) Barrett
Physical and human geography of the West Indies and the mainland from Mexico to Colombia.

5-132.* SOUTH AMERICA. (4 cr) Mather
Regional survey of physical resources, population, agriculture, manufacturing, and transportation in South America.

5-141.* AFRICA: SELECTED TOPICS. (4 cr; prereq 3-141 or #) deSouza, Porter, Scott
Case studies of characteristic geographical problems of Africa. Topics are each dealt with in a regional context and include population pressure, water management, industrialization, commercial and subsistence agriculture, and plural societies.

5-171.* WESTERN EUROPE. (4 cr; prereq 5 cr or ‡) R. Adams, Rice
Physical and human geography considered as a whole, followed by a more intensive discussion of selected topics on the British Isles, France, the Low Countries, the Rhine basin.

5-172.* EAST-CENTRAL EUROPE. (4 cr; prereq 5 cr or ‡) R. Adams, Rice
Physical and human geography of the Socialist realm of Eastern Europe with comparative analyses of individual countries; emphasis upon the historical, economic and political diversity with topical case studies.

5-173.* NORDEN. (4 cr; prereq 5 cr or ‡) Rice
Cultural and political development of Scandinavia, Finland, and Iceland; analysis of effects of changing resource appraisal upon patterns of economic activity and human occupancy.

5-181. REGIONS OF THE USSR. (4 cr; prereq 3-181 or ‡) Adams
Regionalization, production specialization, and interchange within the USSR; cultural variations among regions; effects of policies of centralization and regional autonomy; present trends, prognosis, and comparisons with the United States.

5-211. EAST ASIA: REGIONAL ANALYSIS. (4 cr; prereq 3-211 or ‡) Hsu
A regional analysis of selected 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.

5-212.* SOUTH ASIA. (4 cr; prereq 5 cr or ‡) Schwartzberg
Physical and human geography of India, Pakistan, Ceylon, Afghanistan, and the Himalayan kingdoms; geographic aspects of social structure, population pressure, economic development, and international relations.

5-299.* PROSEMINAR IN EAST AND SOUTH ASIA. (4 cr) Interdepartmental staff
(Same as Hist 5-549) Integrating course for students majoring in East and South Asia Area Studies program.

Topical Studies

5-331.* SPATIAL ORGANIZATION OF EUROPE TO EARLY MEDIEVAL TIMES. (4 cr; prereq 5 cr or ‡) deSouza
Culture areas of Europe and adjacent regions, including the spread of the neolithic economy, the organization of town and city networks, and the impact of Germanic and other peoples on classical culture regions.

5-332.* SPATIAL ORGANIZATION OF MEDIEVAL EUROPE. (4 cr; prereq 5 cr or 3-161 or ‡) Rice
Cultural regions of Europe as they had developed by the end of the Middle Ages. Analysis of these regions as reflected in patterns of trade and the network of towns.

5-333.* SPATIAL ORGANIZATION OF MODERN EUROPE. (4 cr; prereq 5 cr or 3-161 or ‡) Webb
Historical geography of Europe since the 17th century. Areal organization in early modern times. Changes in spatial organization of polity, economy, and settlement. Twentieth-century Europe as a functional region.

5-353. SEMINAR FOR IN-SERVICE TEACHERS. (3 cr; prereq in-service tchr) Hart
Variety of materials, organizational approaches, and teaching strategies available to secondary school teachers of geography and social studies.

5-372/5-373. METROPOLITAN ANALYSIS I, II. (4 cr per qtr) Adams
5-372: 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. 5-373: Neighborhood transition; conflicts in housing, location of facilities, urban renewal.

5-375/5-376.* AMERICAN CITIES—LOCATION AND GEOGRAPHIC DESIGN. (4 cr for 5-375, 4-6 cr for 5-376; prereq ‡) Borchert
5-375: The spread of urbanization across the United States; differentiation of city sizes and functions within the nation's resource regions and circulation network; the evolution of today's system of cities and its regional and national management problems. 5-376: The internal development of the major metropolitan areas of the United States; evolution of today's land-use patterns, activity systems, and metropolitan management problems.

5-381. ECONOMIC GEOGRAPHY III: ADVANCED. (4-6 cr; prereq 1-311 or ‡)
Localization of economic activity; case studies of industries and services; location factors, models, and theory.

5-383.° TRANSPORTATION GEOGRAPHY. (4 cr; prereq 1-311 or ‡) Adams
Principles and theory of spatial development of transport systems; interaction of resource exploitation and network growth; commodity and passenger flows; case studies at national, regional, and local levels.

5-391.° RURAL GEOGRAPHY. (4 cr) Mather
Geographic components and assemblages of rural settlement. World patterns and the geographic problems of rural settlement and agricultural production on the American scene.

5-393. LOOK OF THE LAND. (5 cr) Hart
Major components of landscape; emphasis on interaction between manmade structures and distinctive rural landscapes in North America and northwestern Europe.

5-422. MICROCLIMATOLOGY. (4-6 cr; prereq 3-421 or ‡) Barrett, Skaggs
Detailed study of heat and moisture balance of the earth; reception and disposal of precipitation and energy in local natural and manmade environments. Field experience in measurement of energy flows available.

5-433. DYNAMIC AND SYNOPTIC CLIMATOLOGY. (4 cr; prereq 3-421 or ‡) Skaggs
Application of dynamic and synoptic meteorological theory to broadscale climate genesis; introduction to explanatory climatological models.

5-442. GEOMORPHOLOGY. (4-6 cr) Brown, Loomis, Skaggs
Theoretical, statistical, and descriptive applications of numerical techniques to geomorphic process and form problems. Optional credit available for field work that bears on topics discussed.

5-443. GLACIAL AND PERIGLACIAL GEOMORPHOLOGY. (4-6 cr; prereq 1-401 or ‡) Loomis
Geomorphic patterns and processes in present and past ice-modified landscapes; emphasis on alpine and continental glacier-related settings in North America.

5-811.° ENVIRONMENTALISM, ENVIRONMENT, AND THE QUALITY OF LIFE. (4 cr; prereq ‡) Tuan
Survey of ideas on environmentalism with special emphasis on those that lead to the organization of the physical environment into human settings (rural and urban) in the belief that they affect life's ideals.

Technical Studies

5-511. QUANTITATIVE CARTOGRAPHY. (4 cr; prereq 3-511, 3-531, or ‡) Brown, Hsu, Porter
Analysis of cartographic techniques of representing quantitative data on maps. Principles of generalization. Sampling techniques for areal data and other quantitative techniques related to mapping.

5-512. CARTOGRAPHY: TOPICS. (4 cr; prereq 3-511, 3-531, or ‡) Brown, Hsu, Porter
Advanced statistical mapping techniques; selected topics in cartography; visual preception, automation, spatial statistics, and history of cartography.

5-531. QUANTITATIVE RESEARCH DESIGN. (4 cr; prereq 3-531, Soc 3-801, or ‡) R. Adams, Skaggs
Formulation of quantitative problems for hypothesis testing, sampling, model building; applications to computer methods; study of literature and problem work.

History and Philosophy of Geography

5-001/5-002. GEOGRAPHICAL ANALYSIS I, II. (4 cr per qtr) Adams
5-001: Order, science, and geography; measurement, relationship and classification; location and spatial interaction; spatial diffusion processes; spatial decision-making.
5-002: Models of ecological conflict and equilibrium in man-environment relationships.

5-801.° DEVELOPMENT OF GEOGRAPHIC THOUGHT. (3 cr, §3-801; prereq 15 cr) Lukermann
Concepts and methods of geography; special reference to differing schools of geographic thought as expressed in literature of the past century.

Directed Studies

5-900. TOPICS IN GEOGRAPHY. (4 cr; prereq △)
Course on special topics and regions offered by visiting professors in their research fields.

8-001. INTRODUCTION TO GRADUATE STUDY IN GEOGRAPHY. (3 cr; prereq grad student in geography) Staff

8-010.° SEMINAR: THEORETICAL GEOGRAPHY. (3 cr; prereq ‡) Staff

8-020.° SEMINAR: ECONOMIC GEOGRAPHY. (3 cr; prereq ‡) Staff

8-120.° SEMINAR: HISTORICAL GEOGRAPHY OF MIDDLE AMERICA. (3 cr; prereq ‡) Barrett

8-140.° SEMINAR: AFRICA. (3 cr; prereq ‡) Porter, deSouza, Scott

8-160.° SEMINAR: HISTORICAL GEOGRAPHY OF EUROPE. (3 cr; prereq ‡) Rice

8-180.° SEMINAR: SOVIET UNION. (3 cr; prereq ‡) Adams

8-200.° SEMINAR: EAST ASIA. (3 cr; prereq ‡) Hsu

8-210.° SEMINAR: SOUTH ASIA. (3 cr; prereq ‡) Schwartzberg

8-310. PROSEMINAR: CULTURAL GEOGRAPHY. (3 cr; prereq ‡) Hart

8-310.° SEMINAR: CULTURAL GEOGRAPHY. (3 cr; prereq ‡) Hart

8-320.° SEMINAR: HISTORICAL ECONOMIC GEOGRAPHY. (3 cr; prereq ‡) Lukermann

8-330.° SEMINAR: AGRICULTURAL GEOGRAPHY. (3 cr; prereq ‡) Mather

8-340.° SEMINAR: LAND USE PLANNING. (3 cr; prereq ‡) Borchert

8-350.° SEMINAR: SETTLEMENT AND POPULATION GEOGRAPHY. (3 cr; prereq ‡) Webb

8-400.° SEMINAR: PHYSICAL GEOGRAPHY. (3 cr; prereq ‡) Barrett

8-410. PHYSICAL ENVIRONMENT PROBLEMS IN METROPOLITAN AREAS. (3 cr; prereq ‡) Brown, Loomis, Skaggs
Intensified problems associated with human use of the physical environment in metropolitan areas. Relevant literature, followed by research problems in the local area.

8-510.° SEMINAR: CARTOGRAPHY. (3 cr; prereq ‡) Porter, Hsu

8-530.° SEMINAR: QUANTITATIVE GEOGRAPHY. (3 cr; prereq ‡) Adams, Skaggs

8-700.° SEMINAR: HISTORICAL FIELD. (5 cr; prereq ‡) Lukermann

8-800.° SEMINAR: DEVELOPMENT OF GEOGRAPHIC THOUGHT. (3 cr; prereq ‡)

8-810.° SEMINAR: READINGS IN ANCIENT AND MEDIEVAL GEOGRAPHY. (3 cr; prereq ‡) Lukermann

8-850. SEMINAR: ATTITUDES TO DRY LANDS. (3 cr; prereq ‡) Tuan
Phenomenological approach to human geography, with special emphasis on the interplay of illusion and reality in human attempts to adapt to an arid environment. Methodology. Application to the dry lands of the United States and Australia.

8-970. DIRECTED READINGS. (1-5 cr) Staff

8-990x.° RESEARCH PROBLEMS IN GEOGRAPHY. (Cr ar) Staff

GEOLOGY AND GEOPHYSICS (Geo)

(School of Earth Sciences)

Professor

V. Rama Murthy, *head*
Harold M. Mooney, *associate head*
Alvin G. Anderson
J. Morris Blair
Strathmore R. B. Cooke
William D. Munro
Joseph Shapiro
Paul K. Sims
Robert E. Sloan
Frederick M. Swain
William C. Walton
Herbert E. Wright, Jr.
Tibor Zoltai

Associate Professor

Hans-Olaf Pfannkuch, *director of graduate study*
Subir Kumar Banerjee
Robert C. Bright
Henry T. Hall
Roger LeB. Hooke
Walter E. Parham
Robert O. Pepin
George R. Rapp, Jr.
Frederick J. Sawkins
Paul W. Weiblen

Assistant Professor

Clement G. Chase
Peter Hudleston
William R. Normark
James H. Stout

Prerequisites—For candidates for advanced degrees, a Bachelor's degree in geology, geophysics, or related earth science, with mathematics through differential equations, 1 year of college chemistry, and at least 1 year of college physics; for students in certain special fields of geology, substitutions may be granted on petition. A Bachelor's degree in other fields, such as chemistry, physics, mining and civil engineering, or biological sciences, is entirely acceptable, particularly for those who wish to pursue specialized studies in geochemistry, geophysics, crystallograpy, hydrogeology, and paleontology.

Conditions for a minor in geology and geophysics are established on an individual basis by consultation with the appropriate faculty member and approved by the Committee on Graduate Studies.

Language Requirement—No language requirements exist in the department for either the Master's or the Ph.D. degrees. With the approval of the Committee on Graduate Studies, the adviser and the student may choose to make a language part of the student's program when it is relevant to the course of studies considered.

Master's Degree—The Master's degree, which is not a necessary prerequisite for candidacy for the Ph.D. degree, is offered under Plan A and Plan B. Under Plan B, within the general Graduate School requirements, a minimum of 9 credit hours will be in one research course in which a written report will be prepared and reviewed by at least two members of the faculty. The M.S. may be earned in general geology, geophysics, hydrogeology, and mineralogy and petrology.

Doctor's Degree—Admission to candidacy for the Ph.D. degree is contingent upon passing a review and evaluation examination, generally at the end of the third academic quarter of residence, completing the minor, and passing qualifying written and oral examinations. The Ph.D. can be obtained in four major fields: general geology, hydrogeology, mineralogy and petrology, and geophysics.

General Geology

5-002. STRUCTURAL GEOLOGY. (4 cr, §3-103 or equiv; not open to geology, geophysics, geoengineering, mineral resources engineering, metallurgy-materials science majors; prereq 3-401 or 5-004 or ♯; 3 lect and 2 lab hrs per wk) Hudleston
Primary and secondary structures of rocks, mechanics and modes of deformation, and structural techniques. Laboratory exercises in 3-dimensional representation and solution of selected structural problems.

5-051. PHYSICAL GEOLOGY FOR TEACHERS. (4 cr, §1-001, §1-111; prereq education degree, 1 term college chemistry or physics) Rapp
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.

5-052. HISTORICAL GEOLOGY FOR TEACHERS. (4 cr, §1-002, §1-112; only for students holding degrees in education; prereq 1-001 or 1-111 or 5-051 or ♯) Sloan
Introduction to origin of the earth, physical evolution of its crust through geological time and biological changes that occurred during its history. Laboratory, field work, and seminar.

5-099.* PROBLEMS IN GEOLOGY AND GEOPHYSICS. (1-6 cr; prereq ♯, △) Staff
Individual research in laboratory or field problems at Upper Division or graduate levels.

5-101.* ADVANCED GENERAL GEOLOGY. (3 cr; open to science majors in any field with supplemental reading by nongeologists; prereq ♯; offered when demand warrants) Staff
Considers central problems in modern and classical geology through seminar-type discussion, evaluation of professional publications, special projects.

5-102.* PHYSICAL STRATIGRAPHY. (4 cr; prereq 3-103) Swain
Lecture, readings, discussions of modern literature, and laboratory work on Paleozoic, Mesozoic, and Cenozoic stratigraphy; geosynclinal and shelf development, oceanic and lacustrine deposits.

5-108. ADVANCED ENVIRONMENTAL GEOLOGY. (4 cr; prereq geology core curriculum 1-111 through 3-103 or equiv) Parham
Human impact on the geological environment as well as the effect of geology/geologic processes on humans. Topics include land-use planning, geologic hazards, geologic aspects of health and disease, mineral conservation, waste disposal, and geologic controls and limitations in developed versus underdeveloped countries.

5-110. FIELD GEOLOGY. (9 cr; restricted to majors in geology, geophysics, or geo-engineering; prereq 3-102, ‡) Hudleston
Measurement of stratigraphic sections; study of fossils and igneous, sedimentary, and metamorphic rocks. Geological surveying on aerial photographs and topographic maps. Preparation of geologic maps and cross sections. Study of structural and geomorphic features and geologic setting of mineral deposits.

5-151. INTRODUCTION TO PALEONTOLOGY. (5 cr; prereq 1-002 or 1-112 or ‡) Sloan
Morphology and classification of major fossil groups.

5-152. INVERTEBRATE PALEONTOLOGY. (5 cr; prereq 5-151; offered when demand warrants) Staff
Detailed studies of morphology, classification, and ecology of selected groups of invertebrate fossils.

5-154. VERTEBRATE PALEONTOLOGY I. (5 cr; prereq 5-151 or Zool 5-124) Sloan
Morphology, evolution, and stratigraphic distribution of fossil fish, amphibians, reptiles, and birds.

5-155.* VERTEBRATE PALEONTOLOGY II. (5 cr; prereq 5-154 or Zool 5-124) Sloan
Morphology, evolution, and stratigraphic distribution of fossil mammals.

5-251.* GEOMORPHOLOGY. (5 cr; prereq 1-001, Math 1-111...Geo 3-101 required and 3-401 recommended for geology majors...or ‡) Hooke
Quantitative study of landform processes in various regions of the earth and on surfaces of other planets. Topics: weathering, slope and shore processes, fluvial erosion and deposition, wind action, impact phenomena and tectonics. Field trips 1st, 5th, 7th, and 9th Saturdays. Term project.

8-008. SEMINAR: CURRENT TOPICS IN GEOLOGY. (1 cr per qtr; prereq ‡) Staff

8-103. MARINE BIOSTRATIGRAPHY. (3 cr; prereq 5-102, 5-151) Swain
Fundamentals of biostratigraphic analysis of fossil assemblage, with emphasis on Mesozoic and Cenozoic zonation.

8-128.* SEMINAR: STRATIGRAPHY. (Cr ar; prereq ‡) Swain

8-129.* RESEARCH IN STRATIGRAPHY. (3 cr; prereq 5-102) Swain

8-152. ADVANCED INVERTEBRATE PALEONTOLOGY. (Cr ar; prereq 5-152, ‡...8-161 advisable) Staff

8-156. MARINE MICROPALEONTOLOGY. (3 cr; prereq 5-151 or ‡) Swain
Major groups of marine microfossils; morphology, classification, and geologic distribution.

8-158.* SEMINAR: PALEONTOLOGY. (Cr ar; prereq ‡) Sloan

8-159.* RESEARCH IN PALEONTOLOGY. (Cr ar; prereq ‡) Sloan, Swain

8-161.* PALEOECOLOGY. (3 cr; prereq ‡; offered 1973-74 and alt yrs) Wright
Major features of paleoecology developed through evaluation of current and classical publications and special projects.

8-168. SEMINAR: PALEOECOLOGY. (1 cr; prereq ‡) Bright, Cushing, Wright

8-201.* GEOTECTONICS. (3 cr; prereq 3-201 or 5-002 or ‡; offered 1972-73 and alt yrs) Hudleston, Normark
Basic problems of structure and evolution of the earth's crust.

8-202.* ADVANCED STRUCTURAL GEOLOGY. (3 cr; prereq 3-201 or 5-002, 5-451) 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.

8-208.* SEMINAR: STRUCTURAL GEOLOGY. (3 cr; prereq 3-201 or 5-002 or ‡; offered 1973-74 and alt yrs) Hudleston

8-209.* RESEARCH IN STRUCTURAL GEOLOGY. (Cr ar; prereq 5-201) Hudleston

8-258.* SEMINAR: GEOMORPHOLOGY. (Cr ar; prereq ‡) Hooke

8-259.* RESEARCH IN GEOMORPHOLOGY. (Cr ar; prereq ‡) Hooke

8-262.* PLEISTOCENE GEOLOGY. (3 cr; prereq 5-261) Wright
Problems in Pleistocene history of glaciated and nonglaciated areas, particularly North America, Europe, and the Mediterranean. Relation of Pleistocene climatic changes to soils, biogeography, and archaeology. Pollen analysis.

8-268.* SEMINAR: PLEISTOCENE GEOLOGY. (Cr ar; prereq 5-262) Wright

8-269.* RESEARCH IN PLEISTOCENE GEOLOGY. (Cr ar; prereq 5-212) Wright

Mineralogy and Petrology

5-004.* MINERALOGY. (4 cr, §3-401; not open to geology, geophysics, geo-engineering, mineral resources engineering, or metallurgy-materials science majors; open to majors in College of AFHE and postgrad students in education; prereq 1-001 or 1-111 or ‡; 1 term college chemistry, Math 1-441; 3 lect and 6 lab hrs per wk) Rapp
Introduction of crystallography, crystal chemistry, and mineralogy. Descriptive and determinative mineralogy. Study of minerals in natural rock systems.

5-301. CHEMICAL EQUILIBRIA IN THE EARTH. (3 cr; prereq Chem 5-501 or 5-520 or ¶Chem 5-501 or 5-520) Hall
Recitation/problems course dealing with the application of thermodynamics and kinetics to chemical systems in the earth sciences. Included are reactions in natural gases, solid-state mineral transformations, melting and solid-solution phenomena, rates of nucleation and mineral growth, and reactions in natural waters.

5-302.* GEOCHEMISTRY. (4 cr; prereq Chem 5-502 or Geol 5-506 or ‡) Murthy
Origin and chemical evolution of the earth through geologic time, by detailed studies of distribution of major and minor elements in the earth's crust, mantle, and core. Nature of element fractionation processes in major geologic processes.

5-309.* PROBLEMS IN GEOCHEMISTRY. (2 cr; prereq 5-303 or ‡) Murthy
Selected topics.

5-311. INTRODUCTION TO ORGANIC GEOCHEMISTRY. (3 cr; prereq Chem 3-302, Geo 5-102)
Organic geochemical residues of major types of sedimentary environments, fossils, fossil fuels, Precambrian rocks, and meteorites, and their interpretation; laboratory work on extraction and separation methods.

5-351.* METAL SULFIDE DEPOSITS. (5 cr; prereq 3-401, 3-103 or ‡) Sawkins
Nature and distribution of sulfide deposits, and analysis of processes by which metals are concentrated in magmatic, hydrothermal, sedimentary, and surface environments.

5-401. CRYSTAL CHEMISTRY OF MINERALS. (5 cr; prereq 1-001, 1-111 or ‡; 1 term college chemistry, Math 1-441; 6 lab hrs per wk) Zoltai
Basic concepts of symmetry, packing, coordination, and bonding of atoms in crystal structures. Classification and discussion of crystal structures and crystal chemistry of minerals.

5-452.* IGNEOUS AND METAMORPHIC PETROLOGY. (4 cr; prereq 3-102, Chem 5-502 or 5-521, Math 3-211 or ‡) Stout
Rock associations, textures and structures of world-wide igneous provinces and metamorphic terranes. Petrogesis in light of phase equilibria, experimental studies, and current interpretations. Laboratory and term paper.

8-308.* SEMINAR: GEOCHEMISTRY. (Cr ar; prereq ‡) Murthy

8-309.* RESEARCH IN GEOCHEMISTRY. (Cr ar; prereq ‡) Murthy

8-351.* ADVANCED MINERAL DEPOSITS I. (3 cr; prereq 5-351 or 5-352, 5-301 or ‡) Hall
Geochemistry of hydrothermal ore deposits. Application of solution chemistry to mineral deposits problems. Stability and solubility of hydrothermal minerals. Chemistry of ore-forming fluids and formation of hydrothermal ore deposits.

8-352.* ADVANCED MINERAL DEPOSITS II. (3 cr; prereq 5-351 or ‡) Sawkins
Metalliferous districts. Interpretation of paragnetic relationships of ore minerals, using mineralographic, petrographic, and X-ray methods.

8-355. GEOLOGY OF FERROUS METALS AND NON-METALLIC DEPOSITS. (4 cr; prereq 3-401, 3-103, or ‡) Sawkins
Environmental setting, mineralogy, and genesis of ferrous metal ore deposits and non-metallic deposits.

8-358.* SEMINAR: MINERAL DEPOSITS. (Cr ar; prereq ‡) Hall, Sawkins

8-359.* RESEARCH IN MINERAL DEPOSITS. (Cr ar; prereq ‡) Hall, Sawkins

8-361. MINERAL FUEL DEPOSITS. (3 cr; prereq 3-101, 3-103 or 5-002, or ‡) Swain
Origin and distribution of petroleum and coal deposits; source materials, reservoir rocks and structures, stratigraphic distribution of important deposits.

8-402. 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 special emphasis on the symmetry of the lattice. Principles of X-ray diffraction of polycrystalline material. Indexing of diffraction patterns and determination of space groups.

8-404. X-RAY CRYSTALLOGRAPHY. (4 cr; prereq 5-402 or ‡) Zoltai
Introduction to principles and practice of single-crystal X-ray diffraction. Space group determination. Crystal structure determination methods and problems.

8-408.° SEMINAR: MINERALOGY AND CRYSTALLOGRAPHY. (Cr ar; prereq ‡) Zoltai

8-409.° RESEARCH IN MINERALOGY AND CRYSTALLOGRAPHY. (Cr ar; prereq ‡)

8-418.° SEMINAR: CLAY MINERALOGY. (Cr ar; prereq ‡) Parham

8-453.° PHASE EQUILIBRIA IN MINERAL SYSTEMS. (3 cr; prereq 5-452, Chem 5-521 or Chem 5-504, Math 1-240, offered 1972-73 and alt yrs or yearly when demand warrants) Stout, Hall, and Weiblen
Comprehensive course in principles of homogeneous and heterogeneous equilibria and their application to problems in petrology. Special emphasis is placed on derivations from first principles and the formulation of algebraic and graphical methods essential to the rigorous treatment of multi-component systems.

8-454.° IGNEOUS PETROLOGY. (3 cr; prereq 8-453; offered 1972-73 and alt yrs or yearly when demand warrants) Weiblen
Rigorous treatment of igneous rocks and processes including study of igneous textures and associations, and appropriate phase equilibria to relate current theory and observation to the broad problems of petrogenesis. Term paper required.

8-455.° METAMORPHIC PETROLOGY. (3 cr; prereq 8-453; offered 1972-73 and alt yrs or yearly when demand warrants) Stout
Rigorous treatment of metamorphic processes directed at relating theory and observation with regard to current problems. Fundamental concepts and techniques related to progressive development of mineral assemblages are treated at length. Term paper required.

8-458.° SEMINAR: PETROLOGY. (Cr ar; prereq 5-453; offered when feasible) Stout, Weiblen

8-459.° RESEARCH IN PETROLOGY. (Cr ar; prereq ‡) Sims, Stout, Weiblen
Individual direction of theoretical, experimental and field studies in petrology; includes application of optical and electron microprobe analysis to petrologic problems.

Hydrogeology

5-252.° PROBLEMS IN GEOMORPHOLOGY. (3 cr; prereq 5-251; offered 1973-74 and alt yrs) Hooke
Detailed study of selected geomorphic processes. Fluvial processes and arid region geomorphology.

5-255.° GLACIOLOGY. (3 cr; prereq Math 3-221 or equiv or ‡; offered 1972-73 and alt yrs) Hooke
Theories of glacier flow. Internal structures and heat flow in glaciers. Reading assignments, problems, term paper.

5-261.° GLACIAL GEOLOGY. (3 cr; prereq 1-002 or 1-112) Wright
Physics of modern glaciers. Glacial erosion and deposition, stratigraphy and chronology of the Pleistocene in glaciated and nonglaciated areas.

5-601. LIMNOLOGY. (4 cr, §old Ecol 138; prereq Chem 1-005 or equiv, ‡) Shapiro
Description and analysis of events occurring in lakes, reservoirs, and ponds, beginning with their origins and progressing through a study of their physics, chemistry, and biology. Interrelationships of these parameters, and effects of civilization of lakes. Laboratory, field trips.

5-611. GROUNDWATER GEOLOGY.° (3 cr; prereq 1-001 or 1-111, Math 1-231, 1 yr physics and chemistry, or ‡) Pfannkuch
Origin, occurrence, and movements of groundwater. Characteristics of major aquifers and aquitards. Exploratory investigations. Hydrogeologic units and boundaries. Principles and theoretical aspects of recharge. Quality of groundwater supplies.

5-642. INTRODUCTORY MARINE GEOLOGY. (4 cr; prereq 1-111 or 1-112 or 3-401 or 3-201 or 3-651 or ‡) Normark
Physiography and structure of ocean basins and continental margins; their development as suggested by concepts of new global tectonics. Emphasis on geologic processes within marine environment. Review of marine geological and geophysical techniques.

5-652.* SEDIMENTOLOGY. (4 cr; prereq 3-101, 3-102, 3-103, 5-642 or ‡) Normark
Sedimentary processes and products with particular emphasis on modern marine depositional environments. Special consideration of clastic sedimentation on continental margins.

8-311.* ORGANIC GEOCHEMISTRY. (3 cr; prereq 3-651 or 5-006, Chem 3-302 or ‡) Swain
Extraction and separation of organic residues from recent sediments and rocks; interpretation of origin and diagenesis of sedimentary organic compounds.

8-318.* SEMINAR: ORGANIC GEOCHEMISTRY. (Cr ar; prereq ‡) Swain

8-602.* ADVANCED LIMNOLOGY. (3 cr; prereq 5-601 or equiv, ‡; offered 1973-74 and alt yrs) Shapiro
Detailed study of selected problems in limnology using current and classical literature. Term paper required.

8-603.* METHODS FOR ANALYSIS OF NATURAL WATERS. (2 cr; prereq 5-601 or equiv, ‡; two 3-hour periods per wk) Shapiro
Analysis and significance of ecologically important constituents and parameters of surface and groundwaters with appreciation of different approaches. Term paper.

8-608. SEMINAR: LIMNOLOGY. (1 cr; prereq ‡) Shapiro, Wright

8-609.* RESEARCH IN LIMNOLOGY. (Cr ar; prereq 5-601 or equiv, ‡) Shapiro

8-612.* ANALYTICAL GEOHYDROLOGY. (3 cr; prereq Math 1-240 or Math 5-601, CE 3-400 or equiv, 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.

8-618. SEMINAR: GROUNDWATER GEOLOGY. (Cr ar; prereq ‡) Walton, Pfannkuch

8-619.* RESEARCH IN GROUNDWATER GEOLOGY. (Cr ar; prereq ‡) Walton, Pfannkuch

8-642.* MARINE GEOLOGY. (Cr ar; prereq ‡) Normark

8-649.* RESEARCH IN MARINE GEOLOGY. (Cr ar; prereq ‡) Normark
Independent research topics in marine geological problems; primarily intended for projects carried out on board ship.

8-651. SEDIMENTARY GEOCHEMISTRY. (3 cr; prereq Chem 5-501 or 5-104 or ‡) Hall
Properties of bulk and adsorbed water. Thermodynamics of seawater. Chemical equilibria of the seas, air-sea interface, sea-ocean interface. Origin and chemical history of the earth's ocean. Stable isotope studies.

8-658. SEMINAR: SEDIMENTOLOGY. (Cr ar; prereq ‡) Normark, Swain

8-659. RESEARCH IN SEDIMENTOLOGY. (Cr ar; prereq ‡) Normark, Swain

Geophysics

5-505. PHYSICS AND CHEMISTRY OF THE EARTH I. (4 cr; prereq Phys 1-295, Geo 1-111) Mooney
Earthquake seismology; physical structure of the earth's crust and deep interior; introduction to gravity field of the earth.

5-506. PHYSICS AND CHEMISTRY OF THE EARTH II. (4 cr; prereq 5-505 or ‡) Murthy
Origin and chemical evolution of the earth through geologic time.

5-507. PHYSICS AND CHEMISTRY OF THE EARTH III. (4 cr; prereq 5-506 or ‡) Banerjee, Chase
Gravity and magnetic fields of the earth; paleomagnetism; thermal history of the earth.

5-511.* PRINCIPLES OF GRAVITY AND MAGNETIC EXPLORATION. (3 cr; prereq Phys 1-291) Chase
Instruments, surveying techniques, data reduction, interpretation, case histories.

5-512x.* PRINCIPLES OF SEISMIC EXPLORATION. (3 cr, §5-522; prereq Phys 1-291) Mooney
Reflection and refraction seismology; theory, interpretation, instruments.

5-513.* PRINCIPLES OF ELECTRICAL EXPLORATION. (3 cr; prereq Phys 1-291) Mooney
Resistivity, electromagnetic, induced polarization, and other methods.

5-522.* PRINCIPLES OF REFRACTION SEISMIC EXPLORATION. (2 cr, §5-512; principally for civil engineering and geo-engineering students; prereq Phys 1-291) Mooney
Seismic wave theory; refraction seismology.

5-541.* GEOMAGNETISM. (3 cr; prereq 3 qtrs geology, physics, mathematics) Banerjee
Historical introduction. Magnetic properties of rocks and minerals. Polar wandering and continental drift.

8-521.* LINEAR DATA PROCESSING WITH GEOPHYSICAL APPLICATIONS. (3 cr; prereq 5-513, offered when demand warrants) Mooney
Modern digital data processing methods used in geophysics based on Fourier transform.

8-531/8-532.* THEORY OF ELASTIC WAVE PROPAGATION I, II. (3 cr per qtr; prereq AEM 5-580 or ‡; offered 1973-74 and alt yrs) Mooney
Theoretical seismology, solutions of wave equations, normal mode propagation.

8-535.* THEORY OF ELECTRICAL EXPLORATION. (3 cr; prereq Phys 5-023 or ‡, offered when demand warrants) Mooney
Review of electromagnetic theory; theory of resistivity, electromagnetic, induced polarization, and magnetotelluric methods; geomagnetic phenomena with the earth.

8-542.* PRINCIPLES OF ROCKMAGNETISM. (3 cr; prereq 5-541 or ‡) Banerjee
Principles of magnetism. Magnetic minerals. Properties of magnetite and hematite grains. Thermal activation effects. Origin of thermoremanent magnetization, chemical remanent magnetization, and depositional remanent magnetization. Demagnetization techniques. Piezomagnetism of rocks. Seismomagnetic effect. Self-reversal vs. field-reversal. Magnetism of meteorites.

8-552.* EARTHQUAKE SEISMOGRAM INTERPRETATION. (2 cr; prereq 5-501; offered when demand warrants) Mooney

8-568. SEMINAR: GEOPHYSICS. (Cr ar; prereq ‡) Staff

8-569. RESEARCH IN GEOPHYSICS. (Cr ar; prereq ‡) Staff

GERMAN (Ger)

Professor
Frank D. Hirschbach,
director of graduate study
Evelyn S. Firchow
Edwin F. Menze
Herman Ramras
Wolfgang F. Taraba
Gerhard H. Weiss
Cecil Wood

Associate Professor
Leonard L. Duroche

Assistant Professor
Ray M. Wakefield

Prerequisites—For major work, 27 upper division quarter credits or equivalent, of which 15 credits must be in literature courses. For minor work, 18 upper division quarter credits or equivalent.

Language Requirement—A candidate for the Master's degree must have a reading knowledge of at least one foreign language other than German, preferably French.

Candidates for the Doctor's degree in German must have a good reading knowledge of two foreign languages other than German. They should consult with the adviser as to the languages which would best serve their area of major studies.

Master's Degree—Offered under both Plan A and Plan B.

Doctor's Degree—Candidates are expected to offer 18 credits in Germanic philology.

A minor in philology will require at least 27 credits (for details see Germanic Philology program). Majors in German literature may, however, offer a combined minor by offering 18 credits in philology and 12 or more in one of the following: classics, English literature, fine arts, foreign literature, comparative literature,

history, philosophy. In any case, it is strongly recommended that candidates in German literature supplement their major by courses chosen from one or more of these fields.

Comparative Literature—For information on this program see the Comparative Literature section of this bulletin.

Required Courses for Graduate Majors

5-011. GERMAN STYLE AND COMPOSITION. (4 cr; offered 1972-73 and alt yrs)

8-111. BIBLIOGRAPHY. (3-4 cr; offered 1972-73 and alt yrs [8-701, which also fulfills bibliography requirement, offered 1973-74 and alt yrs]) Duroche, Hirschbach

8-291, 8-292, 8-293, 8-294. GERMAN LITERATURE I, II, III, IV. (3-4 cr per qtr; offered each year if feasible) Duroche, Hirschbach, Ramras, Wakefield, Weiss, Wood
A survey of German literature from the beginnings to the present. 8-291: Early period; Middle High German period; Renaissance; baroque. 8-292: Age of Classicism. 8-293: Romanticism and later 19th century. 8-294: Modern and contemporary literature.

8-711/8-712.† HISTORY OF THE GERMAN LANGUAGE. (3 cr per qtr; offered 1973-74 and alt yrs) Firchow, Wood

All Ph.D. majors in German literature are required to take the following additional course work in Germanic philology:

8-721/8-722/8-723†—Middle High German Language (3 cr per qtr)
At least one quarter of Middle High German literature (a choice of 8-201, 8-202, 8-203, 8-204).

Some of the requirements above may be waived if previous study and reading or residence abroad are substituted.

Methods

5-021. THE GRAMMAR OF STYLE. (4 cr) Wood
The initial approaches to understanding the literary critical vocabulary; an introduction to an analysis of stylistic differences in language strings.

5-101/5-102. STRUCTURE OF MODERN GERMAN. (4 cr per qtr) Firchow, Wood
5-101: German phonology. 5-102: German structure.

5-331. INTRODUCTION TO GERMAN CULTURAL ANALYSIS. (4 cr; prereq 1 qtr German civilization and culture, or equiv) Weiss
Techniques of cultural analysis (contrastive anthropological, traditional) through examination of literary texts, newspapers, language usage, etc., as well as "cultural myths" and forms of humor. Culture in translation.

Literature

5-601, 5-602, 5-603. DRAMA IN TRANSLATION. (4 cr per qtr; prereq 8 cr in theatre arts or in literature above 3-001; no knowledge of German lang required; cannot be used for German major or minor) Menze

5-970. DIRECTED READING. (1-5 cr)

8-100. PROSEMINAR: GERMAN LITERATURE. (3 cr; prereq 1st or 2nd yr grad)
Preparatory seminar to give students experience in techniques of research, presentation of oral reports, and writing of seminar papers.

8-111, 8-112, 8-113. FUNDAMENTALS OF THE STUDY OF GERMAN LITERATURE. (8-111...3-4 cr, 8-112, 8-113...3 cr per qtr) Duroche
8-111: Bibliography. 8-112: Study and interpretation of literature. 8-113: History of literary studies and criticism.

8-201, 8-202, 8-203, 8-204. MIDDLE HIGH GERMAN LITERATURE. (3 cr per qtr; prereq 8-723 or ‡) Firchow

8-211. LITERATURE FROM 1500 TO 1600. (3 cr) Weiss

8-212/8-213. GERMAN LITERATURE OF THE 17TH CENTURY. (3 cr per qtr) Weiss

8-217, 8-218, 8-219. LITERATURE OF THE 19TH CENTURY. (3 cr per qtr) Taraba
Literature, literary movements, and influences represented in drama, lyric, and shorter prose forms.

8-221, 8-222, 8-223. ROMANTICISM. (3 cr per qtr) Duroche

8-230. SEMINAR: 18TH CENTURY. (3 cr; prereq 1 yr grad work in German)

8-235, 8-236. STURM UND DRANG. (3 cr per qtr) Ramras

8-241, 8-242. EXPRESSIONISM IN GERMAN LITERATURE. (3 cr) Hirschbach

8-250. SEMINAR: 19TH CENTURY. (3 cr per qtr; prereq 1 yr grad work in German)

8-251, 8-252, 8-253. STUDIES IN ENGLISH-GERMAN LITERARY RELATIONS. (3 cr per qtr)

8-254, 8-255, 8-256. STUDIES IN FRENCH-GERMAN LITERARY RELATIONS. (3 cr per qtr)

8-261, 8-262. GERMAN LITERATURE SINCE WORLD WAR II. (3 cr per qtr) Hirschbach

8-270. SEMINAR: 20TH CENTURY. (3 cr; prereq 1 yr grad work in German)

8-301, 8-302, 8-303. 19TH-CENTURY NOVEL. (3 cr per qtr) Menze

8-304, 8-305, 8-306. BILDUNGSROMAN. (3 cr per qtr)
German Bildungsroman from 18th to 20th century.

8-307, 8-308, 8-309. GERMAN NOVELLE: FROM GOETHE TO KAFKA. (3 cr per qtr) Taraba

8-311, 8-312, 8-313. 20TH-CENTURY NOVEL. (3 cr per qtr) Ramras, Hirschbach

8-321, 8-322, 8-323. 19TH-CENTURY DRAMA. (3 cr per qtr) Menze

8-324, 8-325, 8-326. GERMAN DRAMA FROM NATURALISM TO THE PRESENT. (3 cr per qtr) Hirschbach, Weiss

8-333, 8-334, 8-335. LYRIC POETRY. (3 cr per qtr) Taraba
8-333: Renaissance through *Sturm und Drang*. 8-334: Goethe through Romanticism. 8-335: Heine to present.

8-401, 8-402. KLOPSTOCK, WIELAND. (3 cr per qtr) Ramras

8-403, 8-404. LESSING. (3 cr per qtr) Hirschbach

8-405, 8-406, 8-407. GOETHE. (3 cr per qtr) Ramras

8-411, 8-412, 8-413. SCHILLER. (3 cr per qtr) Ramras

8-451, 8-452, 8-453. 19TH CENTURY: NIETZSCHE. (3 cr per qtr) Taraba

8-811, 8-812, 8-813. STUDIES IN LITERARY THEORY AND CRITICISM. (3 cr per qtr)

Germanic Philology

8-201, 8-202, 8-203, 8-204. MIDDLE HIGH GERMAN LITERATURE. (3 cr per qtr; prereq 8-723 or ‡) Firchow

8-701. PHILOLOGICAL PROSEMINAR: BIBLIOGRAPHY AND METHODS. (3-4 cr) Firchow

8-711/8-712.† HISTORY OF THE GERMAN LANGUAGE. (3 cr per qtr) Firchow, Wood

8-721/8-722/8-723.† MIDDLE HIGH GERMAN LANGUAGE. (3 cr per qtr) Wood, Wakefield

8-731/8-732/8-733.† OLD HIGH GERMAN. (3 cr per qtr; prereq 8-723 or ‡) Firchow

8-734. OLD SAXON. (3 cr; prereq 8-733) Wood

8-741. GOTHIC. (3 cr; prereq 3-701 or equiv) Wood

8-742/8-743.† METHODS OF COMPARATIVE GERMANIC LINGUISTICS. (3 cr per qtr; prereq 8-741) Wood

8-744. READINGS IN PHILOLOGY. (3 cr; prereq ‡) Wood, Firchow

8-751. MANUSCRIPT READINGS AND TEXT RECONSTRUCTION. (3 cr; prereq ‡) Firchow

8-752. RUNIC INSCRIPTIONS. (3 cr; prereq ‡) Wood

8-761, 8-762, 8-763. PHILOLOGICAL SEMINAR. (3 cr per qtr; prereq ‡) Wood, Firchow

GERMANIC PHILOLOGY

COMMITTEE

Cecil Wood (German), *director*
Evelyn S. Firchow (German)
Nils Hasselmo (Scandinavian)
Walter Lehn (Linguistics)

Students planning to work in the program in Germanic philology as majors or minors must, upon entering, select a graduate adviser from the above committee and file their program with that adviser. Majors in Germanic philology may emphasize the literature of the period or the language of the period depending on their special interest. Course work will be selected accordingly.

Ph.D. Major in Germanic Philology

Language Requirement—A candidate for the Doctor's degree in Germanic philology must be competent in German and English and must demonstrate proficiency in Medieval Latin and in two other modern foreign languages, one of which must be another Germanic language (i.e., Swedish, Danish, Norwegian, Faroese, Modern Icelandic, Dutch).

Requirements and Recommended Courses—A minimum requirement of 63 credits of work or the equivalent of 21 quarter courses in philology (including the 27 credits or 9 quarter courses earned for the M.A. degree).

LANGUAGES

Required

Ger 8-721/8-722/8-723—Middle High German (9 cr)
Ger 8-731/8-732/8-733—Old High German (9 cr)
Ger 8-741—Gothic (3 cr)
Lat 5-235—Medieval Latin (3 cr)

Recommended

Ger 8-734—Old Saxon (3 cr)
Scan 5-701/5-702/5-703. Old Norse; Language and Literature (9 cr)
Engl 5-801—Old English (4 cr)
Engl 5-802—Old English Prose, Verse (3 cr)
Engl 5-803—Beowulf (4 cr)
Fren 8-201—Old French (3 cr)
Fren 8-202, 8-203—French Literature in the Middle Ages (6 cr)
Fren 8-704, 8-705, 8-706—Old Provençal (9 cr)

METHODS AND THEORY

Required

Ger 8-701—Philological Proseminar: Bibliography and Methods (3-4 cr)
Ger 8-742/8-743†—Methods of Comparative Germanic Linguistics (6 cr)
Ger 8-751—Manuscript Reading and Text Reconstruction (3 cr)

Recommended

Ger 8-752—Runic Inscriptions (3 cr)
Ling 5-001/5-002—Introduction to General Linguistics (6 cr)
Ling 5-605/5-606—Comparative Indo-European Linguistics (6 cr)

CULTURAL AND LITERARY HISTORY

Required

Ger 8-711/8-712—History of the German Language (6 cr)
Ger 8-761, 8-762, 8-763—Philological Seminar (3 cr) (choice of one or more)

Recommended

Ger 8-201, 8-202, 8-203, 8-204—Middle High German Literature (12 cr)
Hist 5-111, 5-112—Europe in the High Middle Ages (4 cr per qtr)
Hist 5-271, 5-272, 5-273—History of the Scandinavian Countries (4 cr per qtr)
Hist 5-611/5-612/5-613—Proseminar: Medieval History (9 cr)
Hist 5-641/5-642/5-643—Medieval English History (9 cr)
Hist 5-771/5-772/5-773—Scandinavian History (9 cr)

Hist 8-111/8-112/8-113—Medieval History (9 cr)
Hist 8-141/8-142/8-143—Medieval English History (9 cr)
ArtH 5-203—Early Medieval Art (4 cr)
ArtH 5-643—Prehistoric Art of Northern Europe (4 cr)
ArtH 8-213—Medieval Art (3 cr)
ArtH 8-650—Seminar: Studies in Scandinavian Art (3 cr)
Mus 5-631/5-632/5-633—Music in the Middle Ages and Renaissance (9 cr)
Phil 5-021—Medieval Philosophy (3 cr)

Minor—The choice of a minor is up to the student, but it must be selected in careful consultation with the graduate adviser.

Degree Examinations—See the booklet *Germanic Philology Program,* available in the German Department.

Ph.D. Minor in Germanic Philology

Course Requirements—A minimum requirement of 27 credits or 9 quarter courses of work in philology (including the 18 credits or 6 quarter courses earned for the M.A.). If additional courses are to be taken, they should be selected from the Ph.D. major list of courses.

Required

Ger 8-701—Philological Proseminar (3-4 cr)
Ger 8-711/8-712—History of the German Language (6 cr)
Ger 8-721/8-722/8-723—Middle High German Language (9 cr)

A choice of:

Ger 8-201/8-202/8-203/8-204—Middle High German Literature (12 cr)
(or) Ger 8-731/8-732/8-733—Old High German (9 cr)
(or) Ger 8-741—Gothic (3 cr), *and* Ger 8-742/8-743—Methods of Comparative Germanic Linguistics (6 cr)

Preliminary Examinations—For a Ph.D. minor in Germanic philology, the examination will consist of two parts:

1. A 1-hour written examination.
2. An oral examination.

M.A. Major in Germanic Philology

Offered under Plan B only. Three starred papers in Germanic philology are required.

Language Requirement—Apart from demonstrating competence in German and English, a candidate for the M.A. in Germanic philology will be required to show proficiency in either Medieval Latin or one modern foreign language (recommended are: Swedish, Norwegian, Danish, Faroese, Modern Icelandic, Dutch, French).

Course Requirements—A minimum requirement of 27 credits or 9 quarter courses of work in philology:

Required

Ger 8-701—Philological Proseminar: Bibliography and Methods (3-4 cr)
Ger 8-711/8-712—History of the German Language (6 cr)
Ger 8-721/8-722/8-723—Middle High German Language (9 cr)

A choice of:

Ger 8-731/8-732/8-733—Old High German (9 cr)
(or) Ger 8-201, 8-202, 8-203, 8-204—Middle High German Literature (12 cr)
(or) Ger 8-741—Gothic (3 cr) and Ger 8-742, 8-743—Methods of Comparative Germanic Linguistics (6 cr)

Plus at least 18 credits in related fields to be chosen in consultation with the graduate adviser.

Degree Examinations—See the booklet *Germanic Philology Program* available in the German Department.

M.A. Minor in Germanic Philology

A minor in philology for the M.A. is not recommended. Courses in philology can, of course, be used to fulfill the requirements for concentration in two related fields and will be counted toward a philology minor for the Ph.D. degree.

HISTORY (Hist)

Professor

Clarke A. Chambers, *chairman*
Josef L. Altholz
Paul W. Banford
Hyman Berman
Tom B. Jones
Stanford E. Lehmberg
Rodney C. Loehr
Paul L. Murphy
David W. Noble
Otto P. Pflanze
Theofanis G. Stavrou
Romeyn Taylor
Rudolph J. Vecoli

Associate Professor

Kinley J. Brauer, *director of graduate study*
John R. Howe, *asssociate chairman*
Bernard S. Bachrach
Peter N. Carroll
George D. Green
Allen T. Isaacman
David O. Kieft
David Kopf
Byron K. Marshall
John Modell
John K. Munholland
Stuart B. Schwartz
Allan H. Spear
John A. Thayer
James D. Tracy
William E. Wright

Assistant Professor

Edward L. Farmer
Lansiné Kaba
Thomas Kelly
J. Peyton McCrary
Thomas S. Noonan
Richard L. Rudolph

The department publishes a booklet, *Graduate Study in History,* giving more detailed information concerning its program, requirements, and regulations than can be included here. A copy will be sent on request.

Prerequisites—Students admitted to the Graduate School for work in history will usually be expected to have taken prior to admittance (a) general survey courses in two or three of the following areas or periods: Ancient, European, English, American, Asian, Medieval, African, and Latin-American; (b) a minimum of two full-year advanced or Upper Division courses (or their equivalent) in two of these areas or periods, including (c) at least one course in which intensive work has been done.

A student who minors in history must have completed approximately the same amount of work as that indicated in the preceding paragraph with the possible exception of the course involving intensive work.

Language Requirement—A reading knowledge of one foreign language is required before admittance to the Master's examination and of two languages before admittance to the preliminary examinations for the Ph.D. Where it can be amply demonstrated that either a specific research technique or a collateral field of knowledge would be of significantly greater value to the student's particular research, one or the other can be substituted for one of the two languages required in the doctoral program.

Master of Arts Degree

Plan A—A thesis is required. In addition, the student will complete 24 credits in history and 9 credits in a minor field. Work in the major must include at least one sequence of two or three courses at the proseminar or seminar level. The

necessary distribution of credits as to area and subarea is explained in *Graduate Study in History*.

Plan B—The student will earn 21 credits in history and 18 credits in two or more related minor fields with a minimum of two courses in each (the program must total 45 credits at least). The credits in history must include at least one sequence course of 6 or 9 hours on the proseminar or seminar level. Two or three research essays ("starred papers") written in graduate courses must be presented to the examining committee. A final oral examination is held.

Doctor's Degree

The field of history is divided into the following areas of concentration:

1. Ancient history
2. Medieval and Renaissance history to 1500
3. Modern European history, 1450 to the present
4. English history
5. United States history and its colonial background
6. Latin-American history
7. History of East Asia (China and Japan)
8. History of South Asia (Indian subcontinent)
9. African history

The separate requirements for each of these areas are outlined in the booklet, *Graduate Study in History*. In general, students prepare for the preliminary examinations in the area in which they intend to write a dissertation and in at least one additional subarea outside it.

Preliminary Examination—Written examinations are offered during the fifth week of the fall, winter, and spring quarters. Whether the student will write an examination in the minor field or supporting fields depends upon the requirements of the departments concerned. The oral examination should follow as soon as possible after completion of all written examinations.

Final Examination—The final oral examination shall cover the dissertation and its relationship to the area of history in which it falls.

Minor in History—The candidate for the M.A. degree with a minor in history (Plan A) must take a minimum of 9 credits and be examined in one subarea of history.

The candidate for the Ph.D. degree with a minor in history must be prepared for written and oral examinations in either (a) one area of history and an associated subarea, or (b) two subareas. The number of course credits required for a minor in history is flexible (18-24) and will depend upon the needs and the previous training of the candidate.

All programs for a minor in history must be approved by a member of the graduate faculty and the director of graduate studies of the department.

5-011, 5-012. QUANTITATIVE METHODS IN HISTORICAL RESEARCH. (4 cr per qtr; prereq 1 post-survey course in any social science) Modell

5-021/5-022. COMPARATIVE STUDY OF THE FAMILY IN HISTORY: INDIAN AND AMERICAN. (4 cr per qtr; #) Lelyveld, Modell
Historical information employed on the family to test a series of hypotheses regarding change—shift from agrarian to industrial society.

5-039. CONFUCIANISM AND HUMANISM: TWO CLASSICAL TRADITIONS. (4 cr; prereq course work in relevant periods of Chinese or European history and △)
Comparison and contrast of selected aspects of two intellectual traditions that look back to a "classical" age.

5-041f, 5-042w. EXPANSION OF EUROPE. (3 cr per qtr)
5-041: Era of discovery 1400 to 1763. 5-042: Later colonization 1763 to World War II.

5-051f, 5-052w, 5-053s. ANCIENT NEAR EAST. (3 cr per qtr)

5-061f, 5-062w, 5-063s. GREECE TO 200 B.C. (3 cr per qtr; offered 1973-74 and alt yrs) Kelly

5-071f, 5-072w, 5-073s. HISTORY OF ROME. (3 cr per qtr; offered 1972-73 and alt yrs) T Jones

5-100. SELECTED TOPICS IN EARLY MEDIEVAL EUROPE. (5 cr per qtr; prereq 1-101 or 3-101 or equiv or ♯; reading knowledge of French or German desirable)

5-111, 5-112. EUROPE IN THE HIGH MIDDLE AGES. (4 cr per qtr)
5-111: Medieval revival, 1050-1200. 5-112: Crisis of medieval civilization, 1200-1350.

5-121, 5-122. EUROPE IN THE EARLY RENAISSANCE. (4 cr, offered 1972-73 and alt yrs) Tracy
5-121: Italy 1300-1494. 5-122: France, Germany, and the Low Countries 1300-1494.

5-123, 5-124. EUROPE IN THE 16TH CENTURY. (4 cr per qtr) Tracy
5-123: Age of Reformation, 1494-1550. 5-124: Europe divided, 1550-1600.

5-134f, 5-135w, 5-136s. HISTORY OF EARLY RUSSIA. (4 cr per qtr; prereq ♯) Noonan
5-134: Origins of Russia; Kievan period. 5-135: To mid-16th century. 5-136: Ivan IV to Peter the Great.

5-141, 5-142. ENGLISH CONSTITUTIONAL HISTORY TO 1485. (4 cr per qtr)
5-141: From the Anglo-Saxons through the Magna Carta. 5-142: From the Magna Carta to the Tudors.

5-151, 5-152, 5-153. MODERN ENGLAND: TUDOR AND STUART PERIODS. (4 cr per qtr; offered 1973-74 and alt yrs) Lehmberg
5-151: 1485 to 1588. 5-152: 1588 to 1642. 5-153: 1642 to 1714.

5-171f, 5-172w, 5-173s. MODERN ENGLAND: 1783 TO PRESENT. (4 cr per qtr; offered 1973-74 and alt yrs) Altholz
5-171: 1783 to 1846. 5-172: 1846 to 1901, Victorian era. 5-173: 1901 to 1951, war and social change.

5-201, 5-202. EARLY MODERN EUROPE. (4 cr per qtr, offered when feasible) Bamford
5-201: Reformation and religious wars to 1648. 5-202: Age of absolutism.

5-211. FRANCE IN THE OLD REGIME. (5 cr; offered 1973-74 and alt yrs) Bamford

5-212. FRENCH REVOLUTION AND NAPOLEON. (5 cr; offered 1972-73 and alt yrs) Bamford

5-221, 5-222. 20TH CENTURY EUROPE. (4 cr per qtr) Munholland
5-221: From 1890 to Great Depression. 5-222: From Great Depression to present.

5-231. MODERN FRANCE. (5 cr; offered 1973-74 and alt yrs) Munholland
History of France from 1815 to present.

5-241f, 5-242w, 5-243s. HISTORY OF GERMANY. (4 cr per qtr; 2 qtrs offered each yr) Pflanze
5-241: From 911 to 1648. 5-242: From 1648 to 1871. 5-243: Since 1871.

5-244, 5-245. CENTRAL EUROPE. (4 cr per qtr; prereq 1-003) Wright
5-244: Central Europe to Congress of Vienna. 5-245: Central Europe since 1815.

5-247. HISTORY OF AUSTRIA. (4 cr; offered 1972-73 and alt yrs) Wright
Austria from 16th century through Second Republic.

5-254, 5-255. HISTORY OF MODERN ITALY. (4 cr per qtr; offered 1973-74 and alt yrs) Thayer
5-254: From the 18th century to 1870. 5-255: From 1870 to present.

5-264f, 5-265w, 5-266s. MODERN RUSSIA. (4 cr per qtr) Stavrou
5-264: 18th century background. 5-265: 19th century. 5-266: Revolutions and Soviet regime.

5-271f, 5-272w, 5-273s. HISTORY OF SCANDINAVIAN STATES. (4 cr per qtr) Gold

5-274f, 5-275w. MODERN NEAR EAST: OTTOMAN EMPIRE AND SUCCESSOR STATES (4 cr per qtr) Stavrou
5-274: From 1872 to Congress of Berlin. 5-275: From Congress to present.

5-276. INTELLECTUAL AND CULTURAL HISTORY OF MODERN GREECE. (5 cr) Stavrou
Survey of literary and cultural contributions of modern Greece in national and European contexts.

5-281f, 5-282w, 5-283s. INTELLECTUAL AND CULTURAL HISTORY OF MODERN EUROPE. (3 cr per qtr; offered 1972-73 and alt yrs) Thayer
5-281: 18th century and its background. 5-282: Early 19th century. 5-283: Late 19th and 20th centuries.

5-284f, 5-285w, 5-286s. DIPLOMATIC HISTORY OF EUROPE IN THE 19TH AND 20TH CENTURIES. (4 cr per qtr) Kieft
5-284: 1789 to 1871. 5-285: 1871 to 1918. 5-286: 1918 to present.

5-287. DIPLOMATIC HISTORY OF EUROPE FROM 1648 TO 1789. (4 cr; when feasible) Kieft

5-289s. HISTORY OF EUROPEAN PENAL SYSTEMS. (4 cr per qtr) Bamford
Comparative analysis of European systems.

5-291f, 5-292w. ECONOMIC HISTORY OF EUROPE. (4 cr per qtr) Rudolph
Problems in economic history and development of Europe; relationship of the economy to the social-political structure.

5-294, 5-295. PROBLEMS IN THE ECONOMIC HISTORY OF RUSSIA AND EASTERN EUROPE. (4 cr per qtr; offered 1973-74 and alt yrs) Rudolph
5-294: Pre-1917. 5-295: 1917 to present.

5-317, 5-318. AMERICAN HISTORY, 1850-1900. (4 cr per qtr) Loehr
5-317: 1850-1865. 5-318: 1865-1900.

5-331, 5-332. AMERICAN CONSTITUTIONAL HISTORY. (4 cr per qtr; offered 1972-73 and alt yrs) Murphy
5-331: English and colonial background through the middle period. 5-332: Law as social control in modern America.

5-334, 5-335. HISTORY OF CIVIL LIBERTIES AND CIVIL RIGHTS IN THE UNITED STATES. (4 cr per qtr; offered 1973-74 and alt yrs) Murphy
5-334: Liberty, equality, and justice in pre-industrial American society. 5-335: Civil liberties and civil rights conflicts in industrial America.

5-339. GREAT FIGURES IN AMERICAN JURISPRUDENCE. (4 cr; offered 1973-74 and alt yrs) Murphy
Role of leading jurists and legal thinkers in shaping of American public law.

5-341, 5-342. AMERICAN ECONOMIC HISTORY. (4 cr per qtr) Loehr
5-341: Colonial period to 1865. 5-342: 1865 to present.

5-344, 5-345. HISTORY OF AMERICAN LABOR. (4 cr per qtr) Berman
5-344: Pre-industrial experience and early industrialization. 5-345: Labor in the mature society.

5-349. AMERICAN AGRICULTURAL HISTORY. (3 cr; prereq ♯; offered when feasible)

5-354, 5-355. AMERICAN URBAN HISTORY. (4 cr per qtr) Modell
5-354: Pre-industrial America. 5-355: Industrial America.

5-371, 5-372. RECENT INTELLECTUAL HISTORY OF THE UNITED STATES. (4 cr per qtr) Noble

5-379s. PROBLEMS IN COLONIAL AMERICAN HISTORY. (4 cr; prereq 3-801 or 3-802 or ♯) Carroll
Specific problems in colonial history with emphasis upon intellectual and cultural history.

5-389. RUSSIAN-AMERICAN RELATIONS, 1917 TO PRESENT. (4 cr; prereq ♯) Brauer
Survey of Russian-American relations since the Russian Revolution, emphasizing political, diplomatic, economic and military problems and American foreign policy.

5-391, 5-392. HISTORY OF THE SOUTH. (4 cr per qtr) McCrary
5-391: Slavery and the Antebellum South, 1607-1861. 5-392: Reconstruction of southern society, 1861-1914.

5-419. HISTORY OF ARGENTINA. (4 cr) Wagner
Political, economic, and social history of Argentina since independence.

5-420. TOPICS IN LATIN AMERICAN HISTORY. (4 cr; prereq ♯) Schwartz, Wagner
Detailed treatment of historical themes common to entire Latin-American area. Course content will change from quarter to quarter.

5-421, 5-422. HISTORY OF BRAZIL. (4 cr per qtr) Schwartz
5-421: Survey of colonial Brazilian development, 1500-1808. 5-422: Modern Brazil, 1808 to present.

5-424, 5-425. HISTORY OF MEXICO. (4 cr per qtr) Schwartz, Wagner
5-424: Pre-Columbian period through colonial era. 5-425: Development of the Mexican nation.

5-426. HISTORY OF THE ANDEAN REPUBLICS. (4 cr; offered 1972-73 and alt yrs) Wagner
Comparative historical development of Bolivia, Colombia, Ecuador, and Peru since independence.

5-429. SLAVERY IN THE AMERICAS. (4 cr, §SSci 3-507) Isaacman, Schwartz, Spear
Comparative analysis of slavery in the Americas from the African origins of the trade to emancipation.

5-431. ISLAM AND NATIONALISM: WEST AFRICA AND SOUTH ASIA. (4 cr; prereq prev course work relevant to Islam, West Africa, or South Asia or ‡) Kaba, Lelyveld
Comparative study of religious and political ideologies and movements in two regions of Islamic civilization during European colonial domination.

5-432, 5-433. PROBLEMS IN CONTEMPORARY AFRICA. (4 cr per qtr; offered 1972-73 and alt yrs) Kaba
5-432: Introduction and spread of Islam in Africa. 5-433: Process of Islamization and political influence of Islamic ideology.

5-434, 5-435. SPREAD OF ISLAM. (4 cr per qtr; offered 1973-74 and alt yrs) Kaba
5-434: Introduction and spread of Islam into Africa. 5-435: The course will stress the study of the process and agents of Islamization and the rise of the Islamic ideology for political purposes.

5-444, 5-445. PROBLEMS IN CENTRAL AND SOUTHERN AFRICAN HISTORY. (4 cr per qtr; open also to sophs who have passed 1-431, 1-432, 1-433) Isaacman

5-447. PROBLEMS IN EAST AFRICA. (4 cr; offered 1973-74 and alt yrs) Isaacman
Advanced course in African history focusing on specific themes and methodological problems.

5-454, 5-455. MUSLIMS IN MODERN INDIAN HISTORY. (4 cr per qtr) Lelyveld
5-454: Decline of the Mughals, establishment of British rule 1757-1857. 5-455: Cultural and social change, political mobilization of Indian Muslims, 1857-1947.

5-458, 5-459. MODERN SOUTH ASIA: SOCIAL HISTORY. (4 cr; offered 1973-74) Kopf, Lelyveld
Selected problems in social history of South Asia.

5-461f, 5-462w. CHINESE HISTORY TO 1368 A.D. (4 cr per qtr) Taylor
5-461: To 221 B.C. 5-462: To 1368.

5-464. EARLY MODERN CHINA: MING AND EARLY CH'ING, 1350-1750. (4 cr; offered 1972-73 and alt yrs) Farmer
Political and social institutions in early Ming; 16th and 17th century social and cultural trends; Manchu conquest and early western contacts.

5-465. CHINA'S RESPONSE TO THE WEST, 1750-1911. (4 cr; offered 1972-73 and alt yrs) Farmer
Decline of imperial system; Western impact; cultural crisis and revolution.

5-467. REPUBLICAN CHINA: THE NATIONALIST REVOLUTION, 1900 TO PRESENT. (4 cr; offered 1973-74 and alt yrs) Farmer
Development of Chinese nationalism; interventions of Soviet Union, Japan, and United States; failure of Kuomintang.

5-468. PEOPLE'S REPUBLIC OF CHINA: THE COMMUNIST REVOLUTION, 1900 TO PRESENT. (4 cr; offered 1973-74 and alt yrs) Farmer
Introduction of Marxism to China; rise of Communist Party; restructuring Chinese society.

5-471. TWENTIETH CENTURY JAPAN (5 cr, §3-471) Marshall
Modern transformation, 1870's to 1970's.

5-472. EARLY MODERN JAPAN. (5 cr, §3-472) Marshall
Tradition and change in Tokugawa Society.

5-481, 5-482, 5-483. HISTORY OF SOUTH ASIA. (4 cr per qtr, §3-481, §3-482, §3-483) Kopf, Lelyveld
Introduction to history of South Asia from social, cultural, political, and economic perspectives.

5-484s. HISTORY OF SOUTHEAST ASIA. (4 cr; offered when feasible)
Development of societies and states in Asian region bordered by cultural and political spheres of China and India, with emphasis on Vietnam.

5-970. DIRECTED STUDY. (1-15 cr; prereq ‡; qualified sr and grad students may register with ‡ for work on tutorial basis) Staff

5-990. DIRECTED RESEARCH. (1-15 cr; prereq ‡; qualified sr and grad students may register with ‡ for work on tutorial basis) Staff

Proseminars in European and American History

(All students who wish to enroll in a proseminar or seminar in history are required to consult with the professor before the class meets and gain permission to enroll.)

5-551f/5-552w/5-553s.† ANCIENT HISTORY. (3 cr per qtr) T Jones

5-561f/5-562w/5-563s.† ANCIENT HISTORY. (3 cr per qtr) Kelly

5-601f, 5-602w, 5-603s. EARLY MEDIEVAL WESTERN EUROPE. (3 cr per qtr; prereq 1-101 or 3-051 or equiv, reading knowledge of French or German, ‡) Bachrach

5-611f/5-612w/5-613s. MEDIEVAL HISTORY. (3 cr per qtr; 1 yr of medieval history or equiv, reading knowledge of French or German, ‡)

5-621f/5-622w/5-623s.† RENAISSANCE AND REFORMATION HISTORY. (3 cr per qtr) Tracy

5-634w, 5-635s.† MEDIEVAL RUSSIAN HISTORY. (3 cr per qtr; prereq 5-134, 5-135, 5-136 or ‡, reading knowledge of Russian, French, or German) Noonan

5-641f/5-642w/5-643s. MEDIEVAL ENGLISH HISTORY. (3 cr per qtr; 1 yr of medieval history or equiv, ‡, reading knowledge of French or German)

5-651f/5-652w/5-653s.† ENGLISH HISTORY: TUDOR AND STUART PERIODS. (3 cr per qtr) Lehmberg

5-671f/5-672w/5-673s.† MODERN ENGLAND: 1783 TO PRESENT. (3 cr per qtr; offered 1973-74 and alt yrs) Altholz

5-711f/5-712w/5-713s.† FRENCH REVOLUTION AND NAPOLEON. (3 cr per qtr) Bamford

5-721f/5-722w/5-723s.† RECENT EUROPEAN HISTORY. (3 cr per qtr; prereq lect course in 20th-century Europe or World War II, or ‡)

5-731f/5-732w/5-733s.† 17TH-CENTURY FRANCE. (3 cr per qtr; prereq reading knowledge of French) Bamford

5-741f, 5-742w. GERMANY AND CENTRAL EUROPE IN 18TH CENTURY. (3 cr per qtr) Wright

5-744f/5-745w/5-746s.† 19TH-CENTURY GERMANY. (3 cr per qtr; prereq reading knowledge of German, ‡) Pflanze

5-761f/5-762w/5-763s.† RUSSIAN HISTORY. (3 cr per qtr; prereq 5-136, reading knowledge of Russian, German, or French, or ‡) Stavrou

5-771f/5-772w/5-773s.† SCANDINAVIAN HISTORY. (3 cr per qtr)

5-774. READINGS IN THE MODERN NEAR EAST: OTTOMAN EMPIRE AND SUCCESSOR STATES. (3 cr; prereq 5-274, 5-275) Stavrou

5-777f/5-778w/5-779s.† HISTORY OF THE HAPSBURG MONARCHY. (3 cr per qtr; prereq ‡) Wright

5-781/5-782.† MODERN EUROPEAN INTELLECTUAL HISTORY. (3 cr per qtr) Thayer

5-784w/5-785s.† DIPLOMATIC HISTORY OF 19TH- AND 20TH-CENTURY EUROPE. (3 cr per qtr) Kieft
5-784: 1815 to 1914. 5-785: 1914 to present.

5-787/5-788.† RELIGIOUS HISTORY OF MODERN EUROPE. (3 cr per qtr; offered 1972-73 and alt yrs) Altholz

5-791f/5-792w/5-793s.† EUROPEAN ECONOMIC HISTORY SINCE 1500. (3 cr per qtr) Bamford

5-794f/5-795w/5-796s.† HISTORY OF EUROPEAN COMMERCE. (3 cr per qtr) Bamford

5-801f/5-802w.† 17TH- and 18TH-CENTURY AMERICAN HISTORY. (4 cr per qtr) Carroll

5-804f/5-805w/5-806s.† ERA OF THE AMERICAN REVOLUTION. (3 cr per qtr) Howe

5-811. 19TH-CENTURY AMERICAN HISTORY. (4 cr per qtr) McCrary

5-817f/5-818w/5-819s.† AMERICAN HISTORY, 1850-1900. (3 cr per qtr; offered 1973-74 and alt yrs) Loehr

5-821/5-822.† AMERICAN HISTORY IN THE 20TH-CENTURY. (4 cr per qtr; prereq ‡) Chambers

5-831f, 5-832w, 5-833s. AMERICAN POLITICAL AND CONSTITUTIONAL HISTORY. (3 cr per qtr; prereq 5-331, 5-332, 5-333 or ‡) Murphy

5-841f/5-842w/5-843s.† AMERICAN ECONOMIC HISTORY. (3 cr per qtr; offered 1972-73 and alt yrs) Loehr

5-844f/5-845w/5-846s.† AMERICAN LABOR HISTORY. (3 cr per qtr) Berman

5-847w/5-848s.† AMERICAN BUSINESS HISTORY. (3 cr per qtr) Green

5-854, 5-855. AMERICAN URBAN HISTORY. (3 cr per qtr) Modell

5-861/5-862.† HISTORY OF AMERICAN IMMIGRATION. (3 cr per qtr) Vecoli

5-864w/5-865s.† AFRO-AMERICAN HISTORY. (4 cr per qtr; prereq ‡ for 5-864...5-864 for 5-865) Spear

5-871f/5-872w. INTELLECTUAL HISTORY OF THE UNITED STATES IN THE 19TH- AND 20TH-CENTURIES. (4 cr per qtr) Noble

5-881, 5-882. AMERICAN FOREIGN RELATIONS. (4 cr per qtr; prereq ‡) Brauer

5-897/5-898/5-899.† LITERATURE OF AMERICAN HISTORY. (3 cr per qtr; prereq ‡; required of all grad students intending a PhD program in American history)
Introduction to problems of historiography; survey of major interpretations in American history.

5-901f/5-902w/5-903s.† LATIN-AMERICAN HISTORY. (5 cr per qtr; prereq reading knowledge of Spanish; offered when feasible) Schwartz, Wagner

5-951f, 5-952s.† HISTORY OF HISTORICAL THOUGHT. (3 cr per qtr) Pflanze

5-961w/5-962s.† EXPANSION OF EUROPE. (3 cr per qtr)

5-964s. ATLANTIC COMMUNITY: EARLY MODERN ORIGINS. (3 cr; offered when feasible)

Proseminars in Asian History

5-501f/5-502w/5-503s.† HISTORY OF INDIA. (4 cr per qtr) Kopf

5-511f, 5-512w.† CHINESE HISTORY TO A.D. 1368. (3 cr per qtr) Taylor

5-514f, 5-515w. MODERN CHINA. (3-5 cr per qtr; prereq ‡; offered 1972-73 and alt yrs) Farmer
5-514: China in Ming and early Ch'ing, 1350-1750. 5-515: Late Ch'ing, 1750-1911.

5-517, 5-518. 20TH-CENTURY CHINESE HISTORY. (3-5 cr per qtr; prereq ‡; offered 1972-73 and alt yrs) Farmer
5-517: The Republic. 5-518: The People's Republic.

5-519. TWENTIETH-CENTURY CHINESE HISTORY. (5 cr; prereq ‡)

5-522. CURRENT INTERPRETATIONS AND TOPICS IN JAPANESE HISTORY. (5 cr) Marshall

5-534s. SOUTHEAST ASIAN HISTORY. (3 cr; offered when feasible)

Proseminars in African History

5-931s. HISTORY OF AFRICA. (3 cr; prereq 5-431, 5-432, or ‡)

5-939. METHODOLOGY FOR THE STUDY OF AFRICAN HISTORY. (3 cr)

5-941, 5-942, 5-943. AFRICAN HISTORY. (3 cr per qtr; prereq ‡)
Research training with emphasis on West and North Africa.

5-944, 5-945, 5-946. AFRICAN HISTORY. (3 cr per qtr; prereq ‡) Isaacman
Research training with emphasis on East, Central, and South Africa.

Seminars

8-001f. HISTORICAL BIBLIOGRAPHY AND CRITICISM. (3 cr; required of MA Plan B candidates unless excused by adviser) Staff

8-011. READINGS IN WORKS OF GREAT AMERICAN HISTORIANS. (3 cr; offered when feasible)

8-051f/8-052w/8-053s.† **ANCIENT HISTORY.** (3 cr per qtr) T Jones

8-111f/8-112w/8-113s.† **MEDIEVAL HISTORY.** (3 cr per qtr)

8-121f/8-122w/8-123s.† **RENAISSANCE HISTORY.** (3 cr per qtr)

8-141f/8-142w/8-143s.† **MEDIEVAL ENGLISH HISTORY.** (3 cr per qtr)

8-151f/8-152w/8-153s.† **ENGLISH HISTORY, TUDOR-STUART PERIOD.** (3 cr per qtr) Lehmberg

8-211/8-212. **FRENCH REVOLUTION AND NAPOLEON.** (3 cr per qtr) Bamford

8-221f/8-222w/8-223s.† **RECENT EUROPEAN HISTORY.** (3 cr per qtr)

8-231f/8-232w/8-233s.† **17TH-CENTURY FRANCE.** (3 cr per qtr) Bamford

8-241f/8-242w/8-243s.† **19TH-CENTURY GERMANY.** (3 cr per qtr; prereq 5-241, 5-242, 5-243 or ‡) Pflanze

8-244f/8-245w/8-246s.† **HISTORY OF THE HAPSBURG MONARCHY.** (3 cr per qtr) Wright

8-261f/8-262w/8-263s.† **RUSSIAN HISTORY.** (3 cr per qtr) Stavrou

8-291f/8-292w/8-293s.† **EUROPEAN ECONOMIC HISTORY.** (3 cr per qtr) Bamford

8-301f/8-302w/8-303s.† **17TH-CENTURY AMERICAN HISTORY.** (3 cr per qtr) Carroll

8-311f/8-312w/8-313s.† **19TH-CENTURY AMERICAN HISTORY.** (3 cr per qtr)

8-317f/8-318w/8-319s.† **AMERICAN HISTORY, 1850-1900.** (3 cr per qtr) Loehr

8-321/8-322.† **20TH-CENTURY AMERICAN HISTORY.** (3 cr per qtr) Chambers

8-331f/8-332w/8-333s.† **AMERICAN POLITICAL AND CONSTITUTIONAL HISTORY.** (3 cr per qtr) Murphy

8-341/8-342/8-343.† **AMERICAN ECONOMIC HISTORY.** (3 cr per qtr) Loehr

8-344f/8-345w/8-346s.† **AMERICAN LABOR HISTORY.** (3 cr per qtr) Berman

8-357f/8-358w/8-359s.† **AMERICAN SOCIAL AND EDUCATIONAL HISTORY.** (3 cr per qtr)
See HEd 8-296/8-297/8-298

8-361/8-362/8-363.† **HISTORY OF AMERICAN IMMIGRATION.** (3 cr per qtr) Vecoli

8-371f/8-372w/8-373s.† **INTELLECTUAL HISTORY OF THE UNITED STATES IN THE 19TH- AND 20TH-CENTURIES.** (3 cr per qtr) Noble

8-381/8-382. **HISTORY OF AMERICAN FOREIGN RELATIONS.** (4 cr per qtr; prereq 5-881, 5-882, or ‡; offered when feasible) Brauer

8-394f/9-395w/8-396s.† **THE WEST IN AMERICAN HISTORY.** (3 cr per qtr)

8-401f/8-402w/8-403s.† **LATIN-AMERICAN HISTORY.** (3 cr per qtr) Schwartz

8-451f/8-452w/8-453s.† **HISTORY OF INDIA.** (3 cr per qtr) Kopf

8-464f, 8-465w, 8-466s. **CHINESE HISTORY SINCE 1279.** (3 cr per qtr; prereq ‡; reading knowledge of Chinese) Farmer, Taylor

8-471f/8-472w/8-473s.† **HISTORY OF JAPAN.** (3 cr per qtr; prereq ‡) Marshall
8-471: Research materials. 8-472: Research methods. 8-473: Research seminar.

8-944, 8-945, 8-946. **AFRICAN HISTORY.** (4 cr per qtr) Isaacman
Specific themes and methodological problems. Research will be based on primary historical data as well as anthropological, linguistic, and archaeological sources.

8-970. **DIRECTED STUDY.** (1-15 cr; prereq ‡; grad students may register with ‡ for work on tutorial basis) Staff

8-990. **DIRECTED RESEARCH.** (1-15 cr; prereq ‡; grad students may register with ‡ for work on tutorial basis) Staff

HISTORY OF MEDICINE (HMed)

Professor

Leonard G. Wilson, Ph.D., *director of graduate study*

The program in the history of medicine is designed to allow students to proceed to the Ph.D. degree with specialization either in the history of medicine or

the history of the biological sciences. The doctorate in these areas will prepare students for a career of academic scholarship and teaching in the history of biology and medicine.

Prerequisites—Students intending to specialize in the history of medicine should preferably have received the M.D. degree, or have extensive training in the biological sciences or in public health. Students intending to specialize in the history of the biological sciences should have an undergraduate major in biology or biochemistry and preferably some graduate training in these subjects.

Language Requirement—Students will be required to demonstrate competence in two foreign languages, preferably French and German. They must pass the examination in one foreign language before the end of their first academic year and in both languages before the end of their second year of graduate study. For students interested in a historical period before 1800, Latin will be a third required foreign language.

During their first 2 years, students will take approximately 54 credits of courses in the history of medicine, history of science, history, and science. At the beginning, or during the first quarter of their third year, they will take a comprehensive oral examination in their fields of interest. A student who passes the comprehensive examination successfully may begin work on a thesis.

Thesis Requirement—Candidates for the Ph.D. degree must submit a thesis, prepared under the advisory guidance of a member of the faculty.

5-400, 5-401, 5-402. HISTORY OF MEDICINE. (3 cr per qtr)

5-410, 5-411, 5-412. SEMINAR: EMERGENCE OF MODERN MEDICINE, 1750-1900. (3 cr per qtr)

8-220, 8-221, 8-222. HISTORY OF THE BIOLOGICAL SCIENCES. (3 cr per qtr; offered 1972-73)

8-230, 8-231, 8-232. READINGS: HISTORY OF SCIENCE. (3 cr per qtr)

HOME ECONOMICS

Professor

Keith McFarland, *acting dean, College of Home Economics*
Roxana Ford, *associate dean, College of Home Economics; director of graduate study*
Margaret Doyle (Nutrition)
Gertrude Esteros (Design)
Joan Gordon (Food)
Margaret Grindereng (Textiles and Clothing)
Richard Hey (Family Social Science)
Eugene Larkin (Design)
Lura Morse (Nutrition)

Associate Professor

Paul Rosenblatt (Family Social Science)
Patricia Swan (Nutrition)

Graduate programs are planned individually with students. Study is concentrated in one particular area such as design, family relations, food, home economics education (see College of Education listing for faculty and courses), household equipment, nutrition, or textiles and clothing or in closely related areas. Minor work may be taken in any of a number of other disciplines within the University.

Prerequisites—Students desiring to major in any one of the areas of home economics must present such undergraduate credits in social science, physical sciences, biological sciences, art, and education as shall be satisfactory to the adviser under whose direction the major work is to be done. In addition students must have adequate undergraduate training in that subfield of home economics in which they wish to specialize.

Major and Minor—Students majoring in home economics for a Master's or a Doctor's degree and those minoring in this field for the Doctor's degree must

include one of the following: HE 8-250, HE 8-391, HE 8-395, HE 8-402, HE 8-575, HE 8-662.

Language Requirement—The language requirement is determined by the department or adviser in consultation with the student.

Master's Degree—Offered under both Plan A and Plan B. The M.A. as well as the M.S. may be earned in home economics.

Doctor's Degree—Work for the Ph.D. degree is offered.

Design (Dsgn)

5-502. APPLICATIONS OF ART THEORY IN HOME ECONOMICS. (3 cr; prereq 5-505 or equiv)
Current literature of art with implications for home and family living.

5-505.° ART HISTORY. (4 cr)
Egyptian period to present. Painting, sculpture, and architecture of the past studied for influences on contemporary period. Field trips.

5-507.° HISTORY OF DECORATIVE ARTS: TEXTILES. (3-4 cr; prereq 5-505 or equiv)
Textiles of the world from early civilization to 20th century. Study of design, material, and technique.

5-509.° HISTORY OF DECORATIVE ARTS: METAL, CERAMICS, WOOD, AND GLASS. (3-4 cr; prereq 5-505 or equiv)
Glass, ceramics, metalwork, wood, and other materials from selected historical periods. Application to interior design.

5-512.° HISTORY OF EUROPEAN FURNITURE AND INTERIORS. (3-4 cr; prereq 5-505 or equiv)
Furniture and interiors from ancient times through the 19th century.

5-514.° HISTORY OF AMERICAN FURNITURE AND INTERIORS. (3-4 cr; prereq 5-505 or equiv, 5-512)
Historic styles of American interiors and furnishings from the 17th to the 20th century.

5-517.° HISTORY OF COSTUME. (3 cr; prereq 5-505 or equiv)
Primitive to contemporary styles. Study of costume from historic collection.

5-521. COLOR II. (3 cr; prereq 1-521 or ‡)
Intensive study of color; consideration of visual, emotional, and symbolic aspects; color theory.

5-531. TEXTILE DESIGN III. (3-6 cr; prereq demonstrated proficiency, ‡)
Designing in one selected textile technique. Studio problems. Readings.

5-533. JEWELRY DESIGN III. (4 cr; prereq 5-533)
Advanced processes and design in jewelry construction.

5-541. COSTUME DESIGN III. (3 cr; prereq TexC 1-604, 3-541 or ‡)
Advanced problems in draping and sketching. Pencil, crayon, and water color techniques; studies and reports on selected topics.

5-544. COSTUME DESIGN PROBLEMS. (4 cr; prereq 5-541 or ‡)
Supervised experience in design production; development of a "line," professional ethics and business practice.

5-551. INTERIOR DESIGN PRESENTATION. (3 cr; prereq 1-523 or equiv, 1-553)
Methods of rapid rendering for interiors in various media. Presentation techniques for traditional and modern interior details.

5-552. INTERIOR DESIGN III. (4 cr; prereq 3-550, 3-553, TexC 3-621, FSoS 1-401, 9 cr in social sciences or ‡)
Problems in planning and furnishing a home to meet family needs. Aesthetic, economic, social and managerial aspects considered.

5-554. INTERIOR DESIGN IV. (4 cr; prereq 3-550, 3-553, 3-557)
Emphasis on design problems related to commercial interiors. Solutions rendered in various media.

5-555.° ADVANCED PROBLEMS IN INTERIOR DESIGN. (3-5 cr; prereq HE 5-552 or 5-554 or ‡)
Independent study in interior design under tutorial guidance.

5-556. ENVIRONMENTAL STUDIES IN INTERIOR DESIGN. (3 cr; for postbaccalaureate students; prereq 6 cr in housing, home furnishings, and interior design or equiv)
Exploration of space, color, light, and arrangement in interiors (in specially designed laboratories). Review of current literature.

5-558. PURCHASING HOME FURNISHINGS. (3 cr; prereq 1-551 or 1-553)
Study of home furnishings in terms of use, cost, and appearance. Includes furniture, dinnerware, floor and wall coverings, fabrics, and accessories. Actual materials, slides, and references used. Field trips.

5-565.° HOMES OF THE WORLD. (3-4 cr; prereq 1-551 or 1-553 or 1-563 or equiv)
Study of home design in selected regions of the world.

5-568.° HOUSING PROBLEMS OF THE FAMILY. (3 cr; prereq 1-551 or 1-553 or 3-563 or equiv)
Urban and rural housing problems with evaluation of economic, social and aesthetic aspects.

5-584.° READINGS IN DESIGN. (1-3 cr; prereq ‡)
Independent study and review of books and periodicals in selected areas of design. Written reports.

5-585.° PROBLEMS IN DESIGN: GENERAL. (3-4 cr per qtr [12 cr max]; prereq ‡, △)
Independent study under tutorial guidance.

5-586. PROBLEMS IN DESIGN: HOUSING AND/OR INTERIORS. (3-4 cr per qtr [max 12 cr]; prereq △)
Independent study under tutorial guidance.

5-587. PROBLEMS IN DESIGN: JEWELRY OR TEXTILE DESIGN. (3-4 cr per qtr [12 cr max]; prereq ‡, △)
Independent study under tutorial guidance.

8-531. SPECIAL PROBLEMS IN TEXTILE DESIGN. (1-3 cr; prereq 5-531 or ‡)
Advanced study in textile design such as silk screen, block printing, and batik.

8-552.° SPECIAL PROBLEMS IN HOUSING AND INTERIOR DESIGN. (1-3 cr; prereq 5-552 or 5-554 or ‡)
Independent study and reports.

8-556. ENVIRONMENTAL STUDIES IN INTERIOR DESIGN. (3-5 cr; prereq 6 cr in housing, home furnishing and interior design or equiv)
Exploration of space, color, light, and arrangement, review of research.

8-575. SEMINAR: DESIGN. (1 cr)

8-584. READINGS IN DESIGN. (1-3 cr; prereq ‡)
Independent study and review of books and periodicals.

8-585. PROBLEMS: DESIGN. (1-5 cr; prereq ‡)

8-586/8-587.° PROBLEMS: DESIGN. (1-5 cr; prereq ‡)

Family Social Science (FSoS)

5-200. FAMILY RELATIONSHIPS. (5 cr, §Soc 5-501; prereq Psy 1-001 or equiv, Soc 1-001 or equiv)
Analysis of the family as an institution, and system of relationships. Survey of current developments in study of family. Analysis of changes in American society and their influence on family life.

5-201. FAMILY IN AMERICAN SOCIAL STRUCTURE. (3 cr; prereq 5-200, 25 cr in social science courses exclusive of economics, or ‡)
Analysis of relationships between change in American social structure and parental behavior. Analysis of contribution by psychological and sociological behavior theories to research and knowledge in parenthood and parental behavior.

5-202. INTRODUCTION TO SOCIAL PSYCHOLOGY WITH APPLICATIONS TO THE FAMILY. (5 cr, §Psy 5-201, §Soc 5-201, §PsyF 5-170; prereq Psy 1-001, introductory sociology or ‡)
Introduction to social psychology with applications to courtship, marriage, and the family. Social interaction, communication, social effects on individual functioning, family as small group, social influence, social ecology, person perception, social motivation, interpersonal attraction, and other topics.

5-205. THEORY AND RESEARCH IN FAMILY RELATIONSHIPS. (3 cr; prereq 5-200 or equiv, Soc 3-803 or Soc 5-804 or ‡)
Scientific method in study of family relationships. Current theoretical questions will be discussed and hypotheses derived, tested, and analyzed in laboratory sessions.

5-210. FAMILY IN WORLD PERSPECTIVE. (5 cr, §Anth 5-312, §Soc 5-511; prereq 5-200, Anth 1-002, or ‡)
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.

5-220. FAMILY ECONOMICS. (3 cr; prereq 3-260 or ‡)
Variations in family income, saving, spending, and decision making related to socioeconomic factors. Conceptual development and research on economic problems of families.

5-230. INDEPENDENT STUDY IN FAMILY SOCIAL SCIENCE. (Cr ar [4 cr max per qtr]; prereq ‡)
Independent reading or research under faculty supervision.

5-240. SPECIAL TOPICS IN FAMILY SOCIAL SCIENCE. (2-3 cr per qtr [9 cr max]; prereq 5-205 or 15 cr in behavioral science courses, and/or ‡)
Review of research and discussion.

5-241. SEMINAR IN FAMILY AND SOCIAL PROBLEMS. (4 cr; prereq 5-200 or equiv, 5-202 or Soc 5-201 or Psy 5-201)
Social problems as they affect family structure and functioning. Concepts of "social problem" and "deviance" are discussed. Research findings in problem areas are reviewed. Among topic areas are: alcoholism, divorce, mental retardation, illegitimacy, etc.

5-260. HOME MANAGEMENT PRINCIPLES. (3 cr; prereq AgEc 1-030)
Study and discussion of managerial aspects of homemaking; work simplification of household activities; financial records and budget making for the individual and the family.

5-404. EVALUATION PROCEDURES FOR HOUSEHOLD EQUIPMENT. (3-4 cr; prereq 1-401 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.

5-407. TOPICS IN HOUSEHOLD EQUIPMENT. (1-3 cr; prereq 1-401, total of 15 cr in physics, food, textiles, and clothing)
Assigned readings, reports, and discussions.

5-409. CONSUMER SELECTION GUIDES FOR HOUSEHOLD EQUIPMENT. (3-4 cr; prereq 1-401 or equiv, 3-263...5-220 recommended)
Construction and operating components of current models of selected appliances. Suitability of appliances for kitchen and laundry plans that meet research-based recommendations on kitchen and laundry planning.

5-414. CONSTRUCTION AND USE CHARACTERISTICS OF HOUSEHOLD APPLIANCES. (3-4 cr; prereq 1-401)
Thermal, mechanical, and electrical characteristics of ranges, refrigerators, and home freezers. Use aspects of the equipment.

5-416. EQUIPMENT IN THE HOME LAUNDRY AND KITCHEN. (3-4 cr; prereq HE 1-301, 1-401)
Thermal, mechanical, and electrical characteristics of laundry equipment. Use aspects. Meal preparation in kitchens planned and set up by student groups in flexible research laboratory.

5-418. PROBLEMS IN HOUSEHOLD EQUIPMENT. (2 cr; prereq 5-404, 5-414 or 5-416, ‡)
Utility of selected electric and nonelectric appliances and housewares.

8-200. SEMINAR: RESEARCH AND INTERPRETATION. (3 cr; prereq ‡)
To develop skills in design and interpretation of research relevant to the family; critical examination of published and contrived examples; discussion of research on applied problems; practicum in generation of research designs.

8-250. SEMINAR: FAMILY RELATIONSHIPS. (1-4 cr [max 12 cr]; prereq ‡) Staff
Review and interpretation of current research in the social sciences bearing on the family.

8-251. HOME ECONOMICS PROBLEMS. (1-5 cr per qtr; prereq ‡)
Independent study and written reports.

8-252. HOME ECONOMICS PROBLEMS. (1-5 cr per qtr; prereq ‡)
Independent study and written reports.

8-402. SEMINAR: HOUSEHOLD EQUIPMENT. (2 cr; prereq 6 cr from 5-414, 5-416, 5-418)
Reference sources and research reports on recent and current work in home lighting, kitchen and laundry planning, and selected electric and nonelectric appliances. Student becomes familiar with available literature in household equipment and develops judgment in interpreting it in areas not covered in other courses.

8-411.* INDEPENDENT STUDY AND WRITTEN REPORTS. (1-5 cr per qtr; prereq ‡)

8-412.* INDEPENDENT STUDY AND WRITTEN REPORTS. (1-5 cr per qtr; prereq ‡)

Foods (HE)

5-301. EXPERIMENTAL STUDY OF FOODS. (4 cr; prereq 1-301, Chem 3-302 or BioC 1-301, Stat 3-081 or 5-021, FScI 3-110...HE 3-303 recommended)
In-depth laboratory study of problems in foods and food preparation.

5-302. SPECIAL FOOD PROBLEMS. (3 cr; prereq 5-301 sr or grad)
Class problems in foods and food preparation.

5-303. EVALUATION OF FOOD QUALITY. (4 cr; prereq 5-301, Chem 3-302, 3-100, Stat 5-021)
Subjective and objective methods used in measuring quality of food products.

5-304. PHYSICOCHEMICAL STUDY OF FOOD I. (5 cr; prereq 3-303, MicB 3-103...FScI 3-110 recommended)
Food as a complex biochemical system. Functionality of various biological and chemical constituents of foodstuffs. Physical and chemical changes induced in food systems through preparation or preservation. Survey of current food literature coupled with selected experiments.

5-305. PHYSICOCHEMICAL STUDY OF FOOD II. (5 cr; prereq 5-304)
Continuation of HE 5-304.

5-306. CURRENT LITERATURE IN FOODS. (2-4 cr per qtr [6 cr max]; prereq Chem 3-302 or equiv, 15 cr in food and nutrition)
Assigned readings, reports and discussions of topics in the experimental study of foods.

5-311. ADVANCES IN THE MANAGEMENT AND PREPARATION OF FOOD. (3 cr; prereq 1-301 or equiv)
Recent developments in food material and methods of preparation; their implications in management of time, money, and energy expenditures.

5-312. FOOD PURCHASING. (4 cr; prereq 15 cr in food and nutrition, principles of economics)
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.

5-313. MODERN FOOD PREPARATION PRINCIPLES AND PRACTICES. (4 cr; prereq 15 cr in food and nutrition, organic chemistry)
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.

8-301. DEVELOPMENTS IN EXPERIMENTAL FOODS. (3 cr; prereq 20 cr in food and nutrition, 5-301, organic chemistry, microbiology, ‡)
Scientific basis for generally accepted principles of food preparation, contemporary interpretations of changes produced in food by household practices, food acceptance testing.

8-306. SPECIAL FOOD PROBLEMS. (3 cr; prereq 5-301, BioC 1-301, ‡)
Review of recent research in experimental foods.

8-391.* SEMINAR: FOODS. (1-2 cr; prereq ‡)
Review and interpretation of literature.

8-392. HOME ECONOMICS PROBLEMS. (1-5 cr; prereq ‡)
Independent study and written reports.

8-393. HOME ECONOMICS PROBLEMS. (1-5 cr; prereq ‡)
Independent study and written reports.

Nutrition and Food Service Administration (HE)

5-352. FOOD SERVICE ORGANIZATION AND MANAGEMENT. (3 cr; prereq sr, 3 cr elementary statistics, 6 cr economics)
Management techniques applied to food services. Methods of analysis and control.

5-353. DESIGN AND LAYOUT OF FOOD SERVICES. (4 cr; prereq 1-311, 3-351, FSoS 1-401, or equiv, general physics course, ‡)
Problems related to remodeled and new food services.

5-361. HUMAN NUTRITION. (5 cr; prereq 3-361, BioC 1-301, Phsl 3-051 or ‡)
Nutrition from the standpoint of cellular metabolism and human growth and development. Contributions of micro- and macronutrients to cellular processes and metabolism of the whole organism. Major conditions of malnutrition today.

5-363. HUMAN NUTRITION RESEARCH METHODS. (3 cr; prereq 5-361, BioC 5-002 or ‡)
Theoretical consideration of techniques used in studying human metabolism and nutrient requirements. Discussion of metabolic and balance studies and surveys of nutritional status.

5-371. CLINICAL NUTRITION. (5 cr; prereq 5-361, BioC 5-002 or Biol 3-021 or ‡)
Application of principles of normal nutrition to clinical problems, with description of altered nutrient requirements in human disease. Diet therapy as an applied aspect of clinical nutrition.

5-373. METABOLIC BASIS FOR THERAPEUTIC NUTRITION. (4 cr; prereq 5-393 or ‡; offered at St. Mary's Hospital, Rochester)
Physiological and biochemical basis for dietary principles as related to adequate nutrition. Case study presentations and clinical experience.

5-381. CURRENT DEVELOPMENTS IN NUTRITION. (3 cr; prereq sr, 1-381, 1-301, BioC 1-301, Phsl 3-051 or ‡)
Fundamental facts and techniques for solving current nutrition problems.

5-391. NUTRITION TOPICS. (1 cr; prereq 5-361)
Oral presentation by students of selected nutrition topics.

5-392. READINGS IN NUTRITION. (2 cr; prereq 5-361)
Survey of literature in the field; oral and written reports.

5-393. CLINICAL PROBLEMS IN NUTRITION. (3-5 cr [3 cr at St. Paul and/or 2 cr at Rochester]; prereq 5-361, BioC 5-002 or ‡)
Application of nutrition information to problems in health and disease. Experience in a diabetic clinic.

5-394. SPECIAL PROBLEMS IN FOOD SERVICE ADMINISTRATION. (3 cr; prereq sr, 3-352 and ‡)
Readings, discussion, field work.

5-395. SEMINAR: WORLD FOOD SUPPLY PROBLEMS. (4 cr; enrollment limited; prereq ‡ for srs and grad students)
(Same as AgEc 5-790, PlPa 5-200, Soc 5-675, VM 5-314) Multidisciplinary approach will examine social, economic and technical problems of feeding the world's growing population.

5-396. SELECTED ASPECTS OF NUTRITION. (2-4 cr [12 cr max]; prereq sr, 1-301, 1-381 or ‡)
Special attention to a single, preselected aspect of nutrition. Teaching procedure and approach determined by nature of topic and clientele needs. Both in-breadth and in-depth treatment. Specific aspect to be announced in advance.

8-272. HUMAN METABOLIC STUDIES IN HEALTH AND DISEASE. (4 cr; prereq 5-371 or equiv, ‡; offered at St. Mary's Hospital, Rochester)

8-273. ADVANCED DIET THERAPY. (4 cr; prereq 5-371 or equiv, ‡; offered at St. Mary's Hospital, Rochester)

8-361/8-362. PRINCIPLES OF HUMAN NUTRITION. (3 cr per qtr; prereq 5-361)
Digestion, metabolism, excretion, and food requirements under various conditions.

8-395.* SEMINAR: NUTRITION. (1 cr; prereq ‡)
Review and interpretation of literature. Recent advances. Individual oral and written reports.

8-396.* HOME ECONOMICS PROBLEMS. (1-5 cr per qtr; prereq ‡)
Independent study and written reports.

Textiles and Clothing (TexC)

5-600. ADVANCED APPAREL DESIGN AND CONSTRUCTION PROBLEMS. (2-4 cr per qtr [12 cr max]; prereq 1-602, 1-604, 3-621 and ‡)
Analytical study and construction of advanced apparel design utilizing draping and flat pattern techniques. Relating latest technological developments in textiles to garment design.

5-601. RECENT DEVELOPMENTS IN CLOTHING CONSTRUCTION. (3 cr; prereq 3-601 or ‡)
Discussion, demonstration, and laboratory work emphasizing management of time and materials including newer construction techniques.

5-603. EXPERIMENTAL STUDIES IN CLOTHING CONSTRUCTION. (3 cr; prereq 6 cr clothing construction, tchg exper, ‡)
Comparative study of selected procedures relative to areas of construction and fabric differences. Materials evaluated for teaching on different educational levels.

5-621. ADVANCED TEXTILES. (3 cr; prereq 3-621, BioC 1-301 or Chem 3-302, AgEc 1-030 or Econ 1-002 or ‡)
Structural and physical properties of fibers; measurement and significance of physical characteristics of yarns and fabrics; economic problems involved in manufacture and use.

5-622. TEXTILE ANALYSIS. (3 cr; prereq 3-621, BioC 1-301, Chem 3-302, or ‡)
Application of quantitative methods; special reference to fiber composition and finishes.

5-623. PROBLEMS IN CONSUMER TEXTILES. (3 cr; prereq 3-621 or equiv; offered when demand warrants)
Contemporary textiles, their physical characteristics in relation to end use performance; agencies aiding consumer through development of standards; problems students have met in the textile field.

5-624. TOPICS IN TEXTILES. (3 cr; prereq 15 cr textiles and clothing, sociology or economics, ‡)
Assigned readings, reports, and discussion. Independent study available to high scholarship students.

5-641. TOPICS IN MERCHANDISING. (3 cr; prereq 15 cr in textiles and clothing, sociology or economics, ‡)
Assigned readings, reports, and discussions. Independent study available to high scholarship students.

5-661. CLOTHING AND HUMAN BEHAVIOR. (4 cr; prereq 1-661, 3-621, AgEc 1-030 or Econ 1-002, Soc 1-001, Psy 1-001, or ‡)
Individual and behavior characteristics in relation to clothing; clothing symbolism, cultural norms governing clothing use.

5-662. FAMILY CLOTHING PROBLEMS. (3 cr; prereq 3-621, AgEc 1-030 or Econ 1-002, Soc 1-001, Psy 1-001, or ‡...5-661 or ‡ recommended)
Processes of clothing consumption related to needs and value orientations of individuals, families and households; methods of study and application to specific clothing problems.

5-663. TOPICS IN CLOTHING. (3 cr; prereq 15 cr textiles and clothing, sociology, or economics, ‡)
Assigned readings, reports, and discussions. Independent study available to high scholarship students.

8-621. READINGS IN TEXTILES. (1-3 cr; prereq 5-621, 5-661 or 5-662, or ‡)
Independent study; survey of literature in selected areas. Written reports.

8-622. ANIMAL FIBERS. (2 cr; prereq advanced textiles, ‡)
Structure, composition, properties, and special problems of manufacture of wool, silk, and other protein and protein-like fibers in relation to use.

8-623. PLANT AND OTHER CELLULOSIC FIBERS. (2 cr; prereq botany, advanced textiles, ‡)
Structure, composition, properties, and special problems of manufacture of cotton, flax, rayon, and certain minor and chemically manufactured fibers in relation to use.

8-624. MICROANALYSIS OF TEXTILE FIBERS. (Cr ar; prereq botany, zoology, advanced textiles, ‡)
Histological and microchemical methods.

8-625.* PROBLEMS: TEXTILES. (1-5 cr per qtr; prereq ‡)
Independent study and written reports.

8-626.* PROBLEMS: TEXTILES. (1-5 cr per qtr; prereq ‡)
Independent study and written reports.

8-661. READINGS IN CLOTHING. (1-3 cr; prereq 5-621, 5-661 or 5-662, ‡)
Independent study; survey of literature in selected areas. Written reports.

8-662.* SEMINAR: TEXTILES AND CLOTHING. (1 cr; prereq ‡)
Reviews and interpretations of literature of this field, emphasizing recent advances. Individual oral and written reports.

8-663.* PROBLEMS: CLOTHING. (1-5 cr per qtr; prereq ‡)
Independent study and written reports.

8-664.* PROBLEMS: CLOTHING. (1-5 cr per qtr; prereq ‡)
Independent study and written reports.

Trends (HE)

5-191. DEVELOPMENT OF HOME ECONOMICS. (2 cr)
Discussion of the development of home economics with emphasis upon current problems.

HORTICULTURAL SCIENCE (Hort)

Professor

Albert J. Linck, *dean, College of Agriculture*
Andrew A. Duncan, *head*
Conrad J. Weiser, *director of graduate study*
David W. Davis
Florian I. Lauer
Robert E. Nylund
Leon C. Snyder
Eduard J. Stadelmann
Orrin C. Turnquist
Donald B. White
Richard E. Widmer

Associate Professor

Peter D. Ascher
Leonard B. Hertz
Pen H. Li
Robert Mullin
Harold M. Pellett
Paul E. Read
Cecil Stushnoff
Harold F. Wilkins

Assistant Professor

Mark L. Brenner
James J. Kuska

Prerequisites and Scope—Students majoring in the diverse field of horticultural science may specialize in several ways through orientation of the graduate program toward (a) horticultural commodities, or (b) a biological discipline related to horticulture, or (c) landscape horticulture. The student must have gained sufficient background in undergraduate training to satisfy the adviser that graduate study may be successfully undertaken.

Language Requirement and Alternatives—Students studying for the Ph.D. degree have the option of taking either one foreign language or a *collateral field of knowledge or special research technique* to support the major. Foreign students may substitute a supporting program of study in public administration in their Ph.D. program. No foreign language is required for the M.S. degree.

M.S. Degree—Plan A or Plan B may be selected, either for terminal professional training or in preparation for further graduate study leading to the Ph.D. degree. Students are expected to participate in and present a seminar.

Ph.D. Degree—There is considerable flexibility in program design for the Ph.D. degree. Programs are tailored to complement the student's background and professional interests. Students are expected to participate in and present two seminars.

Major—With the approval of the adviser, courses in related fields may be accepted as part of the major work. Students with advisers housed in horticultural

science may also major in botany, genetics, plant breeding, or plant physiology. Those interested should read descriptions of these specific program areas elsewhere in this bulletin, and should consult with horticultural science faculty who are on the graduate teaching faculty in these related fields of study.

Minor—In addition to a foreign language or the acceptable alternatives described above, the student studying for the Ph.D. degree also will select either a minor field or a supporting program of study from several related fields.

Dissertation Requirements—For either the Plan A Master's degree or the Ph.D. degree the student, in consultation with the adviser, may elect to present a traditional thesis or to develop papers in publishable form. Papers presented for the Plan B Master's degree may be either in publishable form or written in the style of term papers.

5-006f. SYSTEMATICS OF TEMPERATE AND TROPICAL HORTICULTURAL FOOD CROPS. (4 cr; offered 1973-74 and alt yrs) Davis, Stushnoff
Systematic relationships of the world's resources of fruit and vegetable taxa. Lectures, literature review, and laboratory.

5-007w. ADVANCED FRUIT SCIENCE. (4 cr; prereq 3-031; offered 1973-74 and alt yrs) Stushnoff
Review and discussion of research papers dealing with physiological, breeding, genetic and cultural aspects of small and tree fruit crops. New developments emphasized. Lectures, literature review, and discussion.

5-013. ADVANCED LANDSCAPE DESIGN. (5 cr; prereq 3-092)
Site planning related to complex problems. Analytic methods and procedures; detailed design and presentation of solutions.

5-033w. TOPICS: OPTIMIZING HORTICULTURAL FOOD PRODUCTION. (1 cr) Davis, Stushnoff
Current and futuristic concepts in fruit and vegetable production. Topics include mechanical harvesting, population density, new cultural concepts, and environmental modifications as they apply to maximizing yield and quality.

5-038. RESEARCH METHODS IN PLANT PROPAGATION. (3 cr; prereq 1-036 or ‡) Read
Basic concepts, theory, and techniques involved in propagating plants. Students design and conduct experiments with plants or propagation techniques of special interest.

5-040w. PLANT GROWTH REGULATORS. (3 cr; prereq 15 cr in plant sciences incl 3 cr in plant physiology; offered 1973-74 and alt yrs) Brenner
The physiology and agricultural technology of phytohormones and synthetic growth regulators in horticulture. Emphasis on the practical uses of such substances in control of fruit and leaf abscission, parthenocarpy, growth rate, plant size, apical dominance, organ initiation, dormancy, germination, flowering, and others.

5-041. ENVIRONMENTAL REQUIREMENTS OF HORTICULTURAL PLANTS. (4 cr; prereq 15 cr in plant science incl 3 cr in plant physiology) Nylund
Lectures, assigned reading and laboratory exercises on the relation of light, temperature, and water to growth and culture of horticultural plants.

5-042f.* TURF MANAGEMENT. (4 cr; prereq 1-001, PlPa 1-001, Soil 1-122) White
(Lecture and laboratory) Taxonomy, ecology, and culture of grasses for landscape purposes. Areas covered include basic principles, terminology, construction, maintenance, and soil-plant relationships in turf management for lawns, golf courses, athletic fields, and production operations.

5-044. MARKET GRADES AND VARIETAL ADAPTATION OF FRUITS AND VEGETABLES. (4 cr; prereq 3-031, 3-032) Turnquist
Characteristics of leading varieties of fruits and vegetables, market grades, variety testing, impact of environmental factors on varietal types and market grades.

5-045. TOPICS IN NURSERY MANAGEMENT. (1 cr; prereq 1-036, PlPh 3-091; offered 1973-74 and alt yrs) Pellett
Relationship of plant growth requirements to production, storage, and distribution of nursery crops. Discussions and field trips.

5-052f. COMMERCIAL FLORICULTURE, FALL CROPS. (3 cr; prereq 1-016; offered 1973-74 and alt yrs) Widmer
Physiological and cultural aspects of production of principal florist crops of economic importance. Chrysanthemums, carnations, cut flowers, and potted plants especially adapted to Christmas sales. Lectures, reference reading, and field trips to greenhouses, wholesalers, and retail flower stores.

5-053w. COMMERCIAL FLORICULTURE, WINTER CROPS. (3 cr; prereq Biol 1-002, PlPh 3-091 or ‡; offered 1973-74 and alt yrs) Wilkins
Physiological and cultural aspects of bulbous plants (tulips, narcissi, bulbous iris, hyacinths, crocus, 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 reading, laboratory experience, and field trips.

5-054s. COMMERCIAL FLORICULTURE, SPRING CROPS. (3 cr; prereq 1-016 offered 1973-74 and alt yrs) Widmer
Physiological and cultural aspects of production of principal florist crops of economic importance. Roses, bulbous plants, and materials adapted to spring sales. Lectures, reference reading, and field trips to greenhouses, wholesalers, and retail stores.

5-090f/5-091w/5-092s.* SPECIAL PROBLEMS. (1-4 cr per qtr; prereq ‡) Staff
Written report based on library, laboratory, or field research.

8-021w.* BREEDING SEXUALLY PROPAGATED HORTICULTURAL CROPS. (3 cr; prereq Agro 5-020; offered 1972-73 and alt yrs) Davis
Breeding methods and procedures, including modifications used in the seed and processing industries; theory; sex, incompatibility, and sterility mechanisms; approaches and systems unique to breeding horticultural crops.

8-022s. BREEDING ASEXUALLY PROPAGATED CROPS. (3 cr; prereq Agro 5-020; offered 1972-73 and alt yrs) Laver, Stushnoff
Methods applied to improving asexually propagated plants. Apomixis, polyploidy, chimeras, and mutations.

8-023f. EVOLUTION OF CROP PLANTS. (3 cr; offered 1972-73 and alt yrs) Ascher
Origin, distribution, and evolution of cultivated plants; implication of evolutionary processes on crop breeding for needs of modern world.

8-041w. ORGANIZATION OF HORTICULTURAL RESEARCH. (2 cr) Duncan and staff
Organization and administration in agricultural experiment stations; project development and research outlines.

8-042.* HORTICULTURAL SEMINAR. (1 cr per qtr; prereq 9 cr in horticulture) Duncan and staff
Reports and discussions of problems and investigational work.

8-045w.* PLANT HARDINESS. (3 cr; prereq 15 cr in plant sciences incl 6 cr in plant physiology plus 6 cr in biochemistry; offered 1972-73 and alt yrs) Weiser
Physiological and physical bases of plant injury and survival as related to low temperature, high temperature, and drought. Emphasis on physiology of fall hardening and low temperature survival.

8-051.* ADVANCED PROBLEMS IN HORTICULTURAL CROP BREEDING. (3-9 cr; prereq ‡) Staff
Written report based on library, laboratory, or field research.

8-052.* ADVANCED PROBLEMS IN PHYSIOLOGY OF HORTICULTURAL CROPS. (3-9 cr; prereq ‡) Staff
Written report based on library, laboratory, or field research.

See also:

PlPh 5-167—Physiology of the Plant Cell
PlPh 5-168—Experimental Protoplasmatology
PlPh 5-183—Plant Physiology
PlPh 5-703—Internal Water Balance
PlPh 5-721, 5-723, 5-725, 5-726—Methods of Plant Analysis
PlPh 8-281—Growth and Differentiation
LA 5-010—Principles of Outdoor Recreation Design and Planning
LA 5-105—Recreation Planning and Design I
LA 5-107—Regional Landscape Design I
LA 5-110—Advanced Landscape Planning and Design

HOSPITAL AND HEALTH CARE ADMINISTRATION** (PubH)

Professor
Bright M. Dornblaser, M.H.A., *director*
Theodor J. Litman, Ph.D., *coordinator of doctoral study*
James W. Stephan, M.B.A.
Vernon E. Weckwerth, Ph.D.

Assistant Professor
Jerome T. Bieter, M.H.A.
Janet G. Brodahl, M.H.A.
Mario Bognanno, Ph.D.
John M. Phin, M.D., M.H.A.
John Sweetland, Jr., M.H.A.

Prerequisites—Applicants are expected to have demonstrated both marked academic ability as well as potential for independent study and research in the course of their previous academic training. While attainment of a Master's degree in either hospital or health care administration is normally considered to be the first step in the acquisition of the doctoral degree, students with advanced degrees in such allied fields as business administration, industrial relations, medical sociology, public administration, comprehensive planning, public health, medical care, nursing, or medicine are encouraged to seek enrollment as well. Applicants lacking basic public health courses may be required to take such courses concurrently with their doctoral program. Graduate work satisfactorily completed prior to admission may be applied to credit where appropriate and in accordance with the regulations of the Graduate School. An acceptable score on the Miller Analogies Test, graduate level, is required for admission.

Language Requirement—A reading knowledge of one foreign language, or nine credits of computer science, plus a collateral field of knowledge.

Thesis—The dissertation shall deal with a significant problem in the area of health care.

Doctor's Degree—In contrast with the professional Master's degree program offered in the School of Public Health, the doctoral program is designed for those interested in a career in teaching, research and/or planning in the field of health care. Emphasis in the curriculum is thus more upon depth and breadth of learning than in the acquisition of technical and management skills. While the academic program normally takes 3 years to complete, it may take somewhat longer depending upon the individual and the kind of program pursued. Each student's course of study will be developed with the guidance of the adviser to build upon the individual's own background and interests. Candidates will be expected to demonstrate proficiency in four major core areas:

1. Organization and Administration of Health Care Services
2. Social, Political, and Economic Aspects of Health Care
3. Research and Methodology in Health and Health Care
4. Comprehensive Health Planning.

In addition to the work in the major field, the student will be required to pursue a supporting field of study or minor in such related social sciences as business administration, economics, sociology, industrial relations, public administration, or political science. In accordance with the rules and regulations of the Graduate School and with the approval of the adviser, the student may elect to meet this requirement through one of the following options:

** Inquiries concerning courses of study leading to the Ph.D. degree in hospital and health care administration should be addressed to: Coordinator of Doctoral Study Program in Hospital and Health Care Administration, School of Public Health, Box 97, 1260 Mayo Memorial Building, University of Minnesota, Minneapolis, Minnesota 55455; inquiries concerning the Master's degree program (MHA) should be sent to the Director, Program in Hospital and Health Care Administration, same address.

1. One-sixth of the graduate studies in a coherent program of courses selected from the related social sciences
2. All of the minor field requirements in one of the related social sciences or in two social science fields as a split minor
3. A second major in one of the related social sciences

In addition, all candidates must complete a minimum of 9 credits in statistics and/or quantitative analysis in courses numbered 5-000 or higher, which may be used to satisfy the collateral field requirement (see above).

Minor—A minor in this field is also available subject to approval of the minor adviser.

For a more complete statement of admission requirements and related information, see the special *Program in Hospital and Health Care Administration Bulletin* of the School of Public Health.

Note—Courses listed with no description are described under the Public Health section.

5-404. INTRODUCTION TO BIOSTATISTICS AND STATISTICAL DECISION. (3 cr; prereq ‡) Weckwerth

5-750. PRINCIPLES OF ADMINISTRATION IN HOSPITAL AND HEALTH CARE INSTITUTIONS. (6 cr; prereq ‡) Dornblaser, Sweetland and staff

5-751. PRINCIPLES OF ORGANIZATION AND MANAGEMENT. (3 cr; prereq ‡) Dornblaser and staff

5-753. MANAGEMENT PROBLEMS IN HOSPITAL AND HEALTH CARE ADMINISTRATION. (6 cr; prereq 5-750, 5-751, 5-752) Dornblaser, Sweetland, Stephan

5-761. EDUCATION FOR THE HEALTH PROFESSIONS. (3 cr; prereq ‡) Phin and staff

5-763. HEALTH ORGANIZATIONS, STANDARDS, AND EVALUATION. (3 cr; prereq ‡) Phin and staff
Characteristics of health organizations and current standards in the health care field; implications to hospital and health care management; relationship of standards to health care evaluation.

5-785. QUANTITATIVE METHODS APPLIED TO HEALTH ADMINISTRATIVE PROBLEMS. (3 cr; prereq hospital administration student or ‡) Weckwerth and staff
Application of quantitative methods including analysis of cyclicities, PERT, data handling systems, simple ANOVA, linear programming, cost benefit analysis, task analysis, and inventory control in solution of health problems at administrative levels.

5-790. SOCIAL, POLITICAL, AND ECONOMIC ASPECTS OF HEALTH CARE. (3 cr; prereq ‡) Phin and staff

5-855. SOCIOLOGY OF MEDICINE AND MEDICAL INSTITUTIONS. (3 cr, §Soc 5-855; prereq ‡) Litman
Social and psychological components of physical and mental illness and their treatment. Social organization of medical institutions and their relationship to public needs for health care. Role of the major providers of health care.

8-703. RESEARCH PRACTICUM. (6 cr; prereq ‡) Litman, Weckwerth, and staff
Summer field experience in health care research. Supervised independent and team research on selected topics and problems in the field of health care.

8-750/8-751.† SEMINAR: ALTERNATIVE PATTERNS OF HEALTH CARE. (3 cr per qtr; prereq ‡; offered 1972-73 and alt yrs)
Alternative approaches to meeting the health care problems of: ambulatory care, aging, rehabilitation, maternal and child care, mental health, and poor people.

8-752. SEMINAR: COMPARATIVE HEALTH SYSTEMS. (3 cr; prereq ‡; offered f 1973 and alt yrs) Litman
Origin and development of various national systems of health care and their relationship to social, political, economic, and cultural characteristics of countries involved.

8-760. TOPICS IN HOSPITAL AND HEALTH CARE ADMINISTRATION. (Cr ar; prereq ‡) Dornblaser, Weckwerth
Independent study under tutorial guidance on selected problems, current issues.

8-761. READINGS IN THEORY AND PRINCIPLES OF HOSPITAL AND HEALTH CARE ADMINISTRATION. (Cr ar; prereq ‡) Dornblaser, Weckwerth

8-762. CONTEMPORARY PROBLEMS OF HOSPITAL AND RELATED HEALTH SERVICES. (Cr ar; prereq ‡) Weckwerth
Current concepts, problems, principles, and future developments in the field of health and health care.

8-770. HEALTH AND HUMAN BEHAVIOR. (3 cr; prereq Soc 5-855; offered spring 1973-74 and alt yrs) Litman
An examination of the sociology of health and health care; social and personal components of health and illness behavior; community health; and the relationship of social and cultural factors in the organization and delivery of health care services.

8-780. ADVANCED STATISTICAL METHODS IN HEALTH CARE RESEARCH. (3 cr; prereq 5-450 or ‡) Weckwerth
Survey and analysis of the application of nonparametric statistics to health care research.

8-781. SEMINAR: RESEARCH STUDIES IN HEALTH CARE. (3 cr; prereq ‡; offered fall 1972-73 and alt yrs) Litman
Review and appraisal of design, measuring instruments, research methodology, and findings of contemporary studies in the field of health care.

8-790. POLITICAL ASPECTS OF HEALTH SERVICES. (3 cr; prereq ‡; offered winter 1972-73 and alt yrs) Litman
Analysis of the interrelationship between government, politics, and health care; the political and social basis of health legislation and community decision making in provision and modifications of health services.

8-795. ECONOMIC ASPECTS OF HEALTH CARE. (3 cr; prereq ‡) Bognanno
An economic analysis of America's health care sector, emphasizing its problems of pricing, production, and distribution. Evaluating health care services as one-factor input contributing to the nation's health.

8-796. TOPICS IN HEALTH ECONOMICS. (3 cr; prereq minimum of one economics course and ‡) T Dahl
General principles of health economics are applied to current issues in health such as insurance, licensure, family practice, malpractice, and hospital costs. Models of hospital functioning, area planning, and disease intervention are presented within the framework of economic analysis and used to explain and predict health behavior. The concepts of cost benefit and cost effectiveness analysis are discussed and applied to problems in health care delivery.

IMMUNOLOGY

For information on staff, program, and courses, see the microbiology and immunology section of the bulletin, *Graduate Programs in the Health Sciences.*

INDUSTRIAL RELATIONS (IR)

Professor

Herbert G. Heneman, Jr., *chairman*
Hyman Berman
John P. Campbell
Rene V. Dawis
Marvin D. Dunnette
George W. England
John J. Flagler
Richard H. Hall
Thomas P. Lewis
Lloyd H. Lofquist
Thomas A. Mahoney
George Seltzer
Norman J. Simler
John G. Turnbull
Mahmood A. Zaidi

Associate Professor

George T. Milkovich, *director of graduate study*
Mario F. Bognanno
Peter Gregory
Cyrus F. Smythe, Jr.
Emil Starr
William Weitzel

Assistant Professor

Patrick R. Pinto

Prerequisites—Courses in industrial relations are open to all regularly enrolled graduate students who can meet course prerequisites as listed in the *Class Schedule.* Before being accepted as candidates for a graduate degree with a major or minor in industrial relations, students shall satisfy their adviser that they are fully prepared to undertake graduate work in the proposed fields of specialization. Students will be expected to have or obtain such course work as may be necessary to meet the prerequisites of courses selected for their graduate programs.

Master's Degree

(Offered under both Plan A and Plan B)

Plan A—Thesis Program—

A minimum of 29 course credits and an accepted thesis are required. At least 21 of the course credits must be obtained in industrial relations as indicated below. Additional course work may be required by the adviser to insure adequate preparation in the major field of study.

The major course work consists of a *minimum* of 21 course credits which meet the following distribution.

1. IR 8-002
2. IR 8-011
3. One course from at least two areas in industrial relations plus one additional industrial relations course.

Total 21 credits

A minimum of 8 credits is required in an approved minor field of study related to industrial relations. However, more than 8 credits may be required depending upon previous preparation and coverage. Commonly selected fields are business administration, psychology, sociology, or economics.

A thesis dealing with a specialized topic in the major field must be approved for the degree.

There is no language requirement.

The final examination *may* be both written and oral. Candidates will be admitted to the examination only after completion of the following requirements:

1. Written Examination (normally not required)

   Candidates may be admitted to the written examination after all course requirements have been completed. The thesis need only be in first draft form and be sufficiently satisfactory in concept and preliminary framework to meet the adviser's requirements. The student should have the adviser certify this fact in writing to the department examining committee. There must be no incompletes in any required course work at the time of examination. Candidates who fail the written examination may be permitted to retake it on written recommendation of the adviser.

2. Oral Examination

   Candidates may be admitted to the oral examination only after successful completion of the written examination, if one is required, or recommendation of the adviser, and after the required form indicating unanimous approval of the Master's thesis by the thesis committee has been filed in the Graduate School office.

Plan B—Nonthesis Program—

A minimum of 45 course credits and completion of two Plan B papers are required. The major course work consists of the following minimum requirements:

1. IR 8-002
2. IR 8-011

3. IR 8-010
4. One course from at least three areas in industrial relations plus one additional industrial relations course.

Total 29 credits

The minor course work consists of a minimum of 16 credits earned in at least two related fields. A minimum of at least 8 credits must be earned in one related field. Commonly selected fields are business administration, psychology, sociology, or economics.

Papers of the quality but not the scope of the Master's thesis shall be prepared in two advanced courses involving independent work under faculty supervision.

There is no language requirement.

The final examination may be both written and oral. Candidates will be admitted to the examination only after completion of the following requirements:

1. Written Examination (normally not required)
   Candidates must have completed all course requirements and all Plan B papers. Candidates should have those faculty members to whom papers were submitted certify approval of the respective papers to the examining committee. There must be no incompletes in any course at the time of examination. Candidates who fail the written examination may be permitted to retake it on written recommendation of the adviser.
2. Oral Examination
   Candidates may be admitted to the oral examination only after successful completion of all course work and Plan B papers and the written examination, if one is required, or recommendation of the adviser.

Doctor of Philosophy

Admission—Candidates seeking to major in industrial relations at the Ph.D. level must have a Bachelor's or a Master's degree from a recognized college or university, show professional promise, take the Miller Analogies Examination, and offer a minimum of 30 credits of related course work in the social and behavioral sciences with the following minimums:

Economics (8 credits)

Equivalent of IR 3-002 (4 credits)

8 credits in one of the following: anthropology, history, political science, psychology, or sociology (8 credits)

8 additional credits in social or behavioral sciences and/or statistics (8 credits)

Total 28 credits

Requirements for the Ph.D. Degree—

1. Although course work and study done in industrial relations will serve as the core of a Ph.D. program, each student will be expected to have a thorough mastery of more than one of the six designated related social or behavioral science disciplines (anthropology, economics, history, political science, psychology, sociology). If a student and the adviser feel that a student does not need a normal minor, then the Ph.D. program would be composed of the following:

   Major Field: Industrial relations

   Supporting Program: At least 15 credits of course work in each of *two* of the six designated social or behavioral science fields

   Research Technique: Completion of at least 8 credits in designated course sequences

   Foreign Language: Optional (see section d below)

a. Specific requirements in the major

All students must pass written examinations in the following:

(1). Scope and Systems of Industrial Relations

(2) Research Methodology

(3) Choice of two of the following five subfields:

Compensation Theory and Administration
Manpower Resources and Allocation
Staffing, Training, and Development
Collective Bargaining
Organization Theory and Administration

A list of courses and readings providing preparatory study for the examinations can be obtained from the Department of Industrial Relations. Generally, one-third of the courses taken to prepare for examinations in the major field would be courses offered by other departments.

b. Supporting Program

A supporting program of study must include at least 15 credits of course work in courses numbered 5-000 or above in each of *two* of the designated fields in the social and behavioral sciences (anthropology, economics, history, political science, psychology, and sociology). Course work used to satisfy a part of the major requirement or research technique cannot be used in the supporting program. The supporting program, like the normal minor, must be completed before the student is admitted to the preliminary examination.

c. Special Research Technique

Competence in a research technique is required of all candidates and is demonstrated by completion of a sequence of statistical analysis outside industrial relations, and must be completed before the student is admitted to the preliminary examination. A list of courses for this purpose, and for the research methodology requirement, may be obtained from the department.

d. Language Requirement

For the Ph.D. degree, no language is required. The special research technique is required in place of one of the languages formerly required of Ph.D. candidates. In place of a second language, a student selects one of the following options:

(1) Three additional credits in a research technique for a total of 12 credits; or

(2) Demonstrated proficiency in a computer language such as FORTRAN, COBOL, ALGOL, PL/I, or other specialized computer language relevant to the proposed research area; or

(3) One foreign language as previously required.

All language requirements or substitutes for them must be completed before a student can be admitted to the preliminary examination.

2. If students wish to use a normal or traditional minor, they must increase work in one of the designated social or behavioral science fields from 15 credits to a full minor. Another social science field, taken from the six designated, must also be completed with a minimum of 15 credits of course work.

General Requirements—Course work used to satisfy requirements in either the major, supporting program, minor, or special research technique may not be used again to satisfy requirements in any other areas of the student's Ph.D. program. Minimum acceptable grades in each of the areas of the Ph.D. program will be the same as those given in the General Information section of this bulletin; the industrial relations graduate faculty may require higher performance standards than those listed there.

Ph.D. Minor—Industrial relations may be selected as a minor or as part of a supporting program for the Ph.D. where it is associated with a major in one of the following fields: agricultural economics, business administration, economics, history, hospital administration, journalism, political science, psychology, and sociology with the exception that a student writing a dissertation in (a) business administration, subfield industrial relations, or (b) economics, subfield labor economics, may not use industrial relations as the minor for the Ph.D.

The minor program is intended to be flexible and is designed to take into account the student's educational objectives, needs, and background. Courses in the minor program will be selected by the minor adviser in consultation with the student. Additional information can be obtained from the advisers listed above or the Department of Industrial Relations.

Note—Plan B papers may be written in all courses.

8-000. GRADUATE TOPICS IN INDUSTRIAL RELATIONS. (Cr ar; prereq IR 8-002 and ‡) Staff
Selected topics.

8-002. INDUSTRIAL RELATIONS SYSTEMS: LABOR MARKETS AND THE MANAGEMENT OF HUMAN RESOURCES. (5 cr; prereq Econ 1-001, Econ 1-002, Psy 1-001) Bognanno, England, Heneman, Pinto, Seltzer, Weitzel, Zaidi
Labor markets, manpower management, federal-state employment policy, and the resolution of industrial conflict. Process of valuing, employing, developing, motivating, and maintaining human resources in an industrial society.

8-003. ORGANIZATION AND STAFFING. (4 cr; prereq 8-002 or ‡) England, Pinto, Weitzel
Integration of organization goals and objectives with individual needs and objectives through the staffing processes of manpower planning, recruitment, selection/reduction, allocation and evaluation of manpower resources.

8-004. ORGANIZATION THEORY AND ANALYSIS. (4 cr; prereq 8-002 or ‡) Mahoney, Pinto, Weitzel
Survey of organization theories and application of these theories to administrative issue of organizational structuring, coordination, control, job design, organizational decision-making, leadership and organizational development.

8-005. EMPLOYEE COMPENSATION AND REWARD. (4 cr; prereq 8-002 or ‡) Mahoney, Milkovich
Systems of employee compensation reward within economic organizations. Concepts, models, and theories relating to processes of compensation designed to influence manpower behavior and performance within constraints. Processes examined include wage structuring, pricing, individual appraisal and reward, employee motivation, and compensation controls.

8-006. LABOR MARKETS: PROCESSES AND DYNAMICS. (4 cr; prereq 8-002 or ‡) Seltzer, Zaidi
An intensive consideration of basic concepts, applications and data sources pertinent to examining the usefulness of market analysis for manpower development, allocation, and utilization. Topics include labor force dynamics and measurement, mobility, productivity, technological change, changes in the cost-of-living, wage structures and public policy programs.

8-007. COLLECTIVE BARGAINING NEGOTIATIONS: PROCESSES IN THE PUBLIC AND PRIVATE SECTORS. (4 cr; prereq 8-002 or ‡) Bognanno, Flagler, Heneman, Smythe
Elements in collective bargaining negotiations and detailed examination of the legal framework imposed on negotiations both public and private. Conflict and behavioral models containing institutional constraints guide examination of strategies and tactics of employee-employer bargaining relationships.

8-010. INTERMEDIATE MANPOWER MANAGEMENT. (4 cr; prereq substantial completion of industrial relations graduate program or ‡) Heneman
Industrial relations frames of reference and literature (reports on new literature)—emphasis on *applied* and operational aspects of industrial relations.

8-011. QUANTITATIVE METHODS IN INDUSTRIAL RELATIONS. (4 cr; prereq 8-002, 4 cr in statistics) Milkovich, Mahoney
Use of alternative quantitative methods and techniques in the formulation and analysis of various industrial relations problems and practices. Specifically, investigating and practicing the use of quantitative analysis in areas such as manpower planning, manpower forecasting, recruiting, staffing, compensation and collective bargaining. Cases and problem sets are used.

8-015. COMPENSATION, REWARD, MOTIVATION, AND PERFORMANCE. (4 cr; prereq 8-005 or ‡) Mahoney, Milkovich
Theories of motivation, reward, performance and behavior and application of these theories to major issues and policies regarding manpower allocation, development and utilization. Specific topics include the role of indirect compensation, income maintenance and wage subsidies, occupational choice and career compensation, negotiated compensation and productivity bargaining, job enlargement and job performance.

8-016. INTERNATIONAL MANPOWER DEVELOPMENT AND UTILIZATION. (4 cr; prereq 8-002 or ‡) England, Seltzer, Zaidi
Examines relationship of human resources, education, and socio-economic development in settings external to the United States.

8-017. UNION GOVERNMENT AND POLICIES. (4 cr; prereq 8-002 or ‡) Starr
Internal administration and government of unions; collective bargaining policies of unions with regard to wages, hours, and other conditions of employment; policies of the American labor movement in the economic, political, and social life of the nation.

8-023. TRAINING AND DEVELOPMENT. (4 cr; prereq 8-002 or ‡) Dawis, Pinto, Weitzel
Integration of appropriate learning principles and organizational objectives into training program. Design, implementation, and evaluation of training systems to effect the development, utilization, and conservation of manpower resources.

8-026. LABOR MARKETS: THEORETICAL AND EMPIRICAL CONSIDERATIONS. (4 cr; prereq 8-002 or ‡) Seltzer, Zaidi
Advanced examination of theoretical and related empirical studies on the functioning of labor markets and manpower processes. Pricing and allocation of labor resources, with emphasis given to the problems of aggregate employment, wage, and price determination.

8-027. COLLECTIVE BARGAINING NEGOTIATIONS: INDUSTRIAL CONFLICT. (4 cr; prereq 8-002 or ‡) Bognanno, Starr, Smythe
Nature of conflict in employment relationships in general, and in collective bargaining negotiations in particular. Industrial conflict analyzed from theory of games perspective with specific adaptations leading to the development of theories of bargaining. Discussion of practical approaches resulting in the prevention, reduction, and resolution of industrial conflict.

8-033. MANAGEMENT DEVELOPMENT. (4 cr; prereq 8-002 or ‡) Mahoney, Weitzel
Today's management development movement including management development programs within industry and in universities. Basic policy, current problems, and research findings concerning selection of management trainees, management appraisal and inventory, management motivation and compensation; and methods and techniques of development.

8-801. SEMINAR: INDUSTRIAL RELATIONS RESEARCH METHODOLOGY. (4 cr; prereq 8-011 or ‡) Dawis, England, Mahoney
Advanced analysis of research methodology appropriate to study of industrial relations; application of methodology in research projects.

8-802. SEMINAR: INDUSTRIAL RELATIONS SYSTEMS. (4 cr; prereq at least 45 cr in industrial relations and related disciplines or ‡) Heneman, Milkovich
Advanced analysis of industrial relations thought and research. Specifically investigating, integrating, and synthesizing the more traditional related disciplines, theories, and research into an interdisciplinary body of knowledge concerned with manpower resource problems and employment relationships.

8-803. SEMINAR: STAFFING, TRAINING AND DEVELOPMENT. (4 cr; prereq 8-003, 8-023 or ‡) England, Pinto, Weitzel
Advanced analysis and study of staffing and training concepts, problems and research.

8-804. SEMINAR: ORGANIZATION THEORY. (4 cr; prereq 8-004 or ‡) Mahoney, Pinto, Weitzel
Advanced analysis and study of organization theories and their application in industrial relations research and practice.

8-805. COMPENSATION AND REWARD SEMINAR. (4 cr; prereq 8-005 or ‡) Mahoney, Milkovich
Advanced study of issues of employee compensation and reward; analysis of relevant theoretical models; formulation of research into compensation and reward issues.

8-806. SEMINAR: ADVANCED TOPICS ON LABOR MARKET THEORY AND RESEARCH. (4 cr; prereq 8-026 or ‡) Seltzer, Zaidi
Advanced analysis of functions and operations of labor markets, labor market theory and research.

8-807. SEMINAR: ADVANCED TOPICS IN COLLECTIVE BARGAINING. (4 cr; prereq 8-007 and 8-027 or ‡) Bognanno, Heneman, Smythe
Advanced analysis of collective bargaining process, its substance, procedures, determinants, and socio/political/economic incidences.

8-990. INDEPENDENT STUDY IN INDUSTRIAL RELATIONS. (Cr ar; prereq ‡) Staff
Individual readings and/or research projects useful to student's objectives and program.

INFORMATION AND AGRICULTURAL JOURNALISM (AgJo)

Courses Carrying Graduate Credit When Program Related

5-301. FUNCTIONAL PHOTOGRAPHY FOR THE PLANT SCIENCES. (2 cr; prereq ‡) McKay
Use of photography in plant sciences. Includes still photography, both color and black and white, to produce photographs and slides of quality acceptable for teaching and for use in publications, press, television, exhibits, and group presentations.

5-534. RURAL COMMUNICATION MEDIA AND MEDIA BEHAVIOR. (3 cr; prereq 3-530, Psy 1-002, Soc 1-651, or ‡) Swanson
Mass media behavior in rural communities, theoretical approaches relevant to problems of rural mass media behavior; analysis of research aimed at adult education efforts through mass media.

5-535. COMMUNICATIONS IN INTERNATIONAL AGRICULTURAL DEVELOPMENT. (3 cr; prereq 3-530, or Jour 1-001 and Jour 1-101, or ‡)
For United States and foreign students. Analyzes United States and foreign rural communications as developing tools. Develops ability to plan and execute communication programs in developing nations.

5-936.* SPECIAL PROBLEMS IN AGRICULTURAL COMMUNICATION. (Cr ar; prereq ‡) Swanson
Individual projects dealing with agricultural communication.

JOURNALISM AND MASS COMMUNICATION (Jour)

Professor

Robert L. Jones, *director*
Donald M. Gillmor, *director of graduate study*
Roy E. Carter
Edwin Emery
J. Edward Gerald
George S. Hage
Robert Lindsay
Burton Paulu
R. Smith Schuneman
John C. Sim
Willard L. Thompson
Phillip J. Tichenor
Harold W. Wilson

Associate Professor

Walter H. Brovald
Irving E. Fang
Virginia A. Harris
Jack N. Peterman

Assistant Professor

Daniel B. Wackman

The School of Journalism and Mass Communication offers programs within the Graduate School leading to the master of arts or doctor of philosophy degree.

Students with a Bachelor's degree or its approved equivalent from an accredited college or university may apply to the dean of the Graduate School for

admission. Applicants with a satisfactory background for their chosen major field and an excellent scholastic record from an approved college or university may be admitted to graduate work on recommendation of the faculty of the School of Journalism and Mass Communication and with the approval of the dean of the Graduate School.

Detailed information on the school's graduate programs and procedures are sent out in response to letters of inquiry.

Prerequisites—Graduate students in mass communication without an undergraduate major in journalism must take *four* undergraduate courses (15-18 credits), the courses to be chosen in consultation with their adviser. One of the four courses would cover fundamental work in international mass communication, or communication agencies as social institutions, or history of mass communication, or communication theory and research methodology, and would carry graduate credit. Prior academic credits in journalism and/or documented professional experience of at least one year's duration would count toward the fulfillment of prerequisite requirements upon successful petition to the Graduate Affairs Committee. Students would also have the option of meeting prerequisites by special examination.

The major implication of this policy is that different patterns of prerequisites will be required for different programs, and that the responsibility of determining prerequisites will rest with the adviser and the graduate student. A record of how the prerequisite requirements will be or have been met must be appended to every M.A. or Ph.D. program submitted to the director of graduate studies or the Graduate Affairs Committee for approval.

It is recognized that 15-18 credits of prerequisites may not be sufficient to qualify all students for advanced degrees. In such cases it is the obligation of the adviser to discuss with the student the desirability of additional course work in preparation for a professional career or further graduate training. The student must then make a decision based on this advice. The adviser may not *require* a student to take specific course work beyond the 15-18 credit level.

A statement signed by the student's adviser indicating how the graduate program prerequisites have been met must be attached to the student's graduate program proposal.

Degree of Master of Arts—The Graduate School offers the Master's degree under two plans: Plan A, involving a thesis, and Plan B, which substitutes additional course work for the thesis. Either plan may be chosen by students seeking the degree in mass communication. For Plan A, 8-001 and a total of at least 18 graduate credits in journalism and mass communication are required, including two seminars numbered above 8-000. For Plan B, 8-001 and at least two seminars numbered above 8-000 for a total of 21-27 graduate credits in mass communication are required.

Programs with a professional emphasis leading to a terminal M.A. degree in science communication, broadcast journalism, photographic communication, advertising, and urban journalism are also available. These programs do not require 8-001.

Language Requirement—For Plan A, reading knowledge of a foreign language is required of all candidates, except those who present additional work in statistics to support a concentration in theory and research methodology. For Plan B, a foreign language is not required but is recommended for students in international mass communication.

Degree of Doctor of Philosophy—Students planning a Ph.D. program in the School of Journalism and Mass Communication will, in consultation with their adviser, elect two of four subfields—a dissertation field and a secondary field. In the dissertation field students will take a minimum of 24 credits, and in the second field a minimum of 15. A majority of credits in both fields must be

offered in 8-000-level courses. The subfields are (a) communication theory and research methodology; (b) history of mass communication; (c) communication agencies as social institutions; and (d) international mass communication. In addition, the Ph.D. program must include a 12-16 credit core subfield, mass communication research. A minimum of 27 credits in departments outside of the School of Journalism and Mass Communication are required, including at least 18 credits in minor or supporting field courses related to the dissertation field. Prospective students should write to the school's director of graduate study for detailed subfield descriptions. In the preliminary examinations, Ph.D. students will be held responsible for subject matter in their two subfields and the core.

Minor—Candidates for the Ph.D. in other fields may elect a minor by obtaining the approval of their adviser and the director of graduate study of the School of Journalism and Mass Communication. Written preliminary examinations are required of all minors.

Language Requirement—Either (a) two foreign languages, or (b) higher proficiency in one language, or (c) one foreign language and the option of a special research technique or a collateral field of knowledge. Acceptable languages are Arabic, Chinese, French, German, Italian, Russian, Spanish, or Portuguese.

5-131f,w,s. INTERPRETIVE REPORTING. (4 cr; prereq sr, 3-121) Gerald, McGrath
Interpretive and investigative reporting. Interpretive features and series. Advanced problems in material gathering and specialized reporting of government, politics, welfare, and the arts.

5-133w. SPECIALIZED REPORTING: NATURAL AND SOCIAL SCIENCES. (4 cr; prereq 3-121 or 3-176 or ‡) Tichenor
Role of journalistic communication in science; scientist-journalist relationships; communicating results of scientific investigations to public, specialized audiences and industry.

5-141w. OPINION WRITING IN AMERICA. (4 cr; prereq sr, journalism major) Emery, Gerald
Oral and written analysis of major political, economic, and social developments. Study of persuasive communication in newspapers and magazines; columnists; commentators.

5-142. INTERPRETATION OF CONTEMPORARY AFFAIRS. (4 cr; prereq sr, journalism major) Gerald
Analysis of major economic developments and their social and political impacts; interpretation in editorial and interpretative articles.

5-143s. INTERPRETATION OF SCIENCE AND TECHNOLOGY. (4 cr; prereq 5-133, 5-501, Phil 5-601) Tichenor
Analysis of scientific research and technological development for mass and specialized media; critical study of science content in media; audience impact of science content in various media.

5-144s. URBAN JOURNALISM I: THEORY AND PRACTICE. (4 cr; prereq 3-121, 5-131, or grad, professional experience, or ‡) McGrath
Urban problems and mass media role and performance; specialized reporting and commentary; urban media policy and news gathering techniques; critical analysis of media content; reporting projects and appropriate readings.

5-171s.* CRITICAL WRITING. (4 cr; prereq jr or sr writing course, ‡) Hage
Book, theater, and motion picture reviews. Analysis of leading critics and critical periodicals. Weekly writing assignments.

5-221f,w. GRAPHIC ARTS: PROCESSES. (4 cr; prereq 3-121 or 3-231 or 8 cr in upper division art and design) Wilson
Evaluation of processes in graphic communication. Technique and production of illustration. Significant graphic arts development.

5-233s. GRAPHIC DESIGN ANALYSIS. (4 cr; prereq 3-231, 5-221, or ‡) Wilson
Technological development in graphics and its effect on format and efficiency; historical and current trends; field studies, creative problems.

5-251f,w.* PSYCHOLOGY OF ADVERTISING. (4 cr; prereq Psy 1-001) Peterman
(Same as Psy 5-751) Examination of psychological principles, research techniques, and applications in advertising and selling. Analysis of relevant consumer attitudes and behavior. Psychological mechanisms upon which effectiveness of advertisements and commercials depend.

5-252s. PSYCHOLOGY OF CREATIVITY IN ADVERTISING. (4 cr; prereq 5-251 or Psy 5-751) Peterman
Examination of the theories, mechanisms, and correlates of creativity. Theoretical, experimental, and pragmatically derived "explanations" and examples considered and applied in supervised practicum sessions.

5-261f,w. ADVERTISING: MEDIA ANALYSIS. (4 cr; prereq 1-201, Mktg 3-000, or ‡) Brovald
Characteristics of the 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.

5-263w,s. ADVERTISING CAMPAIGN PLANNING AND MEDIA STRATEGY. (4 cr; prereq 3-241, 5-261, or ‡) Peterman
Relation of campaign strategy to media measurement, evaluation, and planning. Coordination of total campaign including media scheduling and purchasing.

5-272w. ADVERTISING COPY-GRAPHICS. (4 cr; prereq sr, 3-241, 5-251) Wilson, Harris
Copy and graphics design for print and television advertising. Preparation and presentation of ads and commercials for consumer, business, industrial, corporate, and public service advertisers. For senior advertising majors.

5-274f,w,s.° CURRENT ADVERTISING DEVELOPMENTS AND PROBLEMS. (4 cr; prereq sr, 5-251, 5-261 and 5-263 or 5-272) Peterman, Thompson
Creative, management, research, media, and technical developments in advertising. Discussion and analysis of specific problems and case studies in the advertising-marketing process. Contributions of related fields of behavioral sciences and communications.

5-353w. PHOTOGRAPHIC COMMUNICATION. (4 cr; prereq 3-121 or ¶3-121 and 1-005 or ¶1-005) Schuneman
Principles, contemporary problems of photographic communication in mass media. Multichannel communication theories, communicative overtones. Visual sources, layout, objectivity in editing. Experimental creative projects, discussion.

5-376f,s. ADVANCED PHOTOJOURNALISM. (5 cr; prereq 1-005, 1-301, 3-121) Schuneman
Photography, its materials and processes, for visual reporting in newspapers and magazines. Thematic visual series. Dynamics of visual content: pattern, texture, movement. Use of miniature camera, light, and lighting. Color photography, transparencies and prints. Analysis of contemporary use of color.

5-377s. DOCUMENTARY PHOTOGRAPHY. (4 cr; prereq 5-353, 5-376) Schuneman
Definition, scope, research, and approaches of documentary picture story for magazines, picture books, and multi-media presentations. Series, sequences, and essays. Photographic markets.

5-402w,s. FILM PRODUCTION. (5 cr; prereq 3-401 and 3-421 or 3-486 or Spch 3-204)
Directed projects in planning, shooting, and editing of silent and sound film. Creative production problems. Lectures, laboratory work, and field experience.

5-442w. ADVANCED TELEVISION NEWS. (5 cr; prereq 3-451) Fang
Techniques of newsfilm editing, preparing and delivering television newscasts. Current problems, legal and ethical considerations.

5-444s. TELEVISION AND RADIO DOCUMENTARY. (4 cr; prereq 4-402 and 5-442 with B or better in each; 1 hr lect, field and lab hrs as needed) Fang
Scope and techniques. Students will be required to produce television or radio news documentaries of broadcast quality.

5-501f,s.° COMMUNICATION AND PUBLIC OPINION I. (4 cr; prereq 15 cr in social science depts) Carter, Fang, Tichenor
Theories of communication process and of persuasion and attitude change. Functions of interpersonal and mediated communication in diffusion of information and in opinion formation.

5-515.° COMMUNICATIONS ANALYSIS: CONTENT, AUDIENCES, EFFECTS. (4 cr; prereq ‡) Staff
Quantitative methods used in studying mass media content, audiences, and effects.

5-531w.° COMMUNICATION AND PUBLIC OPINION II. (5 cr; prereq 5-501 or Soc 5-355) Carter, 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.

5-549f.° PUBLIC RELATIONS. (4 cr; prereq 15 cr in social science depts...‡ for nonmajors)
History and development of public relations practice and principles. Process and applications in a variety of institutional settings. Analysis and critique of public relations in contemporary society.

5-601f.° HISTORY OF JOURNALISM. (4 cr) Emery, Schuneman
Development of American newspapers and periodicals, from early beginnings in Europe to the present day; rise of radio and television; relation of communications developments to political, economic, and social trends in America.

5-603s.° TOPICS IN THE HISTORY OF JOURNALISM. (4 cr; prereq 5-601) Emery
Intensive study of significant individuals, newspapers, and periodicals in the United States, 1865-1920. Individual research projects.

5-606s.° LITERARY ASPECTS OF JOURNALISM. (4 cr; prereq ‡) Hage
Survey as exemplified in and influenced by, works of English and American writers, past and present. Lectures, discussion, weekly papers.

5-611s.° DEVELOPMENT OF AMERICAN BROADCASTING. (4 cr) Lindsay, Paulu
Historical and economic development of radio and television in the United States; government regulations, industry self-regulation, forms of social control, contemporary issues.

5-615w.° DEVELOPMENT OF PHOTOJOURNALISM AND DOCUMENTARY FILM. (5 cr) Schuneman
History of these forms of visual communication and their utilization by the mass media. Principal contributors, visual styles, and changing evaluative criteria, 1839 to present. Analysis of important films, photographs. Individual research projects involving primary data.

5-721w,s. MASS MEDIA IN A DYNAMIC SOCIETY. (4 cr; prereq 1-201 or 3-121 for journalism majors, ‡ for others) Gillmor, Gerald
Economic, political, and social determinants of character and content of mass communications. Patterns of operations, their effect on content, and their relative social utility. Theory of mass society.

5-731s. CURRENT COMMUNICATIONS PROBLEMS. (4 cr; prereq sr, 3-121) Gerald
Individual project method used for analysis of communications problems of current importance in light of their social, economic, and technological environment.

5-777f,s.° CONTEMPORARY PROBLEMS IN FREEDOM OF SPEECH AND PRESS. (4 cr; prereq 15 cr in social science depts) Gerald, Gillmor
Anglo-American concept of freedom and responsibility, constitutional development in the United States, areas of present tension. The Bill of Rights and journalism today.

5-801f.° INTERNATIONAL COMMUNICATION. (4 cr; prereq 15 cr in social science depts) Lindsay
Global telecommunications, channels, and artifacts of international mass communications. Problems in the free flow of information. Roles of international organizations, journalism. Mass communication in social, political, educational, economic development; implications for conflict resolution.

5-825w.° WORLD COMMUNICATION SYSTEMS. (4 cr; prereq 15 cr in social sciences depts) Lindsay
Description and analyses, divergencies and congruence in the world's mass communication systems. Putative issues raised by novel additions to global communications grid —effects, import of near and deep-future communications on the planetary community.

5-971. ADVANCED PROJECTS IN JOURNALISM. (1-4 cr; prereq journalism major, B avg) Staff
Individual research.

8-001f/8-002s/8-003f. SEMINAR: MASS COMMUNICATION RESEARCH. (4 cr per qtr; prereq intro course in statistics [or concurrent regis], consent of adviser) Carter, Tichenor, Wackman
Principles and perspectives; documentary research methods; problems in measurement of attitudes and opinions; analysis of current methodology; theoretical concepts in mass communication.

8-211s.° SEMINAR: ADVERTISING RESEARCH. (4 cr; prereq 8-815 or ‡) Peterman
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.

8-514f.* SEMINAR: MASS COMMUNICATION THEORY. (4 cr; prereq 5-531, ‡) Carter, Tichenor, Wackman
Intensive examination of research concepts and findings which offer the most 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.

8-515w/8-516s.* SEMINAR: COMMUNICATION ANALYSIS. (4 cr per qtr; prereq course in statistics, ‡) Carter, Jones, Tichenor
Research designs; procedures for quantitative studies of media control, content, audiences, and effects; relationships between research and decision making.

8-601f, 8-602w, 8-603s.* SEMINAR: HISTORY OF MASS COMMUNICATION. (4 cr per qtr; prereq 5-601, ‡) Emery
8-601: Analysis of major historical literature in mass communication; development of a research project. 8-602, 8-603: Research in history and development of U.S. mass media.

8-604s.* SEMINAR IN VISUAL COMMUNICATION HISTORY. (4 cr; prereq 5-615 or ‡) Schuneman
Research in photojournalism history and film documentaries.

8-606w.* SEMINAR: LITERARY ASPECTS OF JOURNALISM. (4 cr; prereq 5-606, ‡) Hage
Research in literary aspects of journalism exemplified in careers and works of English and American writers.

8-611.* SEMINAR: DEVELOPMENT OF AMERICAN BROADCASTING. (4 cr; prereq 5-611) Lindsay, Paulu
Critical and systematic analysis of problems related to the history and social, political, economic, and cultural patterns and characteristics of U.S. broadcasting.

8-721f, 8-722w, 8-723s. COMMUNICATION AGENCIES AS SOCIAL INSTITUTIONS. (4 cr per qtr; prereq ‡) Gillmor
Influence of political, social, and economic forces upon national character and performance of mass media.

8-777w.* FREEDOM OF PRESS AND COMMUNICATIONS LAW. (4 cr; prereq 5-777 or ‡) Gerald
Agencies of mass communication under the United States Constitution today.

8-778s/8-779.* GOVERNMENT AND MASS COMMUNICATION. (4 cr per qtr; prereq 5-777, 8-777, or ‡) Gerald
Reconciliation of social and individual interest through government actions affecting mass media.

8-801f, 8-825w, 8-826s.* SEMINAR: INTERNATIONAL MASS COMMUNICATION. (4 cr per qtr; prereq ‡) Carter, Lindsay
Analysis of problems in the communication of news between nations and within countries under different political systems and at varying stages of national development.

8-828s.* MASS COMMUNICATION PROBLEMS OF DEVELOPING COUNTRIES. (4 cr; prereq 8-801) Lindsay
Systematic analysis of problems and factors affecting the development of viable systems of mass communication in developing countries and regions of the world.

8-831. SEMINAR: INTERNATIONAL BROADCASTING AND WORLD AFFAIRS. (4 cr; prereq 8-801) Lindsay
Analysis of factors and conditions giving rise to problems in the collection and dissemination of news and opinion, propaganda and educational matter, via broadcast media, terrestrial and spatial.

8-990f,w,s.* SPECIAL PROBLEMS IN MASS COMMUNICATION. (4 cr per qtr; for grad major or minor in mass communication; prereq ‡) Staff
Individual research.

AgJo 5-301. FUNCTIONAL PHOTOGRAPHY FOR PLANT SCIENCES. (3 cr; prereq ‡) McKay
Use of photography in communicating plant sciences to various audiences. Selection and operation of equipment.

AgJo 5-534. RURAL COMMUNICATION MEDIA AND MEDIA BEHAVIOR. (3 cr; prereq 3-530, Psy 1-002, Soc 1-651, or ‡) Swanson
Mass media behavior in rural communities, theoretical approaches relevant to problems of rural mass media behavior; analysis of research aimed at adult education efforts through mass media.

AgJo 5-535. COMMUNICATIONS IN INTERNATIONAL AGRICULTURAL DEVELOPMENT. (3 cr; prereq 3-530 or Jour 1-001 and 1-101, or ‡)
For United States and foreign students. Analyzes United States and foreign rural communications as developing tools. Develops ability to plan and execute communication programs in developing nations.

AgJo 5-936.* SPECIAL PROBLEMS IN AGRICULTURAL COMMUNICATION. (Cr ar; prereq ‡) Swanson
Individual projects dealing with agricultural communication.

LABORATORY MEDICINE (LMed)

Professor

Ellis S. Benson, M.D., *head*
Jorge J. Yunis, M.D., *director of graduate study*
Eugene Ackerman, Ph.D.
Esther F. Freier, M.S.
Andreas Rosenberg, Ph.D.
R. Dorothy Sundberg, M.D., Ph.D.
Edmond J. Yunis, M.D.

Associate Professor

Miguel Azar, M.D., Ph.D.
Donna Blazevic, M.P.H.
G. Mary Bradley, M.D.
Robert A. Bridges, M.D.
David M. Brown, M.D.
Richard Brunning, M.D.
Agustin Dalmasso, M.D.
Mary E. Dempsey, Ph.D.
J. Roger Edson, M.D.
Ben Hallaway, M.S.
John Matsen, M.D.
Richard Moore, Ph.D.
Herbert F. Polesky, M.D.
Lorraine G. Stewart, M.S.
Osias Stutman, M.D.
Walid Yasmineh, Ph.D.

Assistant Professor

Philip Blume, M.D.
Nancy Staley, M.D.
Patrick C. J. Ward, M.D.

Graduate work in the Department of Laboratory Medicine offers opportunities to physicians, medical technologists and other qualified students to prepare themselves for careers of teaching and research in the field. Only the M.S. degree under Plan A (Master's degree with thesis) is available to students in this program.

Academic Requirements—The program requires a minimum of 18 credits with emphasis in one major area of laboratory medicine (chemistry, genetics, hematology, immunology or microbiology). The minor subject (9 credits) may be chosen from among one of the basic fields of science such as anatomy, biochemistry, genetics or pathology. The student is expected to maintain a B average in courses for both the major and minor. There is no foreign language requirement. Original investigative work in one major area is essential.

Admission Requirements—Admission requirements include either an M.D. degree or a Bachelor's degree from an accredited institution of higher learning with adequate background in the biological sciences to justify graduate work in this specialty. Previous experience in laboratory medicine is desirable.

Residency Requirements—Candidates for the Master's degree must be registered at the University for a minimum of three quarters before receiving a degree. Students are also encouraged to file their program by the end of their first quarter of graduate work in order to be reviewed by the departmental graduate committee.

Student's Progress and Examinations—The student's progress is reviewed at regular intervals by the graduate committee in laboratory medicine. In addition to the usual course examinations, the candidate must pass a final oral examination which will cover the conceptual aspects of the subject covered in the thesis and graduate courses taken. This examination will be conducted by a committee appointed by the Graduate School to examine the thesis.

5-103s. PRINCIPLES OF DIAGNOSTIC MICROBIOLOGY. (3 cr; prereq MdBc 3-103, 5-232 or ‡) Blazevic, Ederer, Matsen

5-138f,w,s,su. CLINICAL MICROBIOLOGY SEMINAR. (1 cr; prereq ‡) Blazevic, Ederer, Matsen

5-139f,w,s,su. ADVANCED MICROBIOLOGY. (Cr ar; prereq ‡) Matsen, staff

5-160s. HUMAN CYTOGENETICS. (2 cr; prereq ‡; offered 1972-73 and alt yrs) J Yunis
Chromosome structure and function and genetic and clinical problems associated with study of human chromosomes.

5-161s. HUMAN CYTOGENETICS LABORATORY (3 cr; prereq ‡; offered 1972-73 and alt yrs) J Yunis, Lindquist
Techniques for study of mammalian and human chromosomes; cell culture, autoradiography, new techniques for chromosome indentification, and chromosome isolation techniques.

5-162s. HUMAN BIOCHEMICAL GENETICS. (2 cr; prereq ‡; offered 1973-74 and alt yrs) J Yunis, Yasmineh
Molecular and genetic basis of human genetic traits.

5-163s. HUMAN BIOCHEMICAL GENETICS LABORATORY. (3 cr; prereq ‡; offered 1973-74 and alt yrs) J Yunis, Aldrich
Biochemical techniques used in study of human genetic traits.

5-164s. CLINICAL GENETICS. (2 cr) J Yunis
Importance of genetic principles in modern medicine. Specific disorders used to illustrate general concepts and their application to common diseases.

5-168f,w,s. GENETICS SEMINAR. (1 cr; prereq ‡) J Yunis and staff

5-169. RESEARCH IN HUMAN GENETICS. (Cr ar; prereq ‡) J Yunis, Yasmineh

5-170. ADVANCED PROBLEMS IN MEDICAL GENETICS. (Cr ar; prereq ‡) J Yunis and staff

5-172f. HUMAN GENETIC TRAITS INCLUDING BLOOD GROUPS AND SERUM PROTEIN POLYMORPHISM. (3 cr, §Anth 5-641; prereq ‡) Polesky

5-173f. ANALYTICAL TECHNIQUES IN LABORATORY MEDICINE. (2 cr; prereq ‡; offered 1973-74 and alt yrs) Rosenberg

5-176f. INTRODUCTION TO CLINICAL CHEMISTRY. (4 cr; prereq ‡) Cox, Freier
Fundamental principles and techniques in clinical chemistry.

5-177w,s. CLINICAL CHEMISTRY. (6 cr; prereq ‡) Freier and staff
Principles of modern clinical chemistry techniques with emphasis on instrumental methods.

5-179f,w,s,su. CHEMISTRY SEMINAR. (1 cr; prereq ‡) Benson, Blume, Bridges, Brown, Dempsey, Freier, Hallaway, Rosenberg, Stewart

5-180f,w,s,su. ADVANCED CHEMISTRY. (Cr ar; prereq ‡) Benson, Blume, Bridges, Brown, Dempsey, Freier, Hallaway, Rosenberg, Stewart

5-267f,w,s,su. MUSCLE CELL STRUCTURE AND FUNCTION. (1 cr; prereq MdBc 5-101 or ‡) Benson, Dempsey, Hallaway, Rosenberg, Staley
Structure and function of heart and skeletal muscle, including the biochemical properties of contractile proteins and their relation to cellular components.

5-268s. TECHNIQUES IN IMMUNOCHEMISTRY. (1 cr; prereq MdBc 5-301 or ‡) Bridges, Stewart
Antigen-antibody reaction applied to quantitative and qualitative analysis of specific patterns of clinical significance. Preparation of antigens and of antisera. Nature of antigen-antibody complexes. Applications of precipitin, neutralization, radioimmune, double antibody and hemolysin techniques.

5-269s. TECHNIQUES IN IMMUNOCHEMISTRY LABORATORY. (1 cr; prereq MdBc 5-301 or ‡) Bridges, Stewart

5-270f. IMMUNOHEMATOLOGY. (3 cr; prereq 5-266 or ‡) Azar, E Yunis
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.

5-271f. IMMUNOHEMATOLOGY LABORATORY. (2 cr; prereq 5-272 or ‡) Azar, McCullough, Swanson, E Yunis

5-272f,w,s,su. IMMUNOLOGY SEMINAR. (1 cr; prereq ‡) Azar, Bridges, Dalmasso, McCullough, Polesky, Stutman, E Yunis

5-273f,w,s,su. ADVANCED IMMUNOLOGY. (Cr ar; prereq ‡) Azar, Bridges, Dalmasso, McCullough, Polesky, E Yunis

5-274w. MOLECULAR ASPECTS OF IMMUNOLOGY. (3 cr; prereq ‡) Dalmasso
Chemistry and pathobiology of immunoglobulins, complement, cell membrane, and mediators of anaphylaxis and cellular immunity.

5-765f, 5-766w. HEMATOLOGY. (4 cr per qtr, §Anat 5-765, 5-766; prereq ‡) Sundberg and staff
Blood and blood forming organs; blood and bone marrow from the standpoint of diagnosis and prognosis.

5-767s. SEMINAR: HEMATOLOGY. (1 cr, §Anat 5-767; prereq ‡) Brunning, Edson, Sundberg

5-768f,w,s,su. ADVANCED HEMATOLOGY. (Cr ar; prereq ‡) Brunning, Edson, Sundberg

5-864f,w,s. RESEARCH SEMINAR. (1 cr; prereq ‡) Benson, J Yunis

5-865f,w,s. DEPARTMENTAL SEMINAR. (1 cr per qtr; prereq ‡) Benson, J Yunis

8-235f,w,s,su. ADVANCED CLINICAL LABORATORY MEDICINE. (Cr ar) Benson, J Yunis

8-236f,w,s,su. RESEARCH ON CLINICAL LABORATORY PROBLEMS. (Cr ar) Benson, J Yunis

LAW

Professor

Carl A. Auerbach,
director of graduate study for the major
William B. Lockhart,
director of graduate study for the minor
David Bryden
Edward H. Cooper
John J. Cound
David L. Graven
Bruno H. Greene
James L. Hetland
Stanley V. Kinyon
K. Bart Koeppen
Robert J. Levy
Thomas P. Lewis
Joseph M. Livermore
Donald G. Marshall
Robert C. McClure
Allan H. McCoid
C. Robert Morris
Fred Morrison
Leo J. Raskind
Glen O. Robinson
Stephen B. Scallen
Ferdinand P. Schoettle
Robert A. Stein
Thomas L. Waterbury
Charles W. Wolfram

Associate Professor

Alan D. Freeman
Joyce A. Hughes
John A. Sebert

Master of Arts Degree in American Legal Institutions—This degree is available for foreign-trained lawyers. It is designed to give lawyers trained under other legal systems some understanding of the American legal system and its institutions. It requires not less than a full year in residence during which the candidate takes law courses as well as courses outside the Law School which are selected to put studies in the Law School in their proper social, economic, political, and cultural framework. The degree is subject to the regular Plan B credit requirements.

Minor—A minor for either the Master's degree or the Ph.D. degree may be earned in law when this field logically relates to the field in which major work is being pursued. Effort will be made to suit the minor program to the particular needs and interests of the student.

Courses will be individually arranged both for the master of arts degree and for the minor in law. For typical course offerings see the *Law School Bulletin*.

Joint Law-Public Affairs Program—The Law School cooperates with the Graduate School and the School of Public Affairs in providing the opportunity for students to receive both the juris doctor and the master of arts with a major in public affairs in four years of full-time study. The School of Public Affairs was formed recently, but is the successor to the Public Administration Center which has been part of the University for a generation. Its creation grew out of a conviction that the study of public affairs, designed to prepare students for policy making leadership and policy analyst positions in the public sector, ought to include the analysis, formulation, implementation, and evaluation of public policy, as well as its administration. Normally, students in the joint program spend their second or third academic year in the Graduate School majoring in public affairs.

A core of 6 courses (or 18 credit hours) in public affairs is required of all degree candidates in that school. Students in the joint program take an additional 6 courses in public affairs. The core includes material from mathematics, statistics, economics, and political science, as well as the less structured experiences of public life. Prospective candidates for the joint program must be admitted to both schools. Further information can be obtained from Director of Graduate Studies, School of Public Affairs, Room 314 Social Sciences Building, University of Minnesota, Minneapolis, Minnesota 55455.

LIBRARY SCIENCE (Lib)

Professor

David K. Berninghausen, *director*
Wesley C. Simonton, *director of graduate study*
Errett W. McDiarmid
John Parker
Raymond H. Shove
Edward B. Stanford

Associate Professor

Lowell E. Olson
Harris C. McClaskey

Assistant Professor

Elmo H. Brekhus
Nancy J. Freeman
Joan H. Leigh

Students may plan their programs of study for work in college, university, special, public, or school libraries. The M.A. degree in library science is the basic preparation for a professional career in library and information service.

Prerequisites—Any student with a Bachelor's degree from a recognized college or university may apply for admission to the Graduate School. For the M.A. degree, it is not necessary to have taken previous work in library science; the general prerequisite for librarianship is a broad liberal arts background in the humanities, social sciences, and sciences with a strong concentration in at least one subject field. For the Ph.D. degree, a Master's degree in library science from an accredited library school and at least 2 years of professional experience will usually be required.

Language Requirement—For the M.A. degree, there is no language requirement. For the Ph.D. degree, the emphasis of the Library School is on the acquisition of the skills of scholarship necessary for research. Students will be required to fulfill one of the following requirements depending on their particular program and research investigation: (a) demonstration of competency in two foreign languages; (b) demonstration of a higher level of proficiency in a single foreign language; (c) demonstration of competency in one language and one or more special research techniques or collateral fields of knowledge; and (d) demonstration of competency in one or more special research techniques or collateral fields of knowledge.

Master's Degree—Offered under both Plan A and Plan B.

Specialist Certificate—A program leading to the Specialist Certificate in Library Science is available at the post-M.A. level. Further information may be obtained from the director of graduate study in library science.

Doctor's Degree—A program of study leading to the Ph.D. with a major in library science is offered. Further information may be obtained from the director of graduate study in library science. Librarians with a Master's degree in library science who prefer a doctoral program in another subject field may apply for admission in the appropriate department and with the approval of the Library School may offer a minor in library science.

FOUNDATION COURSES

5-101. INTRODUCTION TO LIBRARIES AND LIBRARIANSHIP. (5 cr) McClaskey
Librarianship as a profession; development of libraries as social agencies; principles of library administration and management.

5-221. RECORDS OF KNOWLEDGE. (4 cr) Freeman
History and development of the records of knowledge in relation to communication needs of society; principles of selection and dissemination to meet library clientele information needs.

5-401. ORGANIZATION OF INFORMATION I. (4 cr) Brekhus, Simonton
Introduction to the methods and problems involved in the description, subject organization and retrieval of records of knowledge and information in bibliographies, library catalogs and machine-based systems.

ADVANCED COURSES

5-102. MEDIA CENTER ADMINISTRATION. (3 cr; prereq 5-101, 5-221, 5-401) Olson
Organization and administration at the school building level of the library as the single agency that encompasses all forms of instructional materials; philosophy and objectives of service; administration and organization plans, procedures, and relationships.

5-204. PRINT MATERIALS IN LIBRARIES. (3 cr; prereq 5-101, 5-221, 5-401) Olson
Selection, evaluation, and use of books, periodicals, and other printed sources of information and recreation for youth in school and public libraries; reading patterns of children and adolescents, and implications for selection of printed materials to meet the requirements, purposes, and abilities of different age groups.

5-205. MATERIALS RELATED TO THE CURRICULUM. (3 cr; prereq 5-101, 5-221, 5-401, 5-204) Olson
Survey of elementary and secondary school curricula with emphasis on a multimedia approach to teaching and optimum use of school libraries by teachers; consideration of teacher and librarian relations; exploration in depth of materials in at least one curriculum area.

5-301. READING, LISTENING, AND VIEWING GUIDANCE FOR YOUTH IN LIBRARIES. (3 cr; prereq 5-101, 5-221, 5-401) Olson
Philosophy and objectives of library service in schools and children's departments; guidance techniques; planning library programs. Review of relevant research related to reading, viewing, and listening, and survey of professional literature from various fields pertinent to understanding children and adolescents.

8-001. HISTORY OF LIBRARIES AND LIBRARIANSHIP. (4 cr; prereq 5-101, 5-221, 5-401) Shove
Library development from ancient times to the present with emphasis on library service in the United States in the 19th and 20th centuries.

8-003. PUBLISHERS AND PUBLISHING. (4 cr; prereq 5-101, 5-221, 5-401) Shove
History of publishing in the United States with emphasis on the 19th and 20th centuries. Economics and organization, copyright, influence of machines, important publishers and booksellers, censorship, book production and distribution.

8-005. COMMUNICATION MEDIA, INTELLECTUAL FREEDOM, AND LIBRARIES. (4 cr; prereq 5-101, 5-221, 5-401) Berninghausen
Potentialities, limitations and proper use of the various media of communication in relation to the responsibilities of librarians; intellectual freedom in the library.

8-103. PUBLIC LIBRARIES. (4 cr; prereq 5-101, 5-221, 5-401) McClaskey
Development of public library services with emphasis on the growth of cooperative library systems and interrelationships with all types of libraries; social change and problem solving as related to research, literature, organization, administration, and legal factors.

8-111. ACADEMIC LIBRARIES. (3 cr; prereq 5-101, 5-221, 5-401) McDiarmid, Stanford
The academic community; library services, organization, and staffing problems in college and university libraries.

8-131. SPECIAL LIBRARIES. (3 cr; prereq 5-101, 5-221, 5-401)
Development and administration of libraries devoted to serving a special clientele, defined either in terms of a subject field or an organization.

8-132. HEALTH SCIENCES LIBRARIES. (5 cr; prereq 5-101, 5-221, 5-401) McClaskey
Organization and administration of libraries devoted to serving the health sciences community; current trends, including modern techniques of health sciences, communication and the development of cooperative library systems; introduction to the literature of medicine and related fields.

8-222. REFERENCE AND INFORMATION SERVICES. (4 cr; prereq 5-101, 5-221, 5-401)
Information sources and services to meet clientele needs; user-librarian-information interface; research, evaluation, and planning for future services.

8-223. GENERAL BIBLIOGRAPHY. (4 cr; prereq 5-101, 5-221, 5-401) Shove
Major national and trade bibliographies of the world, with emphasis on those of the United States, Great Britain, France, Germany, and Russia; their use in selection and acquisition of print and nonprint materials, and in the preparation of bibliographies.

8-224. SUBJECT BIBLIOGRAPHY. (4 cr; prereq 5-101, 5-221, 5-401) Stanford
An overview of the world of learning and the various disciplines as they have developed in the United States, and study of the bibliographic apparatus in relation to the structure of the disciplines.

8-227. LEGAL LITERATURE AND RESEARCH. (3 cr; prereq 5-101, 5-221, 5-401) Greene
Legal research methods and materials for law libraries.

8-230. SEMINAR: SUBJECT BIBLIOGRAPHY. (3 cr; prereq 8-223 or 8-224) Stanford
Intensive study of the bibliographical apparatus of the social sciences, humanities, science with concentration in any one of these fields; investigation of designated problems relating to the bibliography of all three fields.

8-233. HISTORY OF CHILDREN'S LITERATURE. (4 cr; prereq 5-101, 5-221, 5-401) McClaskey
Introduction to the history and study of children's literature in relation to social history with special reference to current application for library services.

8-241. HISTORY OF BOOKS AND PRINTING. (4 cr; prereq 5-101, 5-221, 5-401) Shove
Bookmaking in its various forms from earliest times to the present. Development of the alphabet and the manuscript book; invention and spread of printing; design of the modern book with emphasis on aesthetic and technical aspects.

8-304. ADULT SERVICES. (4 cr; prereq 5-101, 5-221, 5-401) Freeman
Nature of the adult clientele; selection of library materials and the development of library services to meet changing adult needs and interests.

8-402. ORGANIZATION OF INFORMATION II. (4 cr; prereq 5-101, 5-221, 5-401) Brekhus, Simonton
Advanced study of methods and problems involved in the description, subject organization and retrieval of records of knowledge and information in bibliographies, library catalogs and machine-based systems.

8-403. DESCRIPTIVE BIBLIOGRAPHY. (3 cr; prereq 5-101, 5-221, 5-401) Parker
Problems in bibliographical research, especially those encountered in acquisition, cataloging, and description of antiquarian books.

8-411. LIBRARY MECHANIZATION AND SYSTEMS ANALYSIS. (4 cr; prereq 5-101, 5-221, 5-401) Brekhus
Systems analysis as applied to library operations; data representation and coding systems; application of technological developments such as microforms and computers to library operations.

8-501. SEMINAR: LIBRARY EDUCATION. (3 cr; prereq ‡) Berninghausen

8-701. RESEARCH METHODS IN LIBRARIANSHIP. (3 cr; prereq 5-101, 5-221, 5-401) McDiarmid, Stanford
Purposes and principles of research with emphasis upon the distinctive characteristics of library science problems; critical examination of research studies; preparation of tentative research proposals.

8-950. LIBRARY PROBLEMS. (Cr ar; prereq ‡) Staff
Intensive study of selected problems in library science. Offered as needed for doctoral, specialist and advanced Master's students.

8-970. INDEPENDENT STUDY IN LIBRARY SCIENCE. (Cr ar; prereq ‡) Staff

8-990. LIBRARY RESEARCH. (Cr ar; prereq ‡) Staff
Graduate students under Plan B are required to register for at least 3 credits in library research with the approval of the professor who will guide the research paper.

LINGUISTICS (Ling)

Professor

Walter Lehn, *chairman*
Nils Hasselmo
Andrew MacLeish
Richard A. Narvaez
Betty W. Robinett
Donald C. Swanson
Cecil Wood

Associate Professor

Gerald A. Sanders, *director of graduate study*
Meri Lehtinen
Owen R. Loveless
Lawrence C. Mantini
Stephen S. Wang

Assistant Professor

Adele Donchenko
Larry Hutchinson
Rocky V. Miranda

Prerequisites—For major work, not fewer than 20 Upper Division quarter credits or equivalent in general linguistics, including at least one course in each of the following areas: phonetics, phonology, syntax, and historical linguistics. All applicants are encouraged to submit Graduate Record Examinations scores.

Departmental Qualifying Examination—The departmental qualifying examination is administered annually at the end of the spring quarter. All majors are required to take it, normally at the end of their third quarter of graduate study; if that is not possible, then at the next administration of the examination. Upon passing this examination the student is certified by the department as a candidate for either the M.A. or the Ph.D. degree.

Requirements for the Master's Degree

Language Requirement—Proficiency, demonstrated by an examination approved by the department, in one language not native to the student, selected from French, German, Russian, or other languages approved by the department.

Plan A

1. 5-202, 5-206, 5-303, 5-711, 8-510
2. One of the following: 5-011, 5-211, 5-601, 8-841

Plan B

1. 5-202, 5-206, 5-211, 5-303, 5-711, 8-510
2. Two of the following: 5-011, 5-601, 5-805, 5-811, 5-821, 8-841

Requirements for the Doctor's Degree

Prerequisite for Candidacy—Certification by the department on the basis of the qualifying examination and graduate work in linguistics.

Language Requirement—Proficiency, demonstrated by an examination approved by the department, in two languages not native to the student, at least one of which must be French, German, or Russian; if only one of these is selected, one other language approved by the department may be chosen. The candidate must satisfy the language requirement before taking the preliminary examinations.

Program —

1. Study in phonology, syntax, and historical linguistics beyond that required for the M.A.
2. Two areas of specialization from: phonology, syntax, semantics, historical linguistics, Indo-European linguistics, mathematical linguistics, philosophy of linguistics, psycholinguistics, sociolinguistics, and applied linguistics.

Regardless of the specializations chosen, all candidates will be examined in phonology, syntax, and historical linguistics. All Ph.D. programs must be approved by the departmental director of graduate study.

The Graduate Minor in Linguistics

For the M.A. with a minor in linguistics, 5-001, 5-201, and 5-302, or equivalents.

For the Ph.D. with a minor in linguistics, six courses approved by the department, including 5-001, 5-201, and 5-302, or equivalents.

5-001. INTRODUCTION TO LINGUISTICS. (4 cr, §3-001 or §3-005 or §linguistics major)

5-003. APPLIED PHONETICS. (5 cr, §3-301 or linguistics major; prereq 5-001 or ‡)
Primarily for teachers of English as a second language.

5-006. GENERAL PHONETICS. (4 cr; prereq 3-301 or ‡)
Survey of physiological and instrumental studies of speech sounds.

5-008. INSTRUMENTAL PHONETICS. (4 cr; prereq 5-006 or ‡)
Instrumental studies and acoustic parameters of speech sounds.

5-011/5-012/5-013. MATHEMATICAL LINGUISTICS. (4 cr per qtr; prereq linguistics major or ‡)
The propositional and first order predicate calculi; nonclassical logics; set theory; axiomatics; algebras; grammars; automata theory.

5-201/5-202. INTRODUCTION TO SYNTAX. (4 cr per qtr; prereq 3-001 or ‡)
Description and explanation of syntactic phenomena in natural languages.

5-206/5-207/5-208. SYNTAX. (4 cr per qtr; prereq 5-202, 5-302 or ‡)
Analysis and explanation of facts about the syntax of natural languages.

5-211. SEMANTICS. (4 cr; prereq 5-202, 5-302 or ‡)
Studies in linguistic analysis and explanation of synonomy, analyticity, presupposition, and other meaning relations in natural languages.

5-302. INTRODUCTION TO PHONOLOGY. (4 cr; prereq 3-301 or ‡)

5-303/5-304. PHONOLOGY. (4 cr per qtr; prereq 5-202, 5-302 or ‡)

5-501/5-502. AMERICAN INDIAN LINGUISTICS. (4 cr per qtr; prereq 5-202, 5-302 or ‡)
Genetic and typological survey of representative languages.

5-601/5-602. LANGUAGE CHANGE AND LINGUISTIC RECONSTRUCTION. (4 cr per qtr; prereq 3-601 or ‡)

5-605/5-606/5-607. INDO-EUROPEAN LINGUISTICS. (4 cr per qtr; prereq 3-601 or ‡)
Reconstruction and investigation of phonology, morphology, and syntax of the Indo-European languages.

5-621. INDO-ARYAN LINGUISTICS. (4 cr; prereq 3-601 or ‡)

5-691. HISTORY OF LINGUISTICS. (4 cr; prereq 3-601, 5-202, 5-302 or ‡)

5-701. CONTRASTIVE LINGUISTICS. (4 cr; prereq 5-001, 5-003 or ‡)

5-711. FIELD METHODS IN LINGUISTICS. (4 cr; prereq 5-202, 5-302 or ‡)
Methods of collecting linguistic data from informants.

5-741/5-742. LINGUISTIC DESCRIPTION OF MODERN ENGLISH. (4 cr per qtr; prereq 3-001 or 5-001 or ‡)
Word and sentence structure of present-day English.

5-751/5-752. APPLIED TRANSFORMATIONAL GRAMMAR. (4 cr per qtr)
Survey of transformational grammar from 1957 to the present; techniques of grammar construction, evaluation, and presentation; role of grammar in teaching composition skills.

5-805. PSYCHOLINGUISTICS. (4 cr; prereq 5-202, 5-302 or ‡)
Examination of empirical studies of language acquisition and processing.

5-811. ETHNOLINGUISTICS. (4 cr; prereq 3-001 or 5-001 or ‡)
Intersection of linguistic and nonlinguistic cultural dimensions.

5-821. SOCIOLINGUISTICS. (4 cr; prereq 3-001 or 5-001 or ‡)
Social dimensions of linguistic diversity.

5-910. SEMINAR IN LINGUISTICS. (4 cr; prereq ‡)

5-970. DIRECTED STUDIES. (1-5 cr; prereq linguistics major, #)

8-210. SEMINAR IN SYNTAX. (4 cr; prereq 5-208, 5-211 or #)

8-220. SEMINAR IN SEMANTICS. (4 cr; prereq 5-211 or #)

8-310. SEMINAR IN PHONOLOGY. (4 cr; prereq 5-304, 5-602 or #)

8-500. SEMINAR: TOPICS IN LINGUISTICS. (4 cr [may be repeated for cr with different topics]; prereq #)
Various topics, e.g., Indo-Aryan, Finno-Ugric, and areal linguistics, Pidgin and Creole languages.

8-510. LINGUISTIC STRUCTURES. (4 cr [may be repeated for cr with different languages]; prereq 5-202, 5-302 or #)
Survey of the phonology and syntax of a given language. See *Class Schedule* for language.

8-610. SEMINAR IN HISTORICAL LINGUISTICS. (4 cr; prereq 5-202, 5-302, 5-602 or #)

8-810. SEMINAR IN PSYCHOLINGUISTICS. (4 cr; prereq 5-805 or #)

8-841/8-842. PHILOSOPHY OF LINGUISTICS. (4 cr per qtr; prereq 5-011, 5-202, 5-302 or #)
Nature of scientific explanations and theories; philosophical positions within linguistics.

8-900. INDEPENDENT STUDY. (1-5 cr; prereq major, #)

A list of approved courses in other departments which may be elected as part of a major in linguistics is available in the department office, 142 Klaeber Court.

MARRIAGE AND FAMILY STUDY

Several departments of the Graduate School converge to offer training relevant for marriage and family educators, counselors, and researchers. Three departments offer a major focus in the family area: (1) Sociology, (2) Institute of Child Development, and (3) Family Social Science. One may major in any of these departments and take minor work in the other two. In addition, there are courses offered in law, psychology, education, and elsewhere that may be elected. The staff and advisory committee of the Family Study Center exercise an overall interest and supervision of this graduate program, providing consultation to advisers in the major and aid to graduate students in designing individualized programs of study.

The designing of the individual student's program takes into account the assets and deficiencies peculiar to the discipline in which one is majoring, broadening the program by supplementation in the minor and collateral fields or in the supporting program of study. This enables the student to complete graduate study adequately equipped to serve as an educator or researcher in the field of the family.

See the listing of the relevant graduate courses and faculty in the family area under Department of Sociology, Institute of Child Development, and Department of Family Social Science.

MATHEMATICS (Math)

Professor

Johannes C. C. Nitsche, *head*
Howard B. Jenkins, *associate head*
Robert H. Cameron, *director of graduate study*
Alfred Aeppli
Donald G. Aronson
Rafael V. S. Chacon
Robert Ellis
Steven A. Gaal
Jesus Gil de Lamadrid
Leon W. Green
Gopinath Kallianpur
Bernard Lindgren
Walter Littman
Warren S. Loud
Albert Marden
Lawrence Markus
Charles A. McCarthy
Norman G. Meyers
Williard Miller, Jr.
William D. Munro
Steven Orey
Daniel Pedoe
William F. Pohl
Marian B. Pour-El

William E. Pruitt
Edgar Reich
Peter A. Rejto
Arthur A. Sagle
James B. Serrin, Jr.
Yatsutaka Sibuya
Marvin L. Stein
David A. Storvick
Hans F. Weinberger

Associate Professor

Stephen B. Agard
George U. Brauer
John A. Eagon
Eugene B. Fabes
Bert E. Fristedt
Gebhard E. Fuhrken
Hillel Gershenson
Jay Goldman
Siegfried Grosser
Melvin Hochster
Naresh C. Jain
James T. Joichi
Donald W. Kahn
Harvey Keynes
Chester L. Miracle
J. Ian Richards
Wayne Richter
Nestor Riviere
David Sattinger
George R. Sell
Warren B. Stenberg
Charlotte E. Striebel
James E. Thompson

Assistant Professor

John Baxter
Thomas Berger
Chang-Shing Chen
Edward Cline
David Cohoon
Lisl N. Gaal
Robert Hardt
Eugene Goldberg
Laurence R. Harper, Jr.
David Heath
Robert Jeroslow
David Kinderlehrer
Marvin Kohn
Howard Levine
Richard McGehee
John Piepenbrink
Leonard Shapiro
Donald Singley
Norris Weaver

Students majoring in mathematics should consult Professor Cameron, Director of Graduate Study, School of Mathematics, 127 Vincent Hall.

Prerequisites—A solid background in single and multivariable calculus and a minimum of 15 quarter credits of mathematics on the junior-senior level including a 3 quarter sequence in either analysis or linear algebra.

Students entering with a Bachelor's degree are admitted initially to the Master's degree program. Students are admitted to the Ph.D. program when the written Ph.D. preliminary exam is passed.

Language Requirement—For the Master's degree, one foreign language from the following list: French, German, Russian, Italian. For the Ph.D. degree, two foreign languages from the above list are required.

Master's Degree—Offered under both Plan A and Plan B. Both written exams and an oral exam are required. The degree program should include a 3 quarter mathematics sequence on the 8-000 level or its equivalent. The Plan B paper requirement may be met in connection with any course accepted for graduate credit with the instructor's approval. Until further notice and with the approval of the director of graduate study 9 additional credits on the 8-000 level may be substituted for the Plan B papers. The written Ph.D. preliminary exam may be substituted for the written Master's exam.

Ph.D. Degree—Students must prepare a program of work for the Ph.D. degree in consultation with their adviser. The written preliminary examination is given twice each year, and covers basic analysis, basic algebra and basic point set topology. Students are expected to take it during their first or second year of graduate studies. Upon completion of course work, and after passing the written exam and the language exams, students must pass the Ph.D. preliminary oral exam. This exam is given at the end of each quarter excepting summer sessions. It consists of four parts weighted equally, on the following subjects: (1) real and complex analysis; (2) the minor or internal supporting program; (3 and 4) two out of three of (a) algebra or logic, (b) topology or geometry, (c) a 3-quarter advanced

sequence. Students are expected to complete the Ph.D. oral exam before the end of their fourth year.

Minor—The minor requirement for an M.S. and Ph.D. degree in mathematics can be satisfied by means of a supporting program which may consist partly or entirely of courses within the Department of Mathematics. Further information concerning the internal supporting program is available from the director of graduate study. Students who wish to minor in mathematics at the Ph.D. level must have completed course work in mathematics containing at least one three-course sequence at the 8-000 level or the equivalent.

Note—For information on work in statistics or computer science, see section on statistics or computer science. Attention is called to several Ph.D. programs of an interdisciplinary nature that rely heavily on mathematics. Interested students should consult the entries in this bulletin under control sciences and under fluid mechanics.

5-151. ELEMENTARY SET THEORY. (4 cr; prereq 3-211 or 3-411)
Basic properties of operations on sets, cardinal numbers, simply ordered sets, well-ordered sets, ordinal numbers, axiom of choice, axiomatics.

5-152. ELEMENTARY MATHEMATICAL LOGIC. (4 cr, §5-162; prereq 3-211 or 3-411)
Survey course presenting in outline the subject matter and main results of modern mathematical logic. Of special interest to education students who plan to teach in high schools and to mathematics majors and minors who do not wish to take 5-162/5-163/5-164. Sets and relations; the statement calculus; Boolean algebras and their relation to the statement calculus; the predicate calculus, models, validity and truth; examples of first order theories as illustrations of the axiomatic method; the completeness theorem (discussion only); the incompleteness theorem and meta-mathematics (discussion only).

5-154. INTRODUCTION TO RECURSIVE FUNCTION THEORY. (4 cr; prereq 3-211 or 3-411 or ♯)
For students interested in the foundations of mathematics and theoretical aspects of computation who do not wish to take 5-162/5-163/5-164 sequences. Topics include: alternative definitions of computability; primitive, partial, and general recursive functions; Church's Thesis; Kleene normal form theorem and recursion theorem; recursive and recursively enumerable sets; applications to mathematical logic.

5-157/5-158/5-159. MATHEMATICS OF SYMBOL MANIPULATION SYSTEMS. (4 cr per qtr; prereq 1-211 or 1-411...3rd or 4th yr standing or ♯)
5-157: Finite automata theory: switching circuits, Boolean algebra, and propositional logic. Kleene's theorem on regular sets. Algebraic aspects of finite automata: minimization, decomposition, synthesis. 5-158: The computability of numerical functions: proofs for the basic results connecting abstract models of programmed digital computers, Turing machines, and general recursive functions. Normal form theorem, universal machines. Unsolvability of halting problem. 5-159: Symbol manipulation systems: the formal systems of Herbrand-Godel and Post. Post's normal form theorem. Formal grammars: introduction to the theory of Chomsky on context-free and other languages and related automata. Transduction of languages by automata.

5-162/5-163/5-164. MATHEMATICAL LOGIC. (4 cr per qtr; prereq 3-211 with 3-221 or 3-411 with 3-142 or Phil 5-202 or ♯)
Propositional and predicate calculi, models for systems of logic, recursive functions, decision and completeness problems.

5-200. TOPICS IN ALGEBRA. (4 cr [may be repeated for cr with △]; prereq ♯)
Topics vary from quarter to quarter.

5-209. THEORY OF NUMBERS. (4 cr; prereq 3-211 or 3-411)
Elementary properties of integers; prime and composite numbers; Euclid's algorithm; congruences; the theorems of Fermat and Wilson; primitive roots; indices; Diophantine equations.

5-242/5-243. LINEAR ALGEBRA WITH APPLICATIONS. (4 cr per qtr, §5-283/5-284; prereq 3-221 or 3-142 or 3-511)
Systems of linear equations, finite dimensional linear spaces, bases, linear transformations, matrices, determinants, eigenvalues, reduction to canonical forms, quadratic and bilinear forms; applications.

5-244. GROUP THEORY. (4 cr; prereq 3-221 or 3-142 or 3-511)
Permutation groups; groups related to geometrical configuration; invariant subgroups, Jordan-Holder composition theorem, Sylow groups, Abelian groups, elementary divisors, applications.

5-282/5-283/5-284. FUNDAMENTAL STRUCTURES OF ALGEBRA. (4 cr per qtr, §5-244 for 5-282, §5-242/5-243 for 5-283/5-284; prereq 3-675, 3-221 or 3-142 or 3-511)
Theory-oriented; principally designed for students planning graduate work with a major in mathematics. Group theory — including topics such as 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.

5-300. TOPICS IN GEOMETRY. (4 cr [may be repeated for cr with △]; prereq ♯)
Topics vary from quarter to quarter.

5-341/5-342. INTRODUCTION TO TOPOLOGY. (4 cr per qtr; prereq 3-675, 3-211 or 3-411 or 3-521)
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.

5-343. INTRODUCTION TO ALGEBRAIC TOPOLOGY. (4 cr; prereq 5-342)
Classification of 2-manifolds, fundamental group, homology theory.

5-357. PROJECTIVE GEOMETRY. (4 cr; prereq 3-211 or 3-411)
Geometric properties invariant under projective transformations; theorems of Desargues, Pascal and Brianchon, and applications. Methods used in some quarters are mainly synthetic; in other quarters they are mainly analytic.

5-359. NON-EUCLIDEAN GEOMETRY. (4 cr; prereq 3-211 or 3-411)
Foundations of Euclidean geometry, Euclid's fifth postulate and its implications. Hyperbolic plane geometry and trigonometry. Elliptic plane geometry and trigonometry. Consistency of non-Euclidean geometry.

5-366/5-367/5-368. GEOMETRY. (4 cr per qtr; prereq 3-211 or 3-411 and 3-142 or 3-511 for each qtr)
Selected chapters of geometry, such as convex bodies, projective geometry, geometry and imagination, elementary algebraic geometry, geometry of transformation groups, axiomatic geometry, geometrical constructions.

5-375. DIFFERENTIAL GEOMETRY. (4 cr; prereq 3-231 or 5-602)
Plane and space curves, Frenet formulas, elementary theory of surfaces.

5-376/5-377. DIFFERENTIAL GEOMETRY. (4 cr per qtr; prereq 5-375, 1 qtr linear algebra)
Introduction to differential forms. Advanced theory of surfaces, integral geometry, Riemannian geometry.

5-404. VARIATIONAL PROBLEMS. (4 cr; prereq 5-602 or 5-512 or ♯)
Euler-Lagrange equations, isoperimetric problems, geodesics, Fermat's and Hamilton's principles, methods of Rayleigh-Ritz, eigenvalues and eigenfunctions.

5-427/5-428. APPLIED MATHEMATICS FOR SOCIAL AND BIOLOGICAL SCIENCES. (4 cr per qtr; not accepted for mathematics majors [all degrees] as part of mathematics programs; prereq 3-211 with 3-221 or 3-411 with 3-142)
Mathematical tools and concepts other than statistics useful in behavioral sciences. Examples and problems taken from fields concerned. Topics include matrices, functions of several variables, probability, difference equations, learning models, two person games.

5-436/5-437. ANALYTICAL DYNAMICS. (4 cr per qtr; prereq 3-231 or 5-602, 1 qtr linear algebra)
Basic laws and principles. Lagrange's equations. Motion of particles and rigid bodies; e.g., satellites and gyroscopes. Matrix methods for small oscillations. Variational methods, Hamilton's principle, extremal properties of eigenvalues, Hamilton's equations, transformation theory, separable systems.

5-441. MATHEMATICAL THEORY OF FLUID FLOW. (4 cr; prereq 3-231 or 5-602, 5-568 or 5-572)
General equations of fluid mechanics. Concepts from 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.

5-457/5-458/5-459. METHODS OF APPLIED MATHEMATICS. (4 cr per qtr; prereq 5-603 or 5-614)
Integrated study of analytic tools used in applications of mathematics; emphasis on technique. Real and complex variables, matrices, ordinary and partial differential equations, calculus of variations, asymptotic expansions, etc.

5-472/5-473. INTRODUCTION TO NUMERICAL ANALYSIS. (4 cr per qtr, §CICS 5-301/5-302; prereq 3-211, 3-221, CICS 1-100)
5-472: Finite differences, interpolation, summation of series, numerical integration, Euler-MacLaurin formula and asymptotic expansions. Numerical solutions of systems of algebraic and transcendental equations. Newton's and Graffe's method. 5-473: Approximation of functions and least squares. Approximate solution of ordinary and partial differential equations, Moulton's, Runge's relaxation and iteration methods. Calculation of eigenvalues of matrices and differential problems, Rayleigh-Ritz method. Integral equations.

5-476. THEORY OF APPROXIMATION IN NUMERICAL ANALYSIS. (4 cr; prereq 5-473, 5-568 or 5-573)
Orthogonal functions. Chebyshev approximations, trigonometric approximations, saturation classes, rational approximations in several variables, spline interpolation and approximations, use of approximations in computing.

5-512. DIFFERENTIAL EQUATIONS. (4 cr, §5-523; prereq 3-211 or equiv)
First and second order equations. Power series solutions. Bessel functions, Legendre polynomials. Introduction to boundary value problems. Primarily a technique course, for students whose interests are not theoretical but who wish to learn relevant mathematical facts and methods.

5-514. INTEGRAL EQUATIONS. (4 cr; prereq 3-211, 3-221 or equiv)
Introduction to 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.

5-521/5-522/5-523. INTRODUCTION TO ORDINARY DIFFERENTIAL EQUATIONS. (4 cr per qtr; prereq 3-142 or 3-221 or 3-511, 3-211 or 3-411 or 3-521)
5-521: Existence and uniqueness theorems; successive approximations; differential inequalities; linear systems; fundamental matric solutions; linear systems with constant coefficients; variation of parameters. 5-522: Phase plane analysis; Poincare-Bendixson theory; linear and nonlinear oscillations; stability theory; asymptotic behavior of solutions; control theory. 5-523: Formal and convergent of power series solutions majorant method; regular and irregular singular points; error estimates perturbation methods.

5-541/5-542/5-543. SPECIAL FUNCTIONS IN MATHEMATICAL ANALYSIS. (4 cr per qtr; prereq 5-568 or 5-573)
Properties of gamma, hypergeometric, Bessel and Hermite functions. Applications to mathematical physics. Relationship between symmetry groups and special functions.

5-567. FOURIER SERIES AND BOUNDARY VALUE PROBLEMS. (4 cr, §5-571; prereq 3-211, 3-220 or equiv)
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.

5-568. ELEMENTARY THEORY OF COMPLEX VARIABLES. (4 cr; prereq 5-602 or equiv)
Derivative and integral of a function of a complex variable. Cauchy's integral theorem and formula, residues. Application to evaluation of integrals, conformal mapping.

5-569. OPERATIONAL MATHEMATICS. (4 cr; prereq 5-568)
Laplace transforms, Fourier transforms, inversion theorems; applications to differential equations.

5-571/5-572/5-573. ELEMENTARY PARTIAL DIFFERENTIAL EQUATIONS. (4 cr per qtr, §5-567, §5-568; prereq 3-211, 3-221 or equiv)
Partial differential equations of theoretical physics, one-dimensional wave equations, 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 of heat, wave, and Laplace equations.

5-600. TOPICS IN ANALYSIS. (4 cr [may be repeated for cr with △]; prereq ♯)
Topics vary from quarter to quarter.

5-601/5-602/5-603. ADVANCED CALCULUS. (4 cr per qtr; prereq 3-211 or 3-411)
5-601: 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. 5-602: Line and surface integrals; Stokes theorem; convergence of infinite series; orthogonal functions; uniform convergence; integration and differentiation of series. 5-603: Real numbers; continuous functions; limits; properties of continuous functions; differentiation; the Riemann integral; improper integrals.

5-606/5-607. CRITICAL REASONING IN MATHEMATICAL ANALYSIS. (4 cr per qtr, §5-612; prereq 3-211 or 3-411)
Based on the elementary concepts of mathematical analysis. Develops an understanding of mathematical rigor.

5-612/5-613/5-614. INTRODUCTION TO ANALYSIS. (4 cr per qtr; prereq 3-675, 3-521 or 3-211 with 3-221 or 3-411 with 3-142; for students planning graduate major in mathematics as preparation for graduate courses in analysis)
Theory of real numbers; elements of point set theory; limits; differentiation; multivariable analysis.

5-615. LEBESGUE INTEGRAL. (4 cr; prereq 5-602 or 5-612 or 5-607 or ♯)
Basic limit theorems. Comparison with Riemann integral. Lebesgue measure. Absolute continuity.

5-625. DEVELOPMENT OF NUMBER SYSTEMS. (4 cr, §5-612; prereq 3-211 or 3-411)
Systematic construction of the real number system by extension from natural numbers via rational numbers to irrational numbers; negative numbers; properties of the system; operations with numbers and laws governing the operations.

5-644/5-645. FOURIER SERIES AND ORTHOGONAL FUNCTIONS. (4 cr per qtr; prereq 5-602)
General theory of orthonormal functions developed and applied to Fourier, Legendre, Bessel, Hermite, and other series. Convergence and summability theorems proved, Fourier integral considered.

5-661/5-662. PROBABILITY WITH TECHNOLOGICAL APPLICATIONS. (4 cr per qtr; prereq Stat 5-131, ♯)
Spectral analysis of stationary processes, linear and nonlinear transformations, prediction and smoothing, recurrent events, random walk and diffusion, Markov chains, Poisson processes.

5-679. PROBABILITY. (4 cr, §5-681; prereq 3-211 or 3-411 or 3-521)
Elementary principles of probability, total and compound probability, expectation, repeated trials, and topics chosen from the following: Stirling's formula, the probability integral, geometrical probability, probability of causes, Bayes's theorem, errors of observation, principle of least squares.

5-681/5-682/5-683. INTRODUCTION TO PROBABILITY. (4 cr per qtr; prereq 5-602 or Stat 5-133 or ♯)
Logical development and various applications of probability. Probability spaces, random variables, central limit theorem; Markov chains.

5-701/5-702/5-703. COMBINATORICS. (4 cr per qtr; prereq 3-211 or 3-411; 3rd yr standing . . . 1 qtr linear algebra for 5-702)
5-701: Introduction to basic concepts of combinatorics. Enumeration including binomial counting, Stirling's formula, generating functions, inclusion-exclusion principle, recurrence relations, Polya's theorem, analysis of algorithms. Basic concepts of graph theory and matching theory. Introduction to designs. 5-702/5-703: Further development of topics in 5-701. Topics chosen from graph theory, optimization and designs including planar and dual graphs, coloring problems, flows in networks, linear programming, block designs, latin squares, difference sets.

5-900x. TUTORIAL COURSE IN ADVANCED MATHEMATICS. (Cr ar; prereq ♯)
Qualified students whose needs are not met by courses offered may make special arrangements for obtaining the content of other graduate courses regularly offered by the department.

5-910. PROBLEMS COURSE. (4 cr [may be repeated for cr with △]; prereq ♯)
Develops problem-solving techniques in many areas of mathematics. Topics range from elementary to advanced levels, adapted to students of varied backgrounds.

8-150/8-151/8-152. AXIOMATIC SET THEORY. (3 cr per qtr; prereq 5-162/5-163/5-164 or ♯)
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.

8-166/8-167/8-168. RECURSION THEORY. (3 cr per qtr; prereq 5-162/5-163/5-164 or ♯)
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; a study of "higher order computability."

8-172/8-173/8-174. MODEL THEORY. (3 cr per qtr; prereq 5-164 or ♯)
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 (Lowenheim-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.

8-181/8-182/8-183. FORMAL LANGUAGES AND AUTOMATA. (3 cr per qtr; prereq 5-162, ¶5-163, ¶5-164)
Theory of computability, finite automata theory, algorithmic languages, formal aspects of the organization of abstract and actual machines.

8-190/8-191/8-192. TOPICS IN LOGIC. (3 cr per qtr; prereq 5-164 or ♯)

8-200/8-201/8-202. GENERAL ALGEBRA. (3 cr per qtr; prereq 5-284 or ♯)
8-200: Sets with compositions. Groups and semigroups with operators. Homomorphism theorems. Jordan-Holder 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. 8-201: 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. 8-202: Simple and semisimple rings. Chain conditions on rings and modules. Wedderburn theorem. Representations of finite groups.

8-230/8-231/8-232. FOUNDATIONS OF ALGEBRA. (3 cr per qtr; prereq ♯)
Lattices and structures of algebraic systems, universal algebra, and interconnections between logic and algebra.

8-236/8-237/8-238. STRUCTURE OF RINGS AND ALGEBRAS. (3 cr per qtr; prereq 8-202)
Rings with minimum condition, semisimple rings, Wedderburn theorems; matrix representations; crossed products; cyclic algebras; rational division algebras; primitive rings; rings with a radical; nonassociative rings and algebras.

8-245/8-246/8-247. GROUP THEORY. (3 cr per qtr; prereq 8-202 or ♯)
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.

8-260/8-261/8-262. TOPICS IN NUMBER THEORY AND ALGEBRAIC GEOMETRY. (3 cr per qtr; prereq 5-572, 8-201 or ♯)
Topics include Riemann Zeta function, its functional equation and distribution of its zeros. Explicit formulas will be developed following 8-260. Well in terms of generalized functions. Theory of Zeta functions of algebraic number fields, function fields, and of algebraic varieties, elliptic modular functions. Riemann-Roch theorems and complex multiplication.

8-270/8-271/8-272. LIE GROUPS AND LIE ALGEBRAS. (3 cr per qtr; prereq 8-202 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.

8-290, 8-291, 8-292. TOPICS IN ALGEBRA. (3 cr per qtr; prereq 8-202)
Topics vary depending on instructor and demand. The student is advised to consult the instructor to determine what topics will be covered during a particular quarter.

8-306/8-307/8-308. ALGEBRAIC TOPOLOGY. (3 cr per qtr; prereq 5-342 or ♯)
Axiomatic homology theory; various homology and cohomology theories; introduction to homotopy theory.

8-321/8-322/8-323. HOMOTOPY THEORY. (3 cr per qtr; prereq 5-342 or ♯)
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.

8-330/8-331/8-332. DIFFERENTIAL TOPOLOGY. (3 cr per qtr; prereq 5-342 or ‡)
General introduction to algebraic topology, as far as is needed for development of special tools of differential topology. Theory and applications of differentiable sheaves.

8-342/8-343/8-344. TOPOLOGICAL DYNAMICS. (3 cr per qtr; prereq 5-341 or ‡)
General theory of transformation groups, algebraic theory of minimal sets, structure theorems, flows induced by vector fields, symbolic flows.

8-365/8-366/8-367. RIEMANNIAN GEOMETRY. (3 cr per qtr; prereq 5-377 or ‡)
Differential manifolds. Riemannian metrics. Exterior differential calculus. Methods of global differential geometry. Differential equations of mathematical physics. Tensor algebra.

8-374/8-375/8-376. ALGEBRAIC GEOMETRY. (3 cr per qtr; prereq ‡)

8-380/8-381/8-382. TOPICS IN ADVANCED DIFFERENTIAL GEOMETRY. (3 cr per qtr; prereq ‡)

8-406/8-407/8-408. ADVANCED METHODS OF APPLIED MATHEMATICS. (3 cr per qtr; prereq 5-459 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.

8-412/8-413/8-414. PARTIAL DIFFERENTIAL AND INTEGRAL EQUATIONS OF APPLIED MATHEMATICS. (3 cr per qtr; prereq 5-573 or ‡)
Linear integral equations; Fredholm's theorem, symmetric kernels, the expansion theorem, Volterra equations, topics in calculus of variations; Sturm-Liouville problems. Rayleigh-Ritz method, partial differential equations, introduction and classification. Heat equation and wave equation; energy method. Boundary value problems for Laplace and Poisson equations. Nonlinear hyperbolic problems.

8-430/8-431/8-432. MATHEMATICAL THEORY OF FLUID DYNAMICS. (3 cr per qtr; prereq 5-602, 5-573, 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.

8-433. MATHEMATICAL ASPECTS OF BOUNDARY LAYER THEORY. (3 cr; prereq 5-602/5-573, or ‡)
Navier-Stokes equations, exact solutions illustrating boundary layer concept. Boundary layer equations. General properties and critique. Theory of similar solutions, Goldstein's theorem, Blasius solutions, existence theorems. Von Mises transformation. Qualitative theory, asymptotic behavior, and uniqueness. Remarks on compressible boundary layers, Stewartson-Illingworth theorem.

8-440. VARIATIONAL METHODS IN BOUNDARY VALUE PROBLEMS. (3 cr; prereq 5-573 or ‡)
Variational characterization of the solution of a boundary value problem in elliptic differential equations. Construction of arbitarily close upper and lower bounds for physical quantities such as strain energy, electrostatic capacity, and virtual mass as well as for solutions of steady state problems in elasticity, potential theory, and hydrodynamics.

8-441. VARIATIONAL METHODS IN EIGENVALUE PROBLEMS. (3 cr per qtr; prereq 5-573 or ‡)
Minimum, maximum-minimum, and minimum-maximum characterizations 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.

8-445. ADVANCED NUMERICAL ANALYSIS OF LINEAR SYSTEMS. (3 cr per qtr; prereq 5-284, 5-472, or ‡)
Solution of linear equations, gradient method, projection method, matrix inversion and decomposition, matrix diagonalization, linear programming, extensions to Hilbert space.

8-446. ADVANCED NUMERICAL ANALYSIS OF PARTIAL DIFFERENTIAL EQUATIONS. (3 cr; prereq 5-573, 5-472 or ‡)
Linear equations of first order, hyperbolic, elliptic, and parabolic equations, choice of grid, boundary value problems, eigenvalue problems.

8-460/8-461/8-462. MATHEMATICAL PROBLEMS IN THEORETICAL PHYSICS. (3 cr per qtr; prereq ‡)

8-466/8-467/8-468. JOINT SEMINAR WITH AERONAUTICAL ENGINEERING. (3 cr; prereq ‡)
Topics covered vary from year to year.

8-480/8-481/8-482. SELECTED TOPICS OF CELESTIAL MECHANICS. (3 cr; prereq ‡)

8-500/8-501/8-502. THEORY OF ORDINARY DIFFERENTIAL EQUATIONS. (3 cr per qtr; prereq 5-614 or equiv, 5-521, 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, Poincare-Bendixon theory, equations of Duffing and Van der Pol.

8-516/8-517/8-518. THEORY OF NONLINEAR OSCILLATIONS. (3 cr per qtr; prereq 8-501 or ‡)
Background from theory of ordinary differential equations. Existence and stability of oscillations in nearly linear systems, periodic and almost periodic solutions, parametric resonance, invariant manifolds.

8-540/8-541/8-542. TOPICS IN DIFFERENTIAL AND DIFFERENCE EQUATIONS. (3 cr per qtr; prereq ‡)

8-530/8-531. TOPICS IN CONTROL THEORY. (3 cr per qtr; prereq grad course in differential equations, or control theory, or ‡)
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.

8-550/8-551/8-552. THEORY OF PARTIAL DIFFERENTIAL EQUATIONS. (3 cr per qtr; prereq 5-614 or equiv, 5-521 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.

8-560/8-561/8-562. CALCULUS OF VARIATIONS AND MINIMAL SURFACES. (3 cr per qtr; prereq 5-614 or equiv, 5-521 or ‡)
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 extremnals. Local and global properties of minimal surfaces, Plateau's problem.

8-566/8-567/8-568. CALCULUS OF VARIATIONS IN THE LARGE. (3 cr per qtr; prereq 5-342 or ‡)
Classical variational theories on differentiable manifolds. Morse theory on finite and infinite dimensional manifolds with applications to the theory of geodesics, minimal surfaces, and other variational problems.

8-590/8-591/8-592. TOPICS IN PARTIAL DIFFERENTIAL EQUATIONS. (3 cr per qtr; prereq 8-609, 8-552 or ‡)

8-600/8-601/8-602. REAL ANALYSIS. (3 cr per qtr; prereq 5-614 or equiv or 8-702 or ‡)
Review of fundamental concepts of analysis, elementary set theory. Measures and measure space, 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, Reisz representation theorem, Stone-Weierstrass theorem, Hilbert space, compact operators.

8-609/8-610. THEORY OF DIFFERENTIATION. (3 cr; prereq 8-702)
Vitali's covering theorem; differentiation of set functions, Radon-Nikodym derivative, Lebesgue set, integral averaging. Calculus of generalized derivatives. Relation to classical differentiation process. Sobolev-Morrey inequalities; theory of trace.

8-624/8-625/8-626. GENERALIZED FUNCTIONS, DISTRIBUTIONS, AND APPLICATIONS. (3 cr per qtr; prereq 8-702, 8-602 or ‡)
Material from the books of A. Friedman, Gelfand-Silov, Hormander.

8-630/8-631/8-632. WIENER AND FEYNMAN INTEGRALS. (3 cr per qtr; prereq 8-602 or ‡)
8-630: Heuristic survey of the field. 8-631: Rigorous proof of countable additivity of Wiener measure, the translation theorem, and other topics. 8-632: Analytic and sequential Wiener and Feynman integrals; ILSTOW and related Feynman integrals.

8-640/8-641/8-642. TOPICS IN REAL ANALYSIS. (3 cr per qtr; prereq 8-602)

8-650/8-651/8-652. THEORY OF PROBABILITY. (3 cr per qtr; prereq 8-602 or ‡)
Topics in modern probability theory, including recent advances in limit theorems and introduction to stochastic processes.

8-656/8-657/8-658. MEASURE THEORY AND PROBABILITY. (3 cr per qtr; prereq 5-614 or ‡)
Measure and measure spaces, measurable functions, integration, fundamental convergence theorems, Radon-Nikodyn 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. Students with a strong mathematical background should take 8-650/8-651/8-652.

8-660/8-661/8-662. STOCHASTIC PROCESSES. (3 cr per qtr; prereq 8-652 or ‡)
General theory of continuous parameter stochastic processes. Gaussian processes, processes with independent increments. Markov processes and their connections with functional equations.

8-666/8-667/8-668. STOCHASTIC CONTROL THEORY. (3 cr per qtr; prereq 5-662 or EE 5-703 or 8-652 or ‡)
Stochastic processes with discrete time parameters, controlled random sequences, optimization of stochastic systems and processes with continuous time parameter.

8-672, 8-673, 8-674. COMBINATIONAL THEORY. (3 cr per qtr; prereq ‡)
Combinational geometry, matroids, enumeration, ordered sets and Mobius inversion. Graph theory, coloring problems, matching theory, designs, large sets, statistical physics, finite geometry, linear programming and algorithms.

8-675. INFORMATION THEORY. (3 cr; prereq 5-602 and Stat 5-131, or Math 5-573 and 5-681, or ‡)
Mathematical theory of transmission of information in the presence of noise; heuristic background of the problem; review of some topics from probability theory; the entropy function; discrete memoryless channels; finite memory channels; continuous channels with additive noise. Axiomatic approach—emphasis on mathematical rather than engineering aspects.

8-680/8-681/8-682. ERGODIC THEORY. (3 cr; prereq 8-602)
Concepts of ergodic theory; mixing conditions; norm and almost everywhere ergodic theorems; entropy, recent developments.

8-690/8-691/8-692. TOPICS IN THE THEORY OF PROBABILITY. (3 cr per qtr; prereq 8-652 or ‡)

8-700/8-701/8-702. COMPLEX ANALYSIS. (3 cr per qtr; prereq 5-614 or equiv or 5-573 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.

8-706, 8-707, 8-708. REAL AND COMPLEX ANALYSIS. (6 cr per qtr; prereq 5-284, 5-341, 5-614, or ‡)
Theory of Lebesgue integration, corresponding differentiation theory, theory of holomorphic functions. Stresses interplay and connections between real and complex analysis.

8-720/8-721/8-722. CONFORMAL MAPPING. (3 cr per qtr; prereq 8-702 or ‡)
Mapping of simply connected regions. Riemann's mapping theorem, boundary behavior of mapping function and its derivatives; Schwarz-Christoffel formula, elliptic modular function. Mapping of multiply connected regions onto canonical regions. Some variational problems in the complex domain, kernel functions. Applications to potential theory and aerodynamics. Numerical methods.

8-735/8-736/8-737. RIEMANN SURFACES. (3 cr per qtr; prereq 8-702 or ‡)
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.

8-740/8-741/8-742. THEORY OF QUASICONFORMAL MAPPING. (3 cr per qtr; prereq 8-702)
Extremal length. Conformal moduli. Standard extremal domains. Distortion theorems. Convergence theorems. Extension of mappings. Analytic definition. Hilbert transform. Beltrami equation.

8-780/8-781/8-782. TOPICS IN SEVERAL COMPLEX VARIABLES. (3 cr per qtr; prereq ‡)

8-790/8-791/8-792. TOPICS IN THE THEORY OF ANALYTIC FUNCTIONS. (3 cr per qtr; prereq 8-702 or ‡)

8-800/8-801/8-802. FUNCTIONAL ANALYSIS. (3 cr per qtr; prereq 8-602 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.

8-810/8-811/8-812. TOPOLOGICAL GROUPS. (3 cr per qtr; prereq 8-202, 8-332 or ‡)
Work as found in the books of Pontryagin, Weil, Montgomery-Zippin, Rudin, Hewitt.

8-830/8-831/8-832. BANACH ALGEBRAS AND HARMONIC ANALYSIS. (3 cr per qtr; prereq 8-202, 8-602 or ‡)
Material from the books of Loomis, Nainmark, Rudin, Hewitt.

8-845/8-846/8-847. GROUP REPRESENTATIONS. (3 cr per qtr; prereq 8-202, 8-832 or ‡)
Basic properties through the work of Gelfand, Mackey, etc.

8-874/8-875/8-876. NONLINEAR FUNCTIONAL ANALYSIS AND ITS APPLICATION. (3 cr per qtr; prereq 5-614 or 8-602 or 5-573 or ‡)
Unified treatment of nonlinear problems of mechanics (buckling of plates and shells, hydrodynamic instability, restricted three-body problem), mathematical economics, nonlinear programming, differential geometry, and partial differential equations. Necessary concepts from functional analysis (Lebesgue spaces, Holder spaces, Orlicz spaces, Sobolev spaces) and topology (degree of mapping, Morse theory, Ljusternik-Schnirelmann category) are introduced. Relations between solutions of nonlinear problems and their linearizations. Numerical solution methods.

8-880/8-881/8-882. TOPICS IN OPERATOR THEORY. (3 cr per qtr; prereq 8-702, 8-602 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.

8-990/8-991/8-992. READING AND RESEARCH. (Cr ar)

MECHANICAL ENGINEERING

Professor

Richard C. Jordan, *head*
Edward A. Fletcher, *director of graduate study*
John E. Anderson
Perry L. Blackshear
Ernst R. G. Eckert
Richard J. Goldstein
Warren E. Ibele
Benjamin Y. H. Liu
Clarence E. Lund
Gayle W. McElrath
Thomas E. Murphy
Katsuhiko Ogata
Emil Pfender
Ephraim M. Sparrow
James L. Threlkeld
Kenneth T. Whitby
John S. White

Associate Professor

Sant Ram Arora
Darrell A. Frohrib
Fulton Holtby
William A. Kleinhenz
Charles J. Scott

Assistant Professor

Richard J. Forstrom
Stanley C. Johnson
David B. Kittelson
Patrick J. Starr
Klaus Willeke

Prerequisites — For major work, adequate preparation is required in undergraduate subjects and in science fundamental to mechanical or industrial engineering, in addition to general admission requirements. For minor work, prerequisites to the courses to be pursued and departmental approval is required.

Language Requirement — No language is required for the M.S. degree. For the Ph.D. degree, a reading knowledge of one language pertinent to the area of graduate study is required.

Master's Degree – The M.S. degree is offered under both Plan A and Plan B with the major in mechanical engineering or industrial engineering. Work outside mechanical engineering is recommended for the minor under Plan A and for both of the related fields under Plan B.

In addition to the completion of 45 credits of course work, the Plan B candidate will be required to submit three written reports representing the quality but not the range of the Master's thesis. These papers are to be prepared as an additional part of the work required for three advanced courses, seminars, or independent work with the joint permission of the student's adviser and the instructor of the course.

Recognizing the increasing need for graduate education of engineers remote from the University campus, the faculty of the Department of Mechanical Engineering has established a Master's program of study to utilize closed circuit television to remote locations. This program is governed by specific policies and sets forth long-term course offerings which enable students and their advisers to plan a definite program of study similar to those of students in residence. Certain courses will be offered via closed circuit television to designated sites. Most of this work will be offered during daytime hours. Several other departments also offer courses via closed circuit television, including mathematics and electrical engineering. A brochure describing this program is available upon request from the departmental office.

Professional Master's Degree – The master of mechanical engineering degree involving a design emphasis program is also offered. The program involves both course work and a design project. See the section on general information outlining degree requirements.

Doctor's Degree – Work leading to the Ph.D. degree is offered.

Note – To receive graduate credit in a mechanical or industrial engineering major, courses must be selected from those listed under "Advanced Courses in Mechanical (or Industrial) Engineering."

Mechanical Engineering (ME)

Graduate Credit Courses for Nonmajors

5-190. ADVANCED ENGINEERING PROBLEMS. (2-4 cr; prereq approved dept permission form)
Special investigations in various fields of mechanical engineering and related areas including independent study project.

8-190. MECHANICAL ENGINEERING GRADUATE SEMINAR. (1 cr [addtl 1-3 cr by ar])
Lectures on mechanical engineering and related topics. Additional supervised work permissible by arrangement with seminar course coordinator.

Advanced Courses

DESIGN AND CONTROLS

5-203. ADVANCED ANALYSIS AND SYNTHESIS OF MECHANISM SYSTEMS. (3-4 cr [1 cr term paper option]; prereq 3-203, background in computer programming)
Kinematic and dynamic analysis of mechanism systems, gears, and cams. Synthesis of mechanism systems, function generation, coupler curves, and computerized design of mechanism systems.

5-205. CREATIVITY IN ENGINEERING DESIGN. (3-4 cr [1 cr term paper option]; prereq mechanical engineering program or equiv desirable)
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.

5-207. EXPERIMENTAL STRESS ANALYSIS. (4 cr; prereq AEM 3-016; 3 lab hrs per wk) Kleinhenz
Experimental application and theoretical evaluation of methods of stress analysis. Strain gages, surface coatings, photoelasticity techniques. Design of transducing systems utilizing strain.

5-209. FRICTION AND LUBRICATION. (3-4 cr [1 cr term paper option]; prereq CE 3-400 or equiv) Kleinhenz
Solid friction mechanism and boundary lubrication. Hydrodynamic and hydrostatic lubrication theory applied to bearing design. Introduction to gas bearings.

5-244. VIBRATION ENGINEERING. (4 cr; prereq 3-201 or equiv) Frohrib
Applications of theory of vibration to design and optimization of isolators, detuning mechanisms, viscoelastic suspensions and structures.

5-254. DESIGN MORPHOLOGY WITH APPLICATIONS. (4 cr; prereq 3rd yr basic engineering courses desirable; 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.

5-255. ENGINEERING DESIGN PROJECT. (4 cr [may be repeated for addtl cr]; prereq 5-254 or equiv desirable; 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.

5-283. INDUSTRIAL INSTRUMENTATION AND AUTOMATIC CONTROL. (4 cr; prereq 3-201 or equiv; 3 lab hrs per wk)
Theory and operation of instruments and automatic control. Industrial controls including fluidic controls. On-off, proportional, floating and rate response in control systems.

5-284. CONTROL SYSTEMS. (4 cr; prereq 3-201 or equiv)
Basic theory of linear feedback control systems. Transfer function representation of solid body, fluid, pneumatic, and electromechanical components. On-off, proportional, floating and rate response in control systems, including industrial instrumentation.

8-210.* ADVANCED VIBRATION ENGINEERING. (3 cr; prereq 5-244)
Advanced dynamics of vibration; vibration in mechanical, electrical, and equivalent systems.

8-211/8-212/8-213.* ADVANCED APPLIED DYNAMICS. (3 cr per qtr; prereq 5-244)
Application of principles of dynamics to selected mechanical engineering problems.

8-243.* PHOTOELASTICITY. (3 cr; prereq 5-207)
Stress by photoelasticity. Stress patterns. Frozen stresses. Solution of individual problems.

8-280/8-281/8-282.* FEEDBACK CONTROL SYSTEMS. (3 cr per qtr; prereq 5-284, Math 5-572 or ¶Math 5-572)
Basic considerations of feedback control system design. Root locus method and synthesis of linear feedback control systems in S plane. Describing function analysis and phase plane analysis of nonlinear feedback control systems. Statistical design principles and optimal control systems.

PRODUCTION ENGINEERING

5-260. ENGINEERING MATERIALS AND PROCESSING. (4 cr; prereq Phys 1-291, Chem 1-014, 1st yr calculus)
Introduction to materials and processing including physical and metallurgical properties, consolidation, etc. Material processing including machining, welding and deformation processes.

5-262. MATERIAL WORKING AND FABRICATION PROCESSES. (4 cr; prereq 5-260 or equiv)
Theory and application of joining techniques, welding, brazing, and adhesive bonding. Metal forming operations, rolling, swaging, drawing, etc. Inspection and test methods to control and evaluate fabrication processes including X-ray, magnetic, metallographic and chemical methods.

5-264. MATERIAL CONSOLIDATION PROCESSES. (4 cr; prereq 5-260 or equiv)
Theory and practice of material consolidation including casting and powder metal processes. Composite materials techniques.

5-266. MATERIAL FINISHING PROCESSES. (4 cr; prereq 5-260 or equiv)
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.

5-268. PROPERTIES AND FABRICATION OF PLASTICS. (4 cr; prereq 5-260 or equiv)
Materials, equipment, and processes for fabrication of plastics. Principles of products and tool design. Hydraulic and temperature circuit control for equipment.

5-270. MATERIALS — DESIGN REQUIREMENTS. (4 cr; prereq 5-260 or equiv)
Fundamental properties of engineering materials including fabrication, treating, physical and corrosion properties. Failure mechanism, cost and value analysis as related to material selection and specification.

THERMODYNAMICS AND HEAT TRANSFER

5-342. HEAT TRANSFER. (4 cr; prereq Math 3-221 or equiv, CE 3-400 or equiv)
Steady and unsteady conduction of heat. Convection heat transfer in boundary layer and duct flows; forced and free convection; condensation and boiling; heat exchanges. Heat transfer by thermal radiation; radiative properties of black bodies and real surfaces.

5-344. THERMODYNAMICS OF FLUID FLOW. (4 cr; prereq CE 3-400, ME 3-301 or equiv)
Compressible flow of gases in engineering systems such as nozzles, ducts, combustion chambers, ramjets, pipe lines, etc. Isentropic flow in variable area passages. Shock waves. Flow with wall friction, heat transfer, and mass transfer.

8-310.* ADVANCED THERMODYNAMICS. (3 cr; prereq 3-303) Ibele
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.

8-311.* STATISTICAL AND NONEQUILIBRIUM THERMODYNAMICS. (3 cr; prereq 8-310) Ibele
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.

8-326. BOILING HEAT TRANSFER AND MULTIPHASE FLOW. (3 cr; prereq 5-342 or ‡)
Phenomena pertaining to boiling heat transfer and multiphase flow; supersaturation, nucleation, bubble dynamics, interfacial phenomena, boiling crisis, film boiling; flow patterns in two-component two-phase flows, two-phase critical and supercritical flows.

8-330.* CONDUCTION. (3 cr; prereq 5-344) Eckert
Steady and unsteady heat conduction with and without heat sources or change of state, relaxation method, analogue, the regenerator.

8-331.* CONVECTION. (3 cr; prereq 8-330) Eckert
Heat transfer in laminar and turbulent boundary layer and channel flow, dimensional analysis. Free convection. Condensation and evaporation. Convective mass transfer.

8-332.* RADIATION. (3 cr; prereq 8-331) Eckert
Heat radiation of black bodies, or electrical conductors and nonconductors, or gases and flames. Heat exchange by radiation. Configuration and interchange factors.

8-333.* ADVANCED THEORY OF HEAT TRANSFER. (3 cr; prereq 5-342)
Analytical treatment of problems of convection and radiation. Boundary layer and pipe flow solutions and associated mathematical techniques. Radiation problems, including integral equation formulation, and their solution.

8-350.* ADVANCED FLUID THERMODYNAMICS. (3 cr; prereq 5-344, 8-310 or ‡) Ibele
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.

8-360. THERMODYNAMICS OF HIGH TEMPERATURE GASES. (3 cr; prereq 5-342)
Kinetic theory, energy exchange processes, composition and properties of thermal plasmas, introduction to irreversible thermodynamics for two- and three-component gases.

8-361. THERMODYNAMICS OF HIGH TEMPERATURE GASES. (3 cr; prereq 8-360 or ‡)
Generation of thermal plasmas, diagnostic methods with emphasis on plasma spectroscopy, electrode phenomena in arcs and plasma heat transfer.

8-362. THERMODYNAMICS OF HIGH TEMPERATURE GASES. (3 cr; prereq 8-361 or ‡)
Applications of high temperature plasmas for gas heating, welding, spraying, cutting, reentry simulation and ablation, propulsion, MHD conversion, thermonuclear fusion.

8-370/8-371/8-372.* MAGNETOHYDRODYNAMICS. (3 cr per qtr; prereq 5-340 or AEM 5-202, Math 5-403 or ‡) J Anderson
Basic equations of magnetohydrodynamics. Fundamental properties of magnetohydrodynamic flows. Magnetohydrodynamic models and their extensions. Applications: magnetohydrodynamics power, generation, propulsion.

POWER AND PROPULSION

5-442.* VAPOR CYCLE POWER SYSTEMS. (3-5 cr; prereq 3-303 or equiv)
Vapor cycle analysis, regeneration, reheat, compound cycle modifications, combined gas turbine-vapor cycle systems, binary systems. Combustion problems; unusual energy sources, solar, nuclear for space power systems.

5-443.* TURBOMACHINERY. (3-5 cr; prereq 3-301 or equiv)
Theoretical analysis of energy transfer between fluid and rotor, principles of axial, mixed, and radial flow compressors and turbines. Applications to gas turbines, fluid transmissions and power plants.

5-446x. AN INTRODUCTION TO COMBUSTION AND PROPULSION. (4 cr; prereq 5-342 or equiv)
Flame propagation, quenching and ignition in a gaseous mixture; combustion of solid and liquid particles, and gaseous jets. Applications to selected propulsion systems.

5-455. ROCKET PROPULSION. (3-5 cr [1-2 cr term paper option]; prereq applied thermodynamics [3-303 or equiv]; 3 hr lect per wk)
Mode of operation and performance limitations of chemical rockets with liquid, solid and free radical propellants, nuclear and solar rockets with termal and electromagnetic propellant acceleration.

5-460. INTERNAL COMBUSTION ENGINES. (4 cr; prereq 3-301 or equiv)
Principles of power production, fuel consumption, and emission of gasoline and diesel engines; fuel-air cycle analysis, combustion flames, knock phenomena, air flow and volumetric efficiency, mixture requirements, ignition requirements and performance.

5-461. ADVANCED INTERNAL COMBUSTION ENGINES. (3-5 cr [1-2 cr term paper option]; prereq 5-460 or equiv)
Hydrocarbon fields, octane and cetane ratings, additives and deposits; lubrication systems, lubricants, additives for control of friction; air and liquid coolings; engine design problems.

5-462. GAS TURBINES. (4 cr; prereq 3-301 or equiv)
Gas turbine cycles, regeneration, reheat, and intercooling. Axial and radical flow compressors and turbines; burner types and combustion efficiency; emissions and noise. Matching of compressor and turbine. Turbo-jet, fan-jet, and turbo-prop engine performance.

8-442.* ADVANCED POWER PLANTS. (3 cr; prereq 5-442 or equiv)
Thermodynamic and economic evaluation, planning, and management of modern and anticipated future power plants and components.

8-443. THERMOCHEMICAL ANALYSIS OF POWER SYSTEMS. (3 cr; prereq 3-303 or equiv)
Practical problems involving use of thermochemistry and chemical thermodynamics. Flame composition and temperature calculations. Exhaust gas properties. Vapor pressures and solubilities. Chemical potential and electrode potentials, fuel cells, and batteries.

8-444/8-445.* THERMODYNAMICS AND CHEMICAL KINETICS OF COMBUSTION. (3 cr; prereq 5-446 or ¶5-446)
The nature of combustion problems. Ignition, propagation, quenching, and burning limits, thermochemistry and use of the partition function in calculating thermodynamic properties, free energy, equilibrium constants. Chemical kinetics and the steady state approximation applied to combustion phenomena.

8-446.* ENERGY TRANSPORT IN CHEMICALLY REACTING GASES. (3 cr; prereq 5-446)
Thermodynamics, kinetics, and transport processes in chemically reacting gases; energy fluxes in chemically reacting systems with and without equilibrium; surface phenomena; a review of equations of motion for chemically reacting systems, and energy transport in chemically reacting flowing streams.

8-447.* MASS TRANSFER IN CHEMICALLY REACTING GASES. (3 cr; prereq 5-446)
Review of equations of change; mass transfer in binary mixtures; mass transfer in chemically reacting mixtures; the boundary conditions for vaporization and sublimation; boundary conditions for surface pyrolysis; integral solutions for mass transfer in chemically reacting boundary layers; jet mixing in inert and in chemically reacting gases.

8-448.* ATOMIZATION, VAPORIZATION AND MIXING. (3 cr; prereq 3-303) Blackshear
Survey of current theories on instability of fluid spheres, filaments and sheets, and review of current atomization techniques. These are employed with pertinent transport and vaporization relationships in computing fuel oxidant distributions in some combustor designs.

8-450.* DYNAMICS OF HIGH SPEED ENGINES. (3 cr; prereq 3-205, 5-460) Murphy
Inertia forces; balancing high-speed engines; engine torque analysis; torsional vibration, etc. Conferences, assigned readings, and problems.

8-453.* ADVANCED GAS TURBINES AND JET PROPULSION. (3 cr; prereq 5-462) Murphy
Gas turbines and ramjets for aircraft; performance, control, nozzles, azial and centrifugal compressors, and turbines; cooling, lubrication, and construction.

8-455.* ADVANCED ROCKET PROPULSION. (3 cr; prereq 5-455) Fletcher
Analysis and performance characteristics of chemical, nuclear, solar, and ion rocket motors.

ENVIRONMENTAL ENGINEERING

5-603. THERMAL ENVIRONMENTAL ENGINEERING. (4 cr; prereq 3-303, 5-342 or equiv)
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.

5-605. REFRIGERATION. (4 cr; prereq 3-303)
Mechanical vapor compression system; adsorption systems; thermoelectric cooling; gaseous air cycle; steam-jet refrigeration. Liquefaction of air, hydrogen, and helium; production of oxygen and nitrogen by separation of air.

5-607. INDUSTRIAL VENTILATION AND CONTAMINANT CONTROL. (4 cr; prereq CE 3-400, ME 3-303 or equiv)
Contaminants, dispersion mechanisms, transport, fans, foods, gas cleaners, behavior of jets and sinks, closed and open systems, applications to industrial processing and emission control.

5-612. ENVIRONMENTAL ENGINEERING. (4 cr)
Basic principles of engineering assessment and control of emissions to air and water, noise measurement and control, handling and disposal of solid waste.

5-613. PRINCIPLES OF PARTICLE TECHNOLOGY. (4 cr; prereq 3-303 desirable)
Definition, theory, and measurement of particle properties, particle statistics, fluid dynamics, optical, electrical and thermal behavior of particles.

5-614. PRINCIPLES OF PARTICLE TECHNOLOGY. (4 cr; prereq 5-613)
Gas cleaning, particle transport, comminution, classification, surface properties, packed beds, powder behavior and miscellaneous topics.

8-600/8-601.* PSYCHROMETRICS AND AIR CONDITIONING. (3 cr; prereq 5-603 or ‡)
Moist air properties, psychrometry and humidity measurement, processing of moist air; thermal loads for structures; air distribution; noise control; selected environmental and air conditioning topics.

8-603. THEORETICAL REFRIGERATION. (3 cr; prereq 5-605) Jordan
Problems in theory and design of refrigeration systems. Lectures, assigned reading, and reports.

GENERAL

5-194. GRAPHICS IN ENGINEERING PROBLEMS. (2-4 cr; prereq 1-025 or equiv recommended; hrs ar)
A synthesis and extension of procedures of graphical mathematics, nomography, and descriptive geometry in solutions of complex problems within the individual student's area of interest pursued as an individual project and usually resulting in a comprehensive report.

8-485/8-486/8-487. BIOMEDICAL-ENGINEERING SEMINAR. (1-3 cr per qtr) Bernstein, Blackshear, and Institute of Technology and Medical School faculties
(Same as Surg 8-204/8-205/8-206) 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.

8-770/8-771/8-772. MECHANICAL ENGINEERING RESEARCH. (Cr ar; prereq △)

8-773, 8-774, 8-775. GRADUATE SEMINAR. (No cr for 8-773, 1 cr for 8-774 and 8-775)
Colloquium for graduate students and staff. Reports and discussion by members on assigned research or problems. Recommended for graduate students and junior staff members.

Industrial Engineering (IEOR)

Students who have received a Bachelor's degree in any engineering area may be admitted to graduate study majoring in industrial engineering provided they meet the entrance requirements of the Graduate School. Both the Ph.D. and master of science degrees are offered. Candidates will be expected to complete, either as undergraduates or as graduate students, adequate preparation in undergraduate subjects and in the sciences fundamental to industrial engineering. The M.S. degree in industrial engineering is offered under both Plan A and Plan B.

Related courses in mechanical engineering, business administration, psychology, and public health are recommended in conjunction with industrial engineering.

Students contemplating graduate study in this field should consult the chairman of the industrial engineering division, regarding their individual programs and requirements.

Graduate Credit Courses for Nonmajors

The following courses may be taken for graduate credit by students not majoring in industrial engineering upon the approval of the student's adviser and the mechanical engineering graduate committee.

5-000. INTRODUCTION TO INDUSTRIAL ENGINEERING ANALYSIS. (4 cr; prereq calculus...background in probability and statistics recommended)
Scientific management, mathematical models, methods engineering, work measurement, worker satisfaction and participation, wage payment plans, breakeven analysis, incremental costs, time value of money and present value concept; cost quality and inventory control; production scheduling, plant locations and layouts; linear programming, PERT, systems approach to management problems.

5-010. INTRODUCTION TO WORK ANALYSIS. (4 cr; prereq 5-000)
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.

5-020. ENGINEERING COST ACCOUNTING, ANALYSIS, AND CONTROL. (4 cr; prereq ME 3-900...or 5-000 recommended)
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.

5-030. QUALITY CONTROL AND RELIABILITY. (4 cr; prereq Math 1-231, ME 3-900...5-000 recommended) White
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.

5-040. INTRODUCTION TO OPERATIONS RESEARCH. (4 cr; prereq Math 1-231...5-000 recommended) Starr
Linear programming, algebra and geometry of linear models, simplex method, sensitivity testing, duality, network models, network algorithms, and dynamic models.

5-180, 5-181. APPLIED INDUSTRIAL ENGINEERING. (3-4 cr [1-2 cr term paper option]; prereq background in basic industrial engineering [5-000, 5-010, 5-020, 5-030, 5-040 recommended]; 3 lect)
Industrial engineering surveys and programs, case problems, studies in local plants.

Advanced Courses in Industrial Engineering

5-221.° INDUSTRIAL PLANTS. (3-5 cr; prereq 5-010)
Layout of production and service facilities in manufacturing operations, analysis of materials flow, development of materials handling systems, and industrial packaging techniques.

5-311.* MANAGEMENT FOR ENGINEERS. (3-5 cr [1-2 cr term paper option]; prereq 5-000)
Historical development of management concepts. Organizational systems and authority relationships. Planning, communication, and management responsibility.

5-321.* INDUSTRIAL SAFETY. (3-5 cr [1-2 cr term paper option]; prereq 5-000)
Definition and philosophy of safety, safety training, safety requirements for production processes, equipment and plants, industry standards, safety devices, and product safety.

5-351.* ANALYSIS OF PRODUCTION PROCESSES. (3-5 cr [1-2 cr term paper option]; prereq background in all basic industrial engineering areas, 5-020)
Case course of problems in production engineering and production management. Analysis of production problems from selected industries. Development of student's ability to recognize and diagnose industrial problems.

5-361.* INVENTORY AND PRODUCTION CONTROL. (4 cr; prereq ME 3-900, 5-000, 5-040) Arora
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.

5-441.* OPERATIONS RESEARCH II. (4 cr; prereq Math 1-231, ME 3-900, 5-040) Starr
Dynamic programming, integer programming, non-linear and probabilistic models.

5-442.* OPERATIONS RESEARCH III. (4 cr; prereq 5-441) Starr
Optimization in probability models, Markov chains, queuing theory, and simulation.

5-445.* TOPICS IN MANAGEMENT SCIENCE. (3-5 cr [1-2 cr term paper option]; prereq 5-010, 5-020, 5-030, 5-040 desirable)
Specialized topics in management science. Analytical tools for decision-making and management of the production function. Emphasis on topics appearing in current literature. Topical coverage changes from quarter to quarter.

5-531.* INDUSTRIAL SAMPLING TECHNIQUES. (4 cr; prereq ME 3-900, 5-030) White
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.

5-550.* DESIGN AND ANALYSIS OF EXPERIMENTS I. (4 cr; prereq ME 3-099 or Stat 3-092 or Stat 5-121 or Stat 5-131 or equiv) White
One-factor experiments, analysis of variance, estimation and comparison of effect, orthogonal contrasts, fixed, random, and mixed models, incomplete block designs.

5-551.* DESIGN AND ANALYSIS OF EXPERIMENTS II. (4 cr; prereq 5-550, ME 3-000) White
Two or more factor experiments, designs involving crossed, nested, and mixed classifications; orthogonal polynomials, block confounding, fractional, factorial designs, computer programs for analysis.

8-110/8-111/8-112.* ADVANCED INDUSTRIAL ENGINEERING. (3 cr per qtr; prereq ‡)
Manufacturing policy, production engineering, plant operation, engineering economy, and industrial development.

8-310/8-311/8-312.* PRODUCTION ENGINEERING PROBLEMS. (3-5 cr per qtr; prereq ‡)
Application of industrial engineering principles to solution of manufacturing problems in local plants.

8-410/8-411/8-412.* 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.

8-420. LINEAR PROGRAMMING. (3 cr; prereq 5-040 or ‡; 3 lect hrs per wk)
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.

8-430.* NON-LINEAR PROGRAMMING. (3 cr; prereq 5-040 or ‡) Arora
Theory of convex sets and functions, Kuhn-Tucker theorems, duality theorems, quadratic programming, complementary pivot theory, pivotal methods of non-linear programming; feasible direction, gradient and penalty methods of search.

8-440.* DYNAMIC PROGRAMMING. (3 cr; prereq 5-505 or ‡) Arora
Functional equations and principle of optimality, theory of dynamic programming, computational aspects of dynamic programming, discrete deterministic problems with non-sequential and sequential optimization, discrete problems with random future, discrete dynamic problems in finite Markov chains.

8-450.* QUEUING THEORY. (3 cr; prereq 5-442 or ‡) Arora
Discrete and continuous time Markov chains, stationary stochastic processes, Markovian queues, renewal processes, scheduling problems.

8-460.* STOCHASTIC PROGRAMMING. (3 cr; prereq 8-420, 8-430 or ‡) Arora
Markov decisions, chance constrained linear and non-linear programming maximum principle-discrete and continuous version. Application of stochastic programming to design of production systems and distribution networks, traffic controls; budgeting and investments.

8-470.* ADVANCED INVENTORY AND PRODUCTION CONTROL. (3 cr; prereq 5-361 or ‡) Arora
Design of production facilities, inventory policies for single and multiple items, multi-echelon inventory systems, scheduling problems, role and design of information systems in production.

MEDICAL TECHNOLOGY (MedT)

Professor
Ellis S. Benson, M.D., *head*
Ruth F. Hovde, M.S., *director of graduate study*
Richard P. Doe, M.D.
Esther F. Freier, M.S.
Verna L. Rausch, M.S.
Andreas Rosenberg, Ph.D.
R. Dorothy Sundberg, MD., Ph.D.
Edmond J. Yunis, M.D.
Jorge J. Yunis, M.D.

Associate Professor
Miguel M. Azar, M.D., Ph.D.
Donna Blazevic, M.P.H.
Robert A. Bridges, M.D.
David M. Brown, M.D.
Richard D. Brunning, M.D.
Agustin P. Dalamasso, M.D.
Mary E. Dempsey, Ph.D.
Grace M. Ederer, M.S.
J. Roger Edson, M.D.
Ben Hallaway, M.S.
Paul H. Lober, M.D.
John M. Matsen, M.D.
Lorraine G. Stewart, M.S.
Osias Stutman, M.D.

Assistant Professor
Philip Blume, M.D.
Gloria M. Bradley, M.D.
Herbert F. Polesky, M.D.
Walid Yasmineh, Ph.D.

Graduate work in the field of medical technology is available for qualified candidates who wish to prepare themselves for a career of teaching and investigation in the area of clinical laboratory. Regardless of ultimate aim, all students spend a period of time in the clinical laboratories to familiarize themselves with the aspects of methodology, teaching, and research. All students are required to carry out a problem of independent research in one of the subareas of this field under the direction of their major adviser.

Prerequisites – For a major in medical technology certification as MT(ASCP) or eligibility for such certification is required in addition to a Bachelor's degree from an acceptable institution with sufficient prerequisite work and scholarly attainment in chemistry and biological sciences to justify graduate work in these areas. Previous experience in a clinical laboratory is desirable. For a minor in medical technology, certification as MT(ASCP) is not required.

Minor — It is suggested that students who major in medical technology present a minor in one of the following fields: anatomy (hematology or cytology), biochemistry, microbiology, or pathology.

Master's Degree – Offered under Plan A; in special cases Plan B may be followed by petition to the graduate faculty.

Minor in Medical Technology – Work for a minor is offered to students in allied sciences. Choice of particular courses to be presented in fulfillment of requirements will be made after consultation with the student's adviser.

5-100w. BASIC ELECTRONICS OF LABORATORY INSTRUMENTS. (2 cr)
A review of basic laws of electrical circuits; detection instruments, power sources, amplifiers, and recorders.

5-105. INTRODUCTION TO BIOLOGIC ELECTRON MICROSCOPY. (2 cr)
Electron optics, preparative technique for electron microscopy, recording and interpretation of micrographs.

5-106. BASIC TECHNIQUES FOR ELECTRON MICROSCOPY. (2 cr)
Demonstration and experience in preparing biological material for electron microscopy including microscope maintenance and operation.

5-110, 5-111.* ADVANCED CLINICAL LABORATORY TECHNIQUES. (5 cr per qtr) Staff
Assignment on individual basis for observation, study, and practice in special problems; techniques and methodology in units of clinical laboratories (microbiology, chemistry, hematology, histology, or immunology).

5-120. SEMINAR: MEDICAL TECHNOLOGY. (1 cr) Hovde
Review and discussion of current literature; presentation and discussion of research being carried on in the department.

5-125. PRACTICUM TEACHING. (Cr ar [3 cr max]; prereq △)
Supervised experience in teaching; development of skills in effective use of instructional materials, tests and measurements.

5-130, 5-131.* ELEMENTS OF ADMINISTRATION IN MEDICAL TECHNOLOGY. (2 cr per qtr)
Organization and role of the laboratory service in hospitals; job analysis and classification; personnel assignments and evaluation; plant, supplies, and equipment with assignment of specific problems in management.

5-138x. SELECTED TOPICS IN MICROBIOLOGY. (Cr ar; may be taken 1 or more qtrs) Blazevic, Ederer, Matsen
Advanced seminar; topics assigned for conferences and reading.

5-140, 5-141.* EDUCATIONAL ADMINISTRATION IN MEDICAL TECHNOLOGY. (3 cr per qtr) Rausch
Development, organization, and administration of educational programs in medical technology. 5-140: Lectures. 5-141: Clinical practice in technique; analysis and construction of courses of study.

5-145. DEVELOPMENT OF MEDICAL TECHNOLOGY. (3 cr) Hovde
Current problems.

5-154. SELECTED TOPICS IN ADVANCED TECHNIQUES AND THEORY OF ELECTRON MICROSCOPY. (Cr ar)
Discussion of new techniques and theory of electron microscopy.

5-173. ANALYTICAL TECHNIQUES IN LABORATORY MEDICINE. (2 cr) Benson, Rosenberg

5-179. SELECTED TOPICS IN CHEMISTRY. (Cr ar; may be taken 1 or more qtrs) Benson, Freier

5-268. TECHNIQUES IN IMMUNOCHEMISTRY. (1 cr; prereq MdBc 5-301 or ‡)
Anitigen-antibody reaction applied to quantitative and qualitative analysis of specific patterns of clinical significance. Preparation of antigens and of antisera. Nature of antigen-antibody complexes. Applications of preceptin, neutralization, radioimmune, double antibody and hemolysin techniques.

5-269. TECHNIQUES IN IMMUNOCHEMISTRY. (1 cr; prereq MdBc 5-300, 5-301, ‡)
Laboratory.

5-272. SELECTED TOPICS IN IMMUNOLOGY. (Cr ar; may be taken 1 or more qtrs) E Yunis
Advanced seminar; topics assigned for conferences and reading.

5-274. MOLECULAR ASPECTS OF IMMUNOLOGY. (3 cr; prereq ‡) Dalmasso
Same as LMed 5-274.

MEDICINAL CHEMISTRY (MedC)

Professor

Taito O. Soine, Ph.D., *head, director of graduate study*
Frank E. DiGangi, Ph.D.
Ole Gisvold, Ph.D.
Philip S. Portoghese, Ph.D.

Associate Professor

Herbert T. Nagasawa, Ph.D.
Robert Vince, Ph.D.

Assistant Professor

M. Abdel-Monem, Ph.D.
Patrick E. Hanna, Ph.D.

Medicinal chemistry involves the applications of the principles and processes of the various areas of chemical science to organic and inorganic medicinal agents. It deals with the synthesis of compounds in accordance with molecular and structure-biological activity concepts or as congeners of medicinal agents that are often of natural origin. It also is concerned with the phytochemistry of natural products used for medicinal purposes.

Prerequisites – Graduate work leading to the M.S. and Ph.D. degrees with a major in medicinal chemistry is open to students who have shown exceptional scholarship and ability in undergraduate courses of this or some other college of pharmacy of equal standing. Consideration will be given to applications of students who are not graduates in pharmacy but whose pattern of undergraduate work includes training in such allied or related subjects as would qualify them to do graduate work successfully with a major in medicinal chemistry.

Language Requirement — For the Master's degree, no foreign language is required. For the Ph.D. degree, one foreign language (German would be routinely acceptable, but other languages pertinent to the field of study will be considered by the staff on petition).

Master's Degree — In general, offered under Plan A. Plan B may be followed by petition.

Doctor's Degree — Graduate work leading to the Ph.D. degree is offered to students prepared for advanced work in medicinal chemistry.

5-470/5-480/5-490. ORGANIC MEDICINAL AGENTS. (3 cr for 5-470, 4 cr each for 5-480, 5-490; prereq Chem 3-303, MedC 5-440) Soine and staff
Sources, production, properties, reactions, structure-activity relationships and uses of natural and synthetic organic compounds.

5-494. INSTRUMENTATION IN MEDICINAL CHEMISTRY. (3 cr; prereq Chem 3-303 or ‡) Abdel-Monem
Modern approaches to drug analysis.

5-496. MODERN CONCEPTS IN MEDICINAL CHEMISTRY. (3 cr; prereq 5-494) Staff
Basic principles and concepts in the design of medicinal agents, drug transport, molecular concepts of drug action, chemotherapeutic agents, and analysis of drug receptor interactions.

5-499. SPECIAL PROBLEMS IN MEDICINAL CHEMISTRY. (Cr ar; prereq ‡) Staff
Analysis, synthesis, and phytochemistry of medicinal agents.

8-100.* SEMINAR: MEDICINAL AND NATURAL PRODUCT CHEMISTRY. (Cr ar; required of all majors in medicinal chemistry) Nagasawa

8-200. SELECTED TOPICS. (Cr ar) Hanna

8-300. ADVANCED MEDICINAL CHEMISTRY. (3 cr; prereq 5-490, Chem 3-303 or ‡; offered 1973-74 and alt yrs) Portoghese
General principles of drug design and molecular bases of biological responses to applied agents.

8-400. ADVANCED MEDICINAL CHEMISTRY. (3 cr; prereq 8-300 or ‡; offered 1973-74 and alt yrs) Soine
Correlations of molecular structure and biological activity with principal reference to autonomic nervous system.

8-500. ADVANCED MEDICINAL CHEMISTRY. (3 cr; prereq 8-400; offered 1973-74 and alt yrs) Vince
Modern methods in design and evaluation of chemotherapeutic agents including enzyme inhibitors and metabolic blockers.

8-800. MEDICINAL CHEMISTRY LABORATORY TECHNIQUES. (Cr ar; prereq Chem 3-303 or ‡) Staff

8-900. RESEARCH IN MEDICINAL CHEMISTRY. (Cr ar; prereq Chem 3-303 or ‡) Staff
Study and experimental investigation of topics in the area of natural products and synthetic organic medicinal agents.

MEDICINE (Med)

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

MICROBIOLOGY (MicB)

Professor

Dennis W. Watson, Ph.D., *head*
Peter G. W. Plagemann, Ph.D., *director of graduate study*
Robert W. Bernlohr, Ph.D.
Gerhard K. Brand, M.D.
Martin Dworkin, Ph.D.
V. William Greene, Ph.D.
Wendell H. Hall, M.D., Ph.D.
Howard M. Jenkin, Ph.D.
Robert K. Lindorfer, Ph.D.
Charles F. McKhann, M.D.
Palmer Rogers, Ph.D.
Edwin L. Schmidt, Ph.D.
Henry M. Tsuchiya, Ph.D.
Lewis W. Wannamaker, M.D.
Horace Zinneman, M.D.

Associate Professor

Dwight L. Anderson, Ph.D.
Peter J. Chapman, Ph.D.
Russell C. Johnson, Ph.D.
Yoon Berm Kim, M.D., Ph.D.
Gerald M. Needham, Ph.D.
James T. Prince, M.S.

Assistant Professor

Arthur Y. Elliott, Ph.D.
Beulah H. Gray, Ph.D.
William Liljemark
Edward Savard, Ph.D.
Lea Sekely, Ph.D.
James F. Zissler, Ph.D.

Lecturer

Henry Bauer, Ph.D.
Donna J. Blazevic, M.P.H.
Grace M. Ederer, M.S.
Alan B. Hooper, Ph.D.
Alfred G. Karlson, D.V.M., Ph.D.
John M. Matsen, M.D.
Richard Simmons, M.D.

Language Requirement – For the Master's degree, none. For the Ph. D. degree, either (a) a collateral field of knowledge as outlined by the graduate faculty in microbiology or (b) a high level of proficiency in one foreign language.

Master's Degree – Offered under Plan A.

Doctor's Degree – Work leading to the Ph.D. degree is offered.

Note – Graduate study in microbiology is also offered at the Mayo Graduate School of Medicine of the University of Minnesota. See the bulletin, *Graduate Programs in the Health Sciences.*

5-105f,w,su. BIOLOGY OF MICROORGANISMS.** (4 cr, §3-103, §Biol 3-013; prereq 5 cr in biological sciences, Chem 3-302, or ‡) Dworkin, Chapman
Lectures, demonstrations, and laboratory exercises in taxonomy, anatomy, physiology, biochemistry, and ecology of microbes. Some emphasis on molecular structure in relation to bacterial function.

5-201f. MICROBIOLOGY FOR DENTAL STUDENTS.** (6 cr) Anderson and staff
Nature and diversity of microorganisms; microbial structure and function; metabolism and growth; genetics and virology; principles of sterilization and disinfection; chemotherapy; host-parasite relationships; fundamentals of immunology; pathogenic bacteria, fungi, and viruses; ecology of oral microorganisms; microbiology of dental caries and periodontal diseases.

5-205s. MICROBIOLOGY FOR MEDICAL STUDENTS.** (6 cr; prereq regis med fr or grad) Brand and staff
Immunology, parasitology, mycology, and medical bacteriolog, virology with emphasis on pathogenesis. Principles and techniques enabling diagnosis, treatment (especially chemotherapy), and prevention of infectious disease.

5-206suI. MICROBIOLOGY FOR MEDICAL STUDENTS.** (4 cr)
Continuation of 5-205. Lecture and lab.

** Microscope required. Students may obtain use of microscope by purchasing $3 microscope cards from the bursar.

5-216w. IMMUNOLOGY. (4 cr; prereq 3-103 or 5-105 or Biol 3-013) 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 lab.

5-232s. MEDICAL MICROBIOLOGY.** (4 cr; for other than med students; prereq 5-216) Savard
Pathogenic bacteria, fungi, and viruses, especially in their relationship to disease; principles of infection, pathogenesis, and immunity; emphasis on microbiological techniques for laboratory diagnosis.

5-233f. MICROORGANISMS AND DISEASE.** (7 cr; not open to microbiology majors; prereq 10 cr in chemistry and 5 cr in biological sciences or ‡) Johnson
Lectures, demonstrations, and laboratory instruction in nature of microorganisms, immunology, medical bacteriology, virology, mycology, parasitology, and principles of disease control.

5-321w. PHYSIOLOGY OF BACTERIA. (3 cr; prereq 3-103 or 5-105 or Biol 3-013...10 cr in organic chemistry or biochemistry...3 cr in 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.

5-322w. PHYSIOLOGY OF BACTERIA LABORATORY. (2 cr; prereq 5-321 or ¶5-321 and a lab course in basic bacteriology) Staff
Techniques employed in the study of bacterial physiology and metabolism.

5-424s. BIOLOGY OF VIRUSES. (4 cr; prereq 5-321 or Biol 3-021) 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. Lectures and laboratory.

5-612s. ECOLOGY OF SOIL MICROORGANISMS. (4 cr; prereq 3-103 or 5-105, or Biol 3-013, ‡; offered 1972-73 and alt yrs) Schmidt
(Same as Soil 5-612) Soil as a microhabitat; nature of microbial population of soil; interactions among microorganisms in soil ecosystem; significant activities of soil microorganisms.

5-970f,w,s. SPECIAL PROBLEMS. (Cr ar; prereq ‡)

8-110f. BIOLOGY OF MICROORGANISMS. (3 cr; prereq organic chemistry, general biology, or ‡) Dworkin
First course in coordinated series of core courses designed to satisfy major and minor requirements in microbiology. Lectures dealing with history, structure and function, ecology, classification, and physiology of bacteria.

8-112s. MICROBIAL GENETICS. (2 cr; prereq ‡) Zissler
Genetics of microorganisms: mutation, recombination, control of phage and animal viruses.

8-120w. MICROBIOLOGY LABORATORY. (3 cr; prereq 8-110 or ‡) Dworkin
General microbiology and ecology with selected experiments in physiology, virology, and genetics.

8-122suI. ADVANCED MICROBIOLOGY. (3 cr; prereq 5-321, 8-112 or ‡) Rogers
Experimentation in physiology, genetics, and virology.

8-218f. IMMUNOCHEMISTRY AND IMMUNOBIOLOGY. (3 cr; prereq 5-216 or 5-205 or equiv, grad student in microbiology, others by ‡) Kim
Lectures, assigned reading, and discussion on immunochemistry and synthesis of immunoglobulins; antibody synthesis *in vitro;* regulation of immune response and cellular differentiation of immunocompetent systems. Demonstrations of advanced immunochemical and immunobiological techniques.

8-234. ADVANCED MEDICAL MICROBIOLOGY. (2 cr; prereq ‡; offered when feasible) Brand

---

** Microscope required. Students may obtain use of microscope by purchasing $3 microscope cards from the bursar.

8-237suI,II. METHODS IN CLINICAL MICROBIOLOGY—PART I, DIAGNOSTIC BACTERIOLOGY AND SEROLOGY. (6 cr; prereq ‡) Savard
Lectures and laboratory in techniques of staining bacteria and clinical materials, preparation of media, and a systematic approach to identification and diagnosis of disease producing bacteria. Techniques of serology in the diagnosis of diseases.

8-238f. METHODS IN CLINICAL MICROBIOLOGY — PART II, MEDICAL MYCOLOGY, PARASITOLOGY, AND DIAGNOSTIC VIROLOGY. (6 cr; prereq ‡) Savard and staff
Lectures and laboratory in techniques of diagnostic mycology, parasitology, tissue culture techniques, and procedures in diagnosis of virological diseases.

8-239w. PRECEPTORSHIP IN MEDICAL MICROBIOLOGY — BACTERIOLOGY, FLUORESCENT-ANTIBODY, ANTIBIOTICS, PARASITOLOGY, INSTRUMENTATION. (6 cr; prereq ‡) Savard and staff
Working experience in participating diagnostic laboratories.

8-240s. PRECEPTORSHIP IN MEDICAL MICROBIOLOGY — MYCOBACTERIOLOGY AND MYCOLOGY. (6 cr; prereq ‡) Savard and staff
Working experience in participating diagnostic laboratories.

8-242f,w,s. DIAGNOSTIC MICROBIOLOGY. (Cr ar; prereq grad student in microbiology, ‡) Matsen
Laboratory procedures for isolation and identification of microorganisms from patients. Work is carried out in diagnostic microbiology laboratories of the hospital.

8-425. LABORATORY METHODS, APPLIED ANIMAL CELL CULTURE AND VIROLOGY.** (3 cr; prereq 5-124 or ¶5-124, ‡; offered when feasible) Staff
Laboratory exercises on preparation of animal cell cultures; study and laboratory diagnosis of viral and rickettsial infections.

8-910f,w,s. SEMINAR. (1 cr) Staff

8-911f,w,s. COLLOQUIUM IN MICROBIOLOGY. (1 cr; prereq adv standing in microbiology) Staff
Series of informal colloquia on recent advances in specialized areas of microbiology. Typical subjects are transplantation, autotrophy, pathogenesis, regulation of DNA, RNA and protein synthesis, carcinogenesis, virus replication, developmental microbiology, genetics, mechanisms of immune response, membranes and lipids, virus disease and tumors, microbial ecology, comparative metabolism of animal and bacterial cells, epidemiology, industrial microbiology, and transport and motility.

8-920f,w,s. ADVANCES IN IMMUNOLOGY. (1 cr per qtr) Watson and staff
Research reports: evolution and mechanisms of immune response, cellular and humoral aspects of hypersensitivity, immunological tolerance, autoimmunity and its relation to disease, and other topics.

8-990f,w,s,su. RESEARCH IN MICROBIOLOGY. (Cr and hrs ar)
Graduate students with requisite preliminary training may elect research, either as majors or minors.

MIDDLE EASTERN LANGUAGES

Professor
Anwar G. Chejne, *chairman*
Caesar E. Farah

Assistant Professor
Jerome Clinton
George J. Koury
Jonathan Paradise
Daniel Reisman

The following are offered as courses toward the M.A. degree in Arabic. They may also be used in a minor program or as related fields. Students who wish to minor in the department for their Ph.D. should make their intention known to the department before registration.

Akkadian (Akka)

5-011/5-012/5-013. ELEMENTARY AKKADIAN. (4 cr per qtr; for adv undergrads by ‡ or grads)
Introduction to cuneiform script. Outline of Akkadian grammar, written drills, selected readings from historical annals, law collections, religious and epic literature.

** Microscope required. Students may obtain use of microscope by purchasing $3 microscope cards from the bursar.

Arabic (Arab)

5-011/5-012/5-013. ADVANCED LITERARY ARABIC AND COMPOSITION. (5 cr per qtr; prereq 3-013 or ‡) Chejne
Survey of literary styles and genres in classical and modern writings, with compositions on texts studied.

5-014. STRUCTURE OF ARABIC. (4 cr; prereq 2 yrs Arabic or ‡)
Descriptive analysis of main structure of Arabic, both classical and colloquial.

5-111. READINGS IN LEGAL TEXTS. (4 cr per qtr; prereq 5-013 or ‡)

5-121. READINGS IN ISLAMIC THEOLOGICAL AND PHILOSOPHICAL TEXTS. (4 cr per qtr; prereq 5-013 or ‡)

5-211/5-212. READINGS IN CLASSICAL ARABIC LITERATURE. (4 cr per qtr; prereq 5-013 or ‡)

5-231. ARABIC LITERATURE IN THE 19TH-20TH CENTURIES. (4 cr per qtr; prereq 5-013 or ‡)

5-311. HISPANO-ARABIC POETRY. (4 cr; prereq 5-503 or ‡)

5-405. IBN KHALDUN. (4 cr; prereq 5-503 or ‡)

5-406. IBN HAZM OF CORDOVA. (4 cr; prereq 5-503 or ‡)

5-501, 5-502, 5-503. HISPANO-ARABIC LITERATURE AND CULTURE. (4 cr per qtr; prereq 5-513 and knowledge of Arabic and/or Spanish desirable but not required) Chejne

5-701. DIALECT ANALYSIS. (4 cr per qtr; prereq knowledge of Arabic, ‡)
Differences in various Arabic dialects, contrasting at least two of these.

5-711. READINGS IN ARAB GRAMMARIANS. (4 cr per qtr; prereq 5-013 or ‡)

5-721/5-722. SEMINAR: DEVELOPMENT OF THE ARABIC LANGUAGE AND LITERATURE. (4 cr per qtr; prereq ‡ for 5-721)
5-721: Early state of the Arabic language from pre-Islamic times to middle of 8th century.
5-722: Development of language in Golden Age of the Abbasid.

5-970. DIRECTED READINGS. (Cr for advanced students wishing to work on special problems; prereq 5-013 or ‡)
Reading and periodic consultations.

5-990. HONORS COURSE: RESEARCH. (Cr ar; prereq 5-970 or ‡)
Individual studies for honors work at advanced level.

8-321. JUDEO-ARABIC LITERATURE. (3 cr; prereq knowledge of Arabic and Hebrew or ‡)
Technique and methodology of research. Important works. Selected readings from Saadia, Halevi, Maimonides, and some medieval Jewish chronicles (all written in Judeo-Arabic).

8-970. SEMINAR: ARABIC LITERATURE BY CENTURY AND AUTHOR. (2-5 cr; prereq 3 yrs of Arabic or ‡)
Content will vary. May consist of religious and philosophical, belle-lettristic and lexical, historical and geographical texts, literary criticism and Arabic paleography. Major concentration on primary sources for methodology problems and tools of research.

Aramaic (Aram)

5-011/5-012/5-013. ARAMAIC. (4 cr per qtr; for students preparing for Biblical studies, ancient history majors, and students specializing in Semitic languages, also strongly recommended for students of Talmud; prereq 1 yr Hebrew or Arabic)
5-011: Biblical Aramaic — stresses fundamentals of grammar and fluency in reading of Biblical and ancient Aramaic. 5-012: Syriac — stresses fundamentals of grammar and fluency of reading Syriac texts. 5-013: Aramaic inscriptions — study of epigraphy, morphology, and syntax of old Aramaic inscriptions from the 9th-5th centuries B.C.

Hebrew (Heb)

5-104/5-105. PROBLEMS IN BIBLICAL STUDIES. (4 cr per qtr; prereq 3-202 or ‡)
Selected issues in modern Biblical studies. Scientific methodology and use of research tools.

5-701. INTRODUCTION TO COMPARATIVE STUDY OF SEMITIC LANGUAGES. (4 cr; prereq grad or ‡, 1 yr of 2 Semitic languages)
Historical survey of linguistic development in Semitic languages. Selected problems in phonology and morphology.

5-711. NORTHWEST SEMITIC INSCRIPTIONS. (4 cr per qtr; prereq 3-013 or ‡)
Introduction to Paleo-Hebrew script. Study of morphology, phonology, syntax, and linguistic changes in early Hebrew, Moabite, Phoenician, and Punic inscriptions.

5-970. DIRECTED READINGS. (Cr ar; for advanced students wishing to work on special problems; prereq 3-013 or ‡)

5-990. HONORS COURSE: RESEARCH. (Cr ar; prereq 5-970 or ‡)
Independent research on topic of interest to the student under guidance of a faculty member.

8-321. JUDEO-ARABIC LITERATURE. (3 cr; prereq knowledge of Arabic and Hebrew or ‡)
Same as Arab 8-321.

Persian (Pers)

5-011/5-012/5-013. ADVANCED LITERARY PERSIAN. (4 cr per qtr; prereq 3-013 or 5-103 or ‡) Staff
Reading and analysis of selected texts of classical Persian poetry and prose. 5-011: Medieval art prose. 5-012: Ghazal and Qasida. 5-013: Epic.

5-101/5-102/5-103. BEGINNING CLASSICAL PERSIAN. (4 cr per qtr; prereq 1-103 or Arab 1-103 or grad standing, or ‡)
Intensive reading course designed to prepare students for research in medieval Persian history and literature.

5-970. DIRECTED READINGS. (Cr ar; for advanced students wishing to work on special problems; prereq 3-013 or ‡)

5-990. SEMINAR IN LITERARY CRITICISM. (4 cr; prereq 5-013 or ‡)
Application of modern techniques of literary criticism to classical Persian poetry.

Middle East Studies (MidE)

5-401. BIBLIOGRAPHY OF MIDDLE EAST STUDIES. (4 cr; prereq knowledge of at least one European language other than English, familiarity with at least one Middle Eastern language desirable and ‡)
An introduction to source materials, reference works, and guides to literature of Islamic Middle East.

5-601. CLASSICAL PERSIAN LITERATURE IN TRANSLATION. (4 cr; no knowledge of Persian req)
Reading and discussion of masterworks of Persian prose and poetry from Rudaki to Jami.

5-601H. HONORS COURSE: CLASSICAL PERSIAN LITERATURE IN TRANSLATION. (4 cr; no knowledge of Persian req)
Students will attend lectures in 5-601 and meet with lecturer an additional period each week.

5-661. MODERN TURKISH LITERATURE IN TRANSLATION. (4 cr; no knowledge of Turkish req)
Introduction to historical and social background of 20th century literature. Includes lyrical and narrative texts, Yasar Kemal, Orhan Kemal, Nazim Hikmet, Aziz Nesin, and others.

MINERAL ENGINEERING (MinE)

Professor
Strathmore R. B. Cooke
Gust Bitsianes
Charles Fairhurst
Iwao Iwasaki
James E. Lawver
Eugene P. Pfleider

Associate Professor
Rodney L. Bleifuss, *director of graduate study*
Adrian C. Dornfeld
Norman F. Schulz
Donald H. Yardley

Prerequisites — For major work, adequate preparation in undergraduate subjects and in the sciences fundamental to mineral engineering, in addition to general admission requirements. For minor work, the prerequisites to the courses to be pursued, and approval of the major department.

Language Requirement – For the Master's degree, none. For the Ph.D. degree, either (a) one foreign language selected from German, French, and Russian (other languages may be considered on petition); or (b) a special research technique. Students working toward the Ph.D. degree must show substantial progress toward completion of the language or the special research technique in their first year of residence.

Master's Degree – Either a Master's degree with departmental designation or an undesignated Master's degree is offered. Students who have a B.S. in mineral engineering have the option of obtaining either the designated or the undesignated M.S. degree. Students who have a B.S. degree in other fields (e.g., geology, physics, chemistry, etc.) may choose either (a) to make up the deficiencies in the basic engineering curriculum and proceed normally to the designated M.S. degree in mineral engineering, or (b) proceed directly to the undesignated M.S. degree.

Only Plan A will be allowed for students working toward an undesignated M.S. degree, whereas either Plan A or Plan B will be permitted for students working toward an M.S. degree with departmental designation.

Master of Mineral Engineering Program – The field of mineral engineering sponsors graduate work toward the advanced degrees of M.S., Ph.D., and M.Min.E. The latter program is designed for those Bachelor degree holders interested in design, operations, or management. It is urged that any undergraduates considering advanced work should direct their fourth-year course work with that objective in mind.

Doctor's Degree – Work leading to the Ph.D. degree is offered.

5-437.* COMPUTER APPLICATIONS IN MINERAL ENGINEERING. (3 cr; prereq Math 1-104 or 3-101 or ‡) Crouch
Finite difference techniques and their applications to ore reserve estimates and mine haulage problems. Solution of linear equations, regression analysis, and curve fitting. Iterative methods and ventilation network analysis. Brief introduction to use of random numbers, simulation, and computer models.

5-530.* FLUID FLOW THROUGH POROUS SOLIDS I. (4 cr; prereq 5-613 or ‡) Hayden
Petrophysics of porous rocks and aquifers; porosity, permeability, mineral surface areas; linear, radial, and spherical flow for various types of fluids; units; laboratory experiments.

5-532. FLUID FLOW THROUGH POROUS SOLIDS II. (4 cr; prereq 5-530 or ‡)
Fluid flow possibilities. Darcy's generalized equations; vertical flow; units. Kozeny equations derived; fracture and channel flow; electrical, acoustical, and radioactivity properties of rocks pertaining to porosity and connate water of rocks treated.

5-611. MINERAL RESOURCES I, INTRODUCTORY COURSE. (4 cr; prereq Geo 1-111 desirable or ‡; 3 lab hrs per wk, 1 field trip)
Mineral distribution and demand; non-geologic ore determinants, unit operations of exploration, development and production of mining and petroleum deposits; environmental control; valuation principles.

5-612. MINERAL RESOURCES II, EXPLORATION DEVELOPMENT AND EXPLOITATION OF MINERAL PROPERTY. (4 cr; prereq 5-611 or ‡; 2 lab hrs per wk)
Integrated exploration, development, and production systems for underground mineral properties. Essential criteria for design and selection of mining methods. Unit operations; drilling, blasting, supporting, loading and hauling.

5-613. MINERAL RESOURCES III, EARTH FLUIDS AND FLUID FLOW. (4 cr; prereq 3rd yr or ‡)
Sedimentary rocks and earth fluids characteristics. Fluid flow through porous rocks. Basic principles of underground reservoir engineering.

5-619.* ENGINEERING FIELD STUDY. (3 cr; prereq grad mineral or geological engineering or ‡; offered 2 weeks during summer) Staff
Study of mining and petroleum operations; mine and petroleum plants and metallurgical plants; research and engineering offices in selected regions.

5-630.* SURFACE MINING ENGINEERING. (4 cr; prereq Geo 1-111, MinE 5-611 or ‡) Pfleider
Unit operation of drilling, blasting, loading, hauling and transportation of surface rocks and soils. Equipment productivity, selection and cost estimating. Design of open pits and quarries. Economics, environment, and organization.

5-640. MINERAL ECONOMICS I, EXAMINATION AND VALUATION OF MINERAL PROPERTY. (4 cr; prereq Geo 1-111, MinE 5-612 or 5-630 desirable or ‡)
Geologic factors and mineral laws, sampling and reserve estimates. Analysis of costs and profitability. Taxation, depreciation and depletion. Present worth and rate-of-return computations; financing methods.

5-650/5-652. MINERAL ENGINEERING DESIGN I, II. (4 cr per qtr; prereq grad student in mineral engineering) Pfleider and staff
Systems design in the exploration, development, and exploitation of a mineral property. Integration of concepts from geology and geophysics, rock mechanics, mine or petroleum plant engineering, and mineral economics and valuation principles to a specific problem chosen by student. Preparation of report.

5-660.* SPECIAL MINERAL ENGINEERING PROBLEMS. (Cr and hrs ar; prereq 5-612)
Literature survey or research work on mining problems.

5-720.* MINERAL PLANT ENGINEERING I. (4 cr; prereq 5-612 or ‡) Dorenfeld
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.

5-722.* MINERAL PLANT ENGINEERING II. (4 cr; prereq 5-720 or ‡)
Basic engineering principles in design and selection of mine plant equipment. Calculations involving power transmission, drilling, transporting, and hoisting of crushed ore material.

5-740. METALLURGICAL ENGINEERING DESIGN. (4 cr; prereq 3rd yr IT student; 3 lab hrs per wk; offered alt yrs)
Provides the student with sufficient background information to write equipment specifications and make a preliminary estimate of capital and operating costs of a concentrating plant.

5-800. INTRODUCTION TO MINERAL AND METAL EXTRACTION. (4 cr; prereq inorganic chemistry; 4 lab hrs per wk)
Unit operations in processing a mineral product to desirable concentrate form. Unit processes in treating the concentrate to required metallic state. Economics and environmental considerations in coordinated sequence of events.

5-810. PRINCIPLES OF MINERAL PROCESSING. (4 cr, 3 cr without lab; prereq 3rd yr IT student; 3 lab hrs per wk)
Application of physical and chemical principles to solid material processing problems. Screening, size reduction and size classification, solid transport and storage, mixing and dispersing, flocculation and dispersion, size and gravity classification, filtration and drying, flotation, electrical separation and electrostatic precipitation, magnetic separation, hydrometallurgy, miscellaneous processes.

5-816.* HYDROMETALLURGY I. (3 cr; prereq ‡) Cooke
Application of physicochemical principles to the leaching of ores and concentrates, to purification of leach liquors, and recovery of metals from solutions.

5-820. PRINCIPLES OF METALS EXTRACTION I. (4 cr; prereq 8 cr inorganic chemistry)
Materials and heat balances in metallurgical processes. Chemical equilibrium and rates of reaction. Combustion of fuels and heat utilization. Phases in pyrometallurgical systems.

5-825. PRINCIPLES OF METALS EXTRACTION II. (4 cr; prereq 5-820 or ‡)
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.

5-910. METALLURGICAL UNIT PROCESSES. (4 cr; prereq 5-825 or ‡; 4 lab hrs per wk)
Unit processes of chemical metallurgy covered in chronological order; roasting, agglomeration, smelting, converting, refining, vaporization, and electrolytic methods.

5-940.* SPECIAL PROBLEMS IN EXTRACTIVE METALLURGICAL ENGINEERING. (Cr and hrs ar; prereq sr) Staff
Laboratory investigation of problems in extractive metallurgy.

8-330.* ADVANCED CONCEPTS IN DRILLING OF ROCKS. (3 cr; prereq ‡) Fairhurst
Disintegration and comminution by sound waves and gases at ultrahigh velocities and temperatures. Cutting action of percussion and rotary bits by shear, tensile, and compressive forces.

8-470/8-471/8-472.* MINING RESEARCH PROBLEMS. (Cr ar) Staff

8-601/8-602/8-603/8-604/8-615/8-616/8-617/8-618/8-619.* SEMINAR: MINERAL ENGINEERING. (Cr ar) Fairhurst, Pfleider and staff

8-620.* ADVANCED ENGINEERING DESIGN. (Cr and hrs ar)

8-632.* GRAVITY FLOW OF FRAGMENTED MATERIALS. (2 cr) Pfleider, Fairhurst
Index, strength and flow properties of fragmented materials. Flow-no flow design principles and techniques for gravity bins and drawpoints. Rate of discharge formulas, model consideration. Engineering problems and laboratory exercises.

8-640.* ADVANCED MINERAL ECONOMICS I. (3 cr; prereq 5-482, Geo 5-352, 5-361 or equiv...Econ 1-005 recommended...or ‡) Pfleider
Study and analysis of mineral resources as related to national and world requirements. Presentation of assigned topics and class discussion. Invited lecturers.

8-642.* ADVANCED MINERAL ECONOMICS II. (3 cr; prereq Geo 3-401 or ‡) Pfleider
Distribution, demand, and conservation of strategic supplies. Marketing and prices. State and national policies affecting development. Analysis of mineral data.

8-724.* MINE AIR CONDITIONING. (3 cr; prereq 5-612; 3 lab hrs per wk)
Mine gases, dust control, and physical properties of air; measurement of air properties. Design of ventilation, heating, and refrigeration systems.

8-730/8-732.* OPERATIONS ANALYSIS IN MINERAL ENGINEERING I, II. (3 cr per qtr; prereq 5-720 or ‡)
Problems of variations in capital and operating costs; products.

8-818.* HYDROMETALLURGY II. (3 cr; prereq 5-810) Cooke
Principles of ion exchange and solvent extraction. Integration of operations and processes on a plant basis. Applications in nonferrous metallurgy.

8-830.* ELECTRIC AND MAGNETIC SEPARATION OF MINERALS. (4 cr; prereq ‡) Lawver
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 being used in industry.

8-832.*‡ TECHNIQUES OF MINERAL PROCESSING RESEARCH I. (3 cr; prereq ‡; offered 1972-73 and alt yrs) Lawver
Review of elementary probability theory and theory of statistics as related to experimental design and data analysis. Theory and application of factorial experimentation, experimental methods of determining optimum conditions including path of steepest ascent, response surface methodology, and evolutionary operation. Sampling theory as related to mineral dressing and process metallurgy. Legal aspects of the laboratory notebook as related to patent law. Preparation of research and development reports to be used by engineering companies in preparing cost estimates and machine specifications.

8-834.*‡ TECHNIQUES OF MINERAL PROCESSING RESEARCH II. (3 cr; prereq Chem 5-504 or 5-521, Phys 3-500 or ‡; offered 1972-73 and alt yrs)
Physicochemical methods; emission spectroscopy; absorption spectrophotometry; radio tracer techniques; electrochemical and electrokinetic measurements; chromatography, surface area determinations.

8-836.*‡ TECHNIQUES OF MINERAL PROCESSING RESEARCH III. (3 cr; prereq Phys 3-500 or ‡; offered 1972-73 and alt yrs) Bleifuss
Physical methods; optical microscopy, X-ray diffraction and spectroscopy, high-temperature phase equilibria and X-ray diffraction techniques, differential thermal analyses and thermogravimetric analyses, electron microscopy and electron probe microanalysis.

8-838. OPTIMIZATION AND CONTROL TECHNIQUES IN MINERAL PROCESSING I. (3 cr; prereq IT graduate standing or ‡; 2 lect and 1 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 multi-stage closed comminution circuits. Recognition of physical constraints during simulation. Deficiencies of models. Control of comminution circuits including digital computer control.

8-839. OPTIMIZATION AND CONTROL TECHNIQUES IN MINERAL PROCESSING II. (3 cr; prereq 8-838 or ‡; 2 lect and 1 3-hr tutorial lab per wk; offered alt yrs) Lynch
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.

8-840.* FLOTATION THEORY. (3 cr)

8-842.° SURFACE CHEMISTRY OF FLOTATION. (3 cr)

8-925/8-926/8-927.° RESEARCH IN EXTRACTIVE METALLURGICAL ENGINEERING. (Cr ar)

8-925/8-926/8-927.° SEMINAR: EXTRACTIVE METALLURGICAL ENGINEERING. (1 cr per qtr)

8-930.° PHYSICAL CHEMISTRY OF HIGH-TEMPERATURE METALLURGICAL REACTION I. (3 cr; prereq 5-910 or ‡) Bitsianes
Physicochemical as applied to iron and steelmaking. Thermodynamics of liquid steel. Reactions in liquid metal solutions.

8-932.° PHYSICAL CHEMISTRY OF HIGH-TEMPERATURE METALLURGICAL REACTIONS II. (3 cr; prereq 8-930) Bitsianes
Liquid slag state and slag constitution theories. Slag-metal distribution equilibria. Phosphorus and sulfur problems in iron and steelmaking.

8-934.° PHYSICAL CHEMISTRY OF HIGH-TEMPERATURE METALLURGICAL REACTIONS III. (3 cr; prereq 8-932) Bitsianes
Kinetics and rates of reaction in iron and steelmaking. Mass transport processes. Applications to metallurgical systems.

MUSIC (Mus)

Professor
Roy A. Schuessler, *chairman*
Johannes Riedel, *director of graduate study*
Dominick J. Argento
Frank P. A. Bencriscutto
Paul Fetler
Heinrich Fleischer
Robert T. Laudon
Bernhard D. Weiser

Associate Professor
Paul W. Freed

Assistant Professor
Louise Guhl
Alan L. Kagan
Duncan R. McNab
Eric N. Stokes
D. Clifton Ware, Jr.

Prerequisites – Candidates for graduate work must have a working knowledge of piano and performing ability in some phase of instrumental or vocal music, plus 30 undergraduate quarter credits in one of the following branches of music: (a) history and literature, (b) theory and composition, (c) piano pedagogy, or (d) music education. Placement tests in music theory, music literature, and applied music are required of all entering students.

Language Requirement – For the Master of Fine Arts degree, none. For the Master's degree, a reading knowledge of French or German. Substitution may be made by petition when a different language is needed for an individual research problem. For the Ph.D. degree, either (a) two foreign languages, or (b) one language and the option of a special research technique or a collateral field of knowledge. When two languages are offered, French and German are acceptable.

Master of Fine Arts Degree — Candidates for the master of fine arts degree must complete a program of approximately 2 full years of graduate study (i.e., a minimum of 65 credits, at least 45 of which must be earned in graduate courses at the University of Minnesota). They must execute and leave a record of a creative project which will be accompanied by a supporting paper that deals with the planning and/or execution of the creative work. A minimum of 9 credits is required in areas of study outside the major department. The individual program must be approved by the departmental M.F.A. committee. Candidates will be subject to final oral examination.

Admission to candidacy for the master of fine arts degree is limited to a selected group of students with the Bachelor's degree or an equivalent from an approved university or college or the equivalent and to those who provide evidence of exceptional promise as creative artists in applied music, conducting, or church music. All students entering graduate studies in music at the University are required to take the Theory Placement Test. Applicants for entry into the master of fine arts program are subject to examinations deemed appropriate by the departmental M.F.A. committee in determining their qualifications for candidacy and the efficacy

of a proposed program of studies. Applicants for candidacy in an applied major must qualify for the degree program by audition. Tapes may be submitted in lieu of personal audition. No recommendation concerning admission will be made until the applicant's qualifications have been evaluated in the Department of Music and the completed application for admission to the Graduate School has been received in the Graduate School office.

Master's Degree – Offered under both Plan A and Plan B. The thesis subject and major work may be chosen from either the historical, theoretical or music education subfields. An original composition may be offered in place of the usual research thesis under Plan A. Under Plan B, courses from the subfields of music not used for the concentration may be taken as related work, except that all Plan B students must present at least one field of 6 credits outside the various music subfields.

Doctor's Degree – Work leading to the Ph.D. degree with thesis is offered with emphasis on music history and literature, musicology, ethnomusicology, theory and composition, or music education. (*Note* – Two programs are offered leading to the Ph.D. degree with emphasis in music education, the Ph.D. in music with emphasis in music education and the Ph.D. in education with emphasis in music education). Students with marked creative ability may substitute an original composition for full orchestra for the usual research thesis.

Courses in Applied Music – Graduate-level courses in applied music are offered in three modes. The modes, with their respective functions, are as follows:

Mus 5-101 through 5-125, Applied, Elective
Intended for study of a secondary instrument by graduate-level music majors with established skill in another applied area, and for qualified graduate nonmusic majors.

Mus 8-201 through 8-225, Applied
Intended for study of the principal performing medium of a student majoring in an area of music other than applied.

Mus 8-301 through 8-325, Applied, Performance
Intended for applied major (i.e., M.F.A.).

Students may consult with the department for further clarification of applied offerings in relation to specific degree program requirements (prereq entrance examination).

Instrument	Applied: Elective	Applied	Applied: Performance
Piano	5-101	8-201	8-301
Harpsichord	5-102	8-202	8-302
Organ	5-103	8-203	8-303
Voice	5-104	8-204	8-304
Violin	5-105	8-205	8-305
Viola	5-106	8-206	8-306
Cello	5-107	8-207	8-307
Double Bass	5-108	8-208	8-308
Flute	5-109	8-209	8-309
Oboe	5-111	8-211	8-311
Clarinet	5-112	8-212	8-312
Saxophone	5-113	8-213	8-313
Bassoon	5-114	8-214	8-314
French Horn	5-115	8-215	8-315
Trumpet	5-116	8-216	8-316
Trombone	5-117	8-217	8-317
Baritone	5-118	8-218	8-318
Tuba	5-119	8-219	8-319
Percussion	5-121	8-221	8-321
Harp	5-122	8-222	8-322
Guitar	5-123	8-223	8-323
Accordion	5-124	8-224	8-324
Sitar	5-125	8-225	8-325

Applied

5-101 to 5-125 and 8-201 to 8-225x. ADVANCED APPLIED MUSIC. (2 or 4 cr; prereq entr exam) Staff

Advanced literature in piano, voice, organ, and orchestral instruments.

5-101. Piano (elective)
5-102. Harpsichord (elective)
5-103. Organ (elective)
5-104. Voice (elective)
5-105. Violin (elective)
5-106. Viola (elective)
5-107. Cello (elective)
5-108. Double Bass (elective)
5-109. Flute (elective)
5-111. Oboe (elective)
5-112. Clarinet (elective)
5-113. Saxophone (elective)
5-114. Bassoon (elective)
5-115. French Horn (elective)
5-116. Trumpet (elective)
5-117. Trombone (elective)
5-118. Baritone (elective)
5-119. Tuba (elective)
5-121. Percussion (elective)
5-122. Harp (elective)
5-123. Guitar (elective)
5-124. Accordion (elective)
5-125. Sitar (elective)

8-201. Piano (applied)
8-202. Harpsichord (applied)
8-203. Organ (applied)
8-204. Voice (applied)
8-205. Violin (applied)
8-206. Viola (applied)
8-207. Cello (applied)
8-208. Double Bass (applied)
8-209. Flute (applied)
8-211. Oboe (applied)
8-212. Clarinet (applied)
8-213. Saxophone (applied)
8-214. Bassoon (applied)
8-215. French Horn (applied)
8-216. Trumpet (applied)
8-217. Trombone (applied)
8-218. Baritone (applied)
8-219. Tuba (applied)
8-221. Percussion (applied)
8-222. Harp (applied)
8-223. Guitar (applied)
8-224. Accordion (applied)
8-225. Sitar (applied)

8-301 to 8-325x. GRADUATE APPLIED MUSIC. (12 cr upon completion of 3 qtrs and presentation of complete grad recital; prereq entr exam, minimum of 12 hrs practice per wk) Staff

8-301. Piano (performance)
8-302. Harpsichord (performance)
8-303. Organ (performance)
8-304. Voice (performance)
8-305. Violin (performance)
8-306. Viola (performance)
8-307. Cello (performance)
8-308. Double Bass (performance)
8-309. Flute (performance)
8-311. Oboe (performance)
8-312. Clarinet (performance)
8-313. Saxophone (performance)
8-314. Bassoon (performance)
8-315. French Horn (performance)
8-316. Trumpet (performance)
8-317. Trombone (performance)
8-318. Baritone (performance)
8-319. Tuba (performance)
8-321. Percussion (performance)
8-322. Harp (performance)
8-323. Guitar (performance)
8-324. Accordion (performance)
8-325. Sitar (performance)

Performance Practice

5-182f. BAROQUE PERFORMANCE PRACTICE. (4 cr; prereq sr or grad, 1-506, 1-606 or ♯) Laudon

Ornamentation, phrasing, articulation, and improvisation in music of period 1550-1759. Music instruction books of this era leading to analysis and performance of Baroque music in Baroque style.

Pedagogy and Conducting

5-351f/5-352w/5-353s. PIANO PEDAGOGY I. (2 cr per qtr; prereq 12 cr in 1-101 or 1-201 or 1-301 or 1-151/1-152/1-153 or ♯; offered 1972-73 and alt yrs) Guhl

Demonstration and discussion of group piano instruction at the elementary level. Analysis of selected literature appropriate to conceptual learning through the discovery approach.

5-354f/5-355w/5-356s. PIANO PEDAGOGY II. (2 cr per qtr; prereq 12 cr in 1-101 or 1-201 or 1-301 or 1-151/1-152/1-153 or ♯; offered 1973-74 and alt yrs) Guhl

Principles of piano pedagogy. Survey of teaching materials and opportunity to apply principles and techniques in a directed teaching setting.

5-357f/5-358w/5-359s. GRADUATE PIANO SEMINAR. (2 cr per qtr; prereq ♯; offered 1973-74 and alt yrs) Weiser, Freed, McNab
Recognition and discussion of problems in piano study, instruction and performance. Terminology, repertory, evolution of piano construction, performance practice from baroque to contemporary literature.

5-361f/5-362w/5-363s. VIOLIN PEDAGOGY I. (2 cr per qtr; prereq 12 cr in 1-205 or 1-206 or 1-305 or 1-306 or ♯)
Teaching of private violin students at beginning, intermediate, and advanced levels. Discussion and demonstrations of pedagogical techniques.

5-381f/5-382w/5-383s. SEMINAR: CHORAL TECHNIQUES, REHEARSAL AND PERFORMANCE PRACTICE. (2 cr per qtr; prereq ♯; offered alt yrs) Lancaster
Score analysis, conducting technique, performance practice, and various aspects of choral technique with emphasis on practical application of these studies in rehearsal and performance.

5-384/5-385. CHORAL CONDUCTING. (4 cr per qtr; prereq ♯; offered 1973-74 and alt yrs)
Advanced study of the art of choral conducting—hand techniques, sound control, articulation, breath control, intonation, etc.

5-387/5-388. INSTRUMENTAL CONDUCTING. (4 cr per qtr; prereq ♯; offered 1972-73 and alt yrs)
Advanced study of the art of instrumental conducting—conducting techniques, score analysis, performance practice.

5-399f,w,s. PERFORMANCE IN CONDUCTING. (2 cr; prereq 5-388 or 5-385, ♯)
Preparation and conducting, with documentation, of an ensemble program.

8-391/8-392. ADVANCED CONDUCTING. (4 cr per qtr; prereq ♯) Staff
Application of conducting techniques to music from 16th century to contemporary times by analysis of stylistic and technical characteristics of each historical period.

Ensembles and Miscellany

5-410f,w,s. BAND. (1 cr per qtr; prereq ♯) Bencriscutto, Nyline
Concert Band Ensemble; Symphony Band Ensemble; Symphony Bands I and II; Marching Band. Concert and Symphony Bands perform standard and contemporary repertoire. Marching Band performs at University functions.

5-420f,w,s. ORCHESTRA. (1 cr qtr; prereq ♯)
A study of 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.

5-430f,w,s. CHORUS: WOMEN'S CHORUS; MEN'S CHORUS; ST. PAUL CAMPUS CHORUS; RESIDENT ORATORIO CHOIR. (1 cr per qtr except 1 cr for 3 qtr participation in Resident Oratorio Choir; prereq ♯) Lancaster
Sec. 1, 2, 3—University Chorus: Performance of major symphonic works with Minnesota Orchestra, University Symphony Orchestra, and University Concert Band.
Sec. 3—Concert Choirs: A select ensemble auditioned from eligible members of the University Chorus.
Sec. 4—Women's Chorus: Rehearsals and performances cover standard women's chorus material. Group appears for on- and off-campus functions.
Sec. 5—Men's Chorus: Rehearsals and performances cover standard men's chorus materials as well as special arrangements. Group appears for on- and off-campus functions.
Sec. 6—St. Paul Campus Chorus: Prepares for at least one public appearance each quarter as well as for special events connected with St. Paul Campus.
Sec. 7—Resident Oratorio Choir: Mixed chorus open to all residents of University Campus. Performances each quarter of standard choral literature.

5-440f,w,s. ENSEMBLE. (1 cr per qtr; prereq ♯)
Performance of chamber music of major and minor composers; sonatas, trios, quartets, quintets, etc. Includes various combinations of vocal and instrumental chamber ensemble materials.

5-450f,w,s. COLLEGIUM MUSICUM. (1 cr per qtr; prereq ♯) Lancaster
Small ensemble of singers and instrumentalists for the study and performance of early music.

5-460f,w,s. CONTEMPORARY MUSIC ENSEMBLE. (2 cr per qtr; prereq ♯) Stokes
Practice and performance of new and recent music for various combinations of vocal and instrumental ensembles.

5-470f,w,s. OPERA WORKSHOP. (3 cr per qtr; prereq ability to sing arias satisfactorily, ‡) Sutton
Student prepares and performs operatic arias and scenes, exploring combined problems of musical and dramatic interpretation. In addition the class prepares a fully staged production.

5-480su. OPERA AND OPERETTA PRODUCTION. (4 cr; prereq singers with ‡) Sutton
Singer prepares and performs roles in opera and operetta. Special projects, including stage direction, musical direction, and accompanying coaching, are offered for the non-singer.

5-490f,w,s. CHAMBER SINGERS. (2 cr per qtr; prereq ‡) Lancaster
Mixed chorus of sixteen to twenty voices. Performances each quarter of works for small chorus.

Music Theory and Composition

5-501f, 5-502w, 5-503s. ADVANCED MATERIALS AND STRUCTURE OF MUSIC. (2 cr per qtr; prereq 1-506) Argento
Stylistic study of musical materials and structures. 5-501: Before 1850. 5-502: 1850-1950. 5-503: Since 1950; electronic, aleatoric, mathematical procedures. New attitudes and notational practices.

5-511. ADVANCED EAR TRAINING I. (3 cr; prereq 1-516 or ‡) Fetler
Dictation of melodic, harmonic and rhythmic materials in a variety of styles. Introduction to contemporary sonorities.

5-512. ADVANCED EAR TRAINING II. (3 cr; prereq 1-516 or ‡) Fetler
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.

5-521f, 5-522w, 5-523s. KEYBOARD HARMONY. (2 cr per qtr; prereq 1-506, sr or grad, primarily for piano and organ majors)
Practical study of diatonic and chromatic harmony at the piano. Realization of figured bass music of the 17th and 18th centuries. Playing of choral, orchestral, and chamber music of classical and early romantic periods from open score using all clefs.

5-532w. ANALYSIS II. (3 cr; prereq 1-566) Stokes
Study of various procedures and techniques of analysis applied to music composed since ca. 1950.

5-533s. ANALYSIS III. (3 cr; prereq 1-506) Fetler
Analysis of representative masterworks of the 20th century.

5-541f/5-542w/5-543s. ADVANCED COUNTERPOINT. (2 cr per qtr; prereq 3-543; offered 1972-73 and alt yrs) 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.

5-551f, 5-552w, 5-553s. COMPOSITION I. (2 cr per qtr; prereq 1-506) Argento, Fetler, Stokes
Original work in various forms. Students are exposed to variety of techniques and styles of composition after which they are encouraged to develop their own original approach.

5-554f, 5-555w, 5-556s. COMPOSITION II. (2 cr per qtr; prereq 3-543, 5-553) Argento, Fetler, Stokes
Original works in various forms.

5-560. ELECTRONIC MUSIC LABORATORY. (2 cr; prereq 3-791 or ‡) Stokes
Study of and practice in electronic music techniques and compositional methods. Performance in combination with instruments and voices.

5-561f/5-562w/5-563s. ORCHESTRATION. (2 cr per qtr; prereq 1-506) Argento
Scoring instruments of the orchestra for ensemble combinations and full orchestra.

5-564. BAND ARRANGING. (4 cr; prereq 1-506, 5-563 or MuEd 3-557 or ‡; offered 1973-74 and alt yrs)
Analysis of current scoring techniques for wind and percussion instruments. Scoring for band. Creative arrangements for marching or concert band.

8-551, 8-552, 8-553. COMPOSITION III. (3 cr per qtr; prereq grads who have completed undergrad major sequence in music theory and composition incl 3-543, 5-503, 5-553, 5-563) Argento, Fetler, Stokes
Original works in various forms. Emphasis on advanced work in composition.

History and Literature

5-027f, 5-028w, 5-029s. HISTORY OF MUSICAL STYLES. (4 cr per qtr) Cardamone
Principal stylistic developments in history of western music, 9th century to present day. 5-027: Middle Ages, Renaissance, Baroque. 5-028: Classical Period, Early Romanticism, Nationalism. 5-029: 1850 to present.

5-601f/5-602w/5-603s. HISTORY OF OPERA. (3 cr per qtr; prereq 9 cr in history of music or history of art or history of theatre or European history from 1600 or ‡) Argento
Origins of opera; its development as a musico-dramatic form through analysis of libretto and music of representative masterpieces of the late Renaissance, Baroque, Classic, Romantic and Contemporary periods.

5-604f, 5-605w. HISTORY OF CHURCH MUSIC. (4 cr per qtr; prereq 1-606 or ‡; offered 1972-73 and alt yrs) Riedel
Trends, relationship of music to various theologies and liturgies.

5-607. GREGORIAN CHANT. (4 cr; prereq 1-606 or ‡) Riedel
Introduction to Gregorian Chant, its forms and style.

5-608. LEITURGIA. (4 cr; prereq 1-606 or ‡; offered alt yrs) Fleischer, Riedel
Survey of liturgies ranging from the Roman Chant to the twentieth century.

5-611. HYMNOLOGY (4 cr; prereq 6 cr in 1-603/1-604/1-605/1-606 or Art 3-104/3-105/3-106 or Phil 3-001, 3-002, 3-003 or Engl 3-966/3-967, or ‡) Fleischer, Riedel
History of hymn texts and tunes. Byzantine and Roman hymns. Lutheran, Anglican, Baptist, Congregational, Methodist, Presbyterian, Unitarian, and other hymns. History of hymn books. History of hymn settings.

5-631f. MUSIC IN MIDDLE AGES. (4 cr; prereq 1-606) Cardamone
Growth and development of western musical style from the time of its earliest written records to Machaut: Gregorian chant and accretions to the liturgy, chivalric song traditions in Spain, France, and Germany; organum, clausula, and motet.

5-632w/5-633s. THE MUSIC OF HUMANISM: ARS NOVA AND RENAISSANCE. (4 cr per qtr; prereq 5-631) Cardamone
Stylistic achievements in the 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; emphasis on stylistic analysis.

5-634f/5-635w/5-636s. MUSIC IN BAROQUE ERA. (3 cr per qtr; prereq 1-606; offered 1972-73 and alt yrs) Laudon
Development of vocal, instrumental, and sacred styles of baroque era.

5-637f/5-638w/5-639s. MUSIC IN GALLANT AND CLASSIC PERIODS. (3 cr per qtr; prereq 1-606; offered 1973-74 and alt yrs) Laudon
Transition from late baroque to gallant and classical styles.

5-641/5-642. MUSIC IN ROMANTIC ERA. (5 cr for 5-641, 4 cr for 5-642; prereq 1-606 or ‡; offered 1973-74) Riedel
Romanticism as a complex of individual styles having elements in common, developed by composers who had to resolve certain basic conflicts between their artistic heritage and their environment. Relationship to literary trends; nationalism.

5-661. GEORGE FRIEDRICH HANDEL: LIFE AND WORKS. (4 cr; prereq 1-606 or ‡) Riedel
Musical culture in middle and northern Germany during 17th and 18th centuries. Oratorio in Italy, France, Germany, and England. G. F. Handel's work with emphasis on his oratorios. Handel and England.

5-662. HEINRICH SCHÜTZ: LIFE AND WORKS. (4 cr; prereq 8 cr in music history or history of art or German literature or political history to 1700 or ‡) Riedel
Political events in 17th century Germany, Europe; Protestant hymn, psalm literature. Their musical elaborations in works of Schütz. Madrigals, monodies, sacred concerti and cantatas, passions.

5-663. LASSO AND PALESTRINA. (4 cr; prereq 8 cr in music history or Renaissance and Baroque art, or political history to 1700, or general history of Western philosophy or ‡) Riedel
Council of Trent, influence on sacred music of 16th century. Lasso's cosmopolitan style, Palestrina's a cappella style. Palestrina style, 17th, 18th centuries. Caecilianism of 19th, 20th centuries.

5-664. CHARLES IVES: LIFE AND WORKS. (4 cr) Riedel
Detailed study of Ives' compositions. Ives and American Transcendentalism. Ives and the Progressive Party. Ives as a 19th and 20th century composer.

5-665. RABINDRANATH TAGORE: MUSIC AND POETRY. (4 cr) Kagan
Life, philosophy, works. Influences: Europe, India's classical and folk traditions. His poetic forms and themes. Influence upon Bengali literature. Songs, operas, with bilingual texts.

5-666. STRAVINSKY. (4 cr) Cardamone
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 the ballet).

5-701, 5-702. AMERICAN MUSIC. (4 cr per qtr; prereq 1-606 or 8 cr in American history or American Studies or ‡) Riedel
From colonial times to present. American Indian music; sacred music in America, Puritan New England to the present time; jazz; music education; the symphony orchestra; contemporary music.

5-704, 5-705. LATIN AMERICAN MUSIC. (4 cr per qtr; offered 1973-74 and alt yrs) Riedel
Pre-Maya and pre-Inca times through colonial period to present. Music of Indians in Brazil, Inca countries. Afro-, Ibero-Latin American music. Folk, popular, contemporary music.

5-707. SCANDINAVIAN MUSIC. (4 cr; prereq major in music or Scandinavian or humanities or ‡)
Survey of the music of the Scandinavian countries, Norway, Sweden, Finland, Denmark, Iceland; historical backgrounds, folk music, church music, and the music of today.

5-741, 5-742. VOCAL LITERATURE. (4 cr per qtr; prereq 12 cr in 1-104 or 1-204 or 1-304 or ‡; offered 1973-74 and alt yrs) Schuessler, Sutton
Literature and pedagogy: performance of representative songs from major and minor composers. Study of significant vocal techniques from major schools of singing as they relate to song performance.

5-744f, 5-745w, 5-746s. PIANO LITERATURE. (2 cr per qtr; prereq 12 cr in 1-101 or 1-201 or 1-301 or ‡; offered 1972-73 and alt yrs) Weiser
History of keyboard literature suitable for piano performances from end of 16th century to present; its background and development. Performance illustrations by instructor, recordings.

5-747. ORGAN LITERATURE. (2 cr; prereq grad organ and musicology students or ‡) Fleischer
Development of organ literature and playing from 14th century to the present. Mutual influence of organ construction and composition emphasized, as well as various national schools of organ playing.

5-748. INTRODUCTION TO PIPE ORGAN BUILDING. (2 cr; prereq organ major, other music students with ‡)
Construction, scaling, voicing and tuning of organ pipes; lay-outs of mixtures; evaluation of specifications; construction and evaluation of different types of chests and actions; historical styles of organ building.

5-751f, 5-752w, 5-753s. GERMAN LIEDER. (2 cr per qtr; prereq 18 cr in 1-204 or 3-204, Ger 1-002, or ‡; offered 1972-73 and alt yrs)
Selected songs as regards interpretation and style. 5-751: Schubert, Mozart, Beethoven. 5-752: Schumann, Brahms, Franz, Wolf, Strauss. 5-753: Mahler, Hindemith, Berg, Schoenberg, Henze, Schoeck.

5-754. CHORAL LITERATURE: SMALL FORMS. (4 cr; prereq ‡; offered 1972-73 and alt yrs)
Survey of selected sacred music and secular choral music (small forms, i.e., motets, anthems, madrigals, etc.).

5-755. CHORAL LITERATURE: LARGE FORMS. (4 cr; prereq sr or grad, 1-506 or ‡; offered 1972-73 and alt yrs)
Study of selected sacred and secular choral compositions (large forms; i.e., mass, oratorio, magnificat, Stabat Mater, cantata) from 16th century to present.

5-757f. SYMPHONIES OF THE CLASSICAL ERA. (4 cr; prereq 8 cr in music history or art history or political history since 1750 or English or German literature since 1750, or ‡)
Through Haydn and Mozart; evolution of form and style in relation to contemporary thought and art through French Revolution.

5-758w. SYMPHONIES OF BEETHOVEN. (4 cr; prereq 8 cr in music history or art history or political history since 1750 or English or German literature since 1750, or ‡)
Evolution of Beethoven's symphonic form and style as reflection of intellectual, political, and artistic currents of the Napoleonic era.

5-759s. SYMPHONIES OF ROMANTIC ERA. (4 cr; prereq 8 cr in music history or art history or political history since 1750 or English or German literature since 1750, or ‡)
Schubert, Schumann, Mendelssohn, Berlioz, Liszt, Brahms, Franck, Dvorak, Tschaikowsky, Bruckner, Richard Strauss; their relation to dominant romantic trends of 19th century.

8-614, 8-615. HISTORY OF VOCAL ART. (4 cr per qtr; prereq 18 cr in 1-204, 3-204, or ‡; offered 1972-73 and alt yrs) Schuessler
Significant schools of singing from 1600 to present.

Ethnomusicology and Musicology

5-810. ASIAN MUSIC IN PERFORMANCE. (2 cr; prereq ‡) Kagan, staff
Development of vocal and/or instrumental skills through applied training and lecture demonstrations.

5-811. TRADITIONAL INDIAN MUSIC: THE SACRED AND THE PROFANE. (5 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 practice.

5-841. MUSIC BIBLIOGRAPHY. (4 cr; prereq 1-606 or ‡) Riedel
Survey and examination of music bibliographies, reference materials and monuments of music.

5-844, 5-845. INTRODUCTION TO MUSICOLOGY. (4 cr per qtr; prereq 5-841 or ‡; offered 1973-74 and alt yrs) Riedel
Scope, aims, methods, and resources of research in musicology including fields of acoustics, psychology, sociology, and theory.

5-861. INTRODUCTION TO ETHNOMUSICOLOGY. (5 cr; prereq ‡; offered 1973-74 and alt yrs) Kagan
Scope, aims, methods, and resources of research in ethnomusicology; including fields of acoustics, sociology, anthropology, folklore.

5-863. MUSICAL INSTRUMENTS OF THE WORLD. (4 cr; offered 1973-74 and alt yrs) Kagan
Organology; classification; comparative study of musical instruments in all cultures; history, distribution, structure, technology, acoustics. Instruments in literature, myths, iconography.

8-847/8-848. NOTATION OF POLYPHONIC MUSIC. (8-847, 5 cr; 8-848, 4 cr; prereq ‡) Cardamone
Transcription of vocal and instrumental polyphonic ensemble music from the Middle Ages through the 16th century. Transcription of music in black notation, white mensural notation, keyboard and lute tabulatures. Problems of transcribing and editing.

8-851. HISTORY OF MUSIC THEORY. (4 cr; prereq ‡) Cardamone, Riedel
From antiquity to 20th century. Ancient and medieval treatises; instruction and performance books of Renaissance and baroque eras; counterpoint, harmony, and analysis books of 19th and 20th centuries.

8-854/8-855. BASIS OF MUSICAL EXPRESSION. (4 cr per qtr; prereq ‡)
Factors of music which convey other impressions of emotional character than those attributable to structure. Application of the analytical process to the work of one composer, presented in a final critical study.

8-864/8-865. RESEARCH IN ETHNOMUSICOLOGY. (4 cr per qtr; prereq 5-861 or 5-862 or ‡) Kagan
Methods and techniques of field work, 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.

8-990.* ADVANCED TOPICS. (2-12 cr; prereq 5-841) Staff

8-990. ADVANCED TOPICS — COMPUTER. (2-12 cr) Riedel

8-990x.* SPECIAL PROBLEMS. (2-12 cr; prereq 5-841) Staff

NEUROLOGY, NEUROSURGERY, AND NURSING

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

NUTRITION (Nutr)

Professor

Robert J. Meade, *chairman* (Animal Science)
Joseph T. Anderson, *vice chairman* (Physiological Hygiene)
Charles F. Code (Mayo Foundation, Rochester)
John D. Donker (Animal Science)
Margaret D. Doyle (Nutrition, Home Economics)
Clifford F. Gastineau (Mayo Foundation, Rochester)
Robert L. Glass (Biochemistry, Biological Sciences)
Richard D. Goodrich (Animal Science)
Francisco Grande (Physiological Hygiene)
Lester E. Hanson (Animal Science)
Lavell M. Henderson (Biochemistry, Biological Sciences)
Ancel Keys (Physiological Hygiene)
Irvin E. Liener (Biochemistry, Biological Sciences)
Jay C. Meiske (Animal Science)
Lura M. Morse (Nutrition, Home Economics)
Donald E. Otterby, *director of graduate study* (Animal Science)
Max O. Schultze (Biochemistry, Biological Sciences)
John F. Van Pilsum (Biochemistry, Medical Sciences)
Paul E. Waibel (Animal Science)
Jesse B. Williams (Animal Science)

Associate Professor

John D. Smith (Animal Science)
George M. Speers (Animal Science)
Ruth E. Stief (Public Health)
Patricia B. Swan (Nutrition, Home Economics)

Assistant Professor

James D. Jones (Mayo Foundation, Rochester)
Ralph A. Nelson (Mayo Foundation, Rochester)
James W. Nordstrom (Animal Science)

Prerequisites – A strong foundation in biological sciences including 1 quarter of microbiology, college mathematics through calculus, the equivalent of a year of general chemistry, a year of organic chemistry, a course in quantitative analysis, and a minimum of 2 quarters of college physics. Deficiencies must be removed before students can become candidates for a degree. For minor work, students must satisfy the nutrition graduate faculty that they have an adequate background.

Language Requirements – No foreign language is required for the M.S. or Ph.D., in nutrition. However, an individual adviser may specify one or two foreign languages for a student's program. Students wishing to have proficiency in a foreign language recorded on their transcript must pass the Graduate School Foreign Language Test or be certified as proficient by the appropriate language department.

Master's Degree – Offered under Plan A and Plan B.

Doctor's Degree—For major study, students will be required to develop and demonstrate a general competence in nutrition, including a comprehensive knowledge of basic biochemistry and statistics. In addition, students will be expected to develop a minor or coherent program in field(s) of study closely allied to nutrition, e.g., biochemistry, histology, embryology, anatomy, microbiology, physiology, and zoology. Thesis work can be conducted in the area of (a) human nutrition, (b) nonruminant nutrition (laboratory rat, swine, and poultry), or (c) ruminant nutrition. General competence in nutrition will be required of students with a nutrition minor.

Graduate study in nutrition is also offered at the Mayo Graduate School of Medicine of the University of Minnesota. See the bulletin, *Graduate Programs in the Health Sciences.*

Note — The following is a list of courses from which selections for major and minor programs are commonly made; other courses are also available. Detailed descriptions of all courses can be seen in the course lists of the indicated departments.

AnSc 8-420.* ENERGY IN ANIMAL NUTRITION. (3 cr; prereq BioC 5-002 or equiv or ♯...BioC 5-743 recommended; offered 1972-73 and alt yrs)

AnSc 8-421.* PROTEIN AND AMINO ACID NUTRITION. (3 cr; prereq BioC 5-002 or equiv or ♯...BioC 5-743 recommended; offered 1972-73 and alt yrs)

AnSc 8-422.* VITAMIN NUTRITION. (3 cr; prereq BioC 5-742 or ♯; offered 1973-74 and alt yrs)

AnSc 8-423.* MINERAL NUTRITION. (3 cr; prereq BioC 5-002 or ♯...BioC 5-742 recommended; offered 1973-74 and alt yrs)

AnSc 8-440.* RUMINANT NUTRITION. (3 cr; prereq BioC 5-002 or ♯...MicB 5-321 recommended; offered 1972-73 and alt yrs)

AnSc 8-740. CONCEPTS AND DEVELOPMENTS IN RUMINANT NUTRITION. (2 cr; prereq ♯)

AnSc 8-741. CONCEPTS AND DEVELOPMENTS IN AVIAN NUTRITION. (2 cr; prereq ♯; offered 1972-73 and alt yrs)

AnSc 8-742. CONCEPTS AND DEVELOPMENTS IN SWINE NUTRITION. (2 cr; prereq ♯; offered 1972-73 and alt yrs)

AnSc 8-840x.* RESEARCH: ANIMAL NUTRITION. (Cr ar; prereq ♯)

BioC 5-741f/5-742w/5-743s. GENERAL BIOCHEMISTRY. (3 cr per qtr; prereq ¶5-745/5-746 except with △, Chem 3-303, 5-501 or 5-520 or equiv or ¶Chem 5-501 or 5-520 or ♯) Same as MdBc 5-741/5-742/5-743.

BioC 5-745/5-746. GENERAL BIOCHEMISTRY LABORATORY. (3 cr per qtr; prereq ¶5-741/5-742, cr in analytical chemistry and ♯)

BioC 5-747. ADVANCED BIOCHEMICAL TECHNIQUES. (3 cr; prereq 5-746, ¶5-743, ♯) Staff

BioC 8-225. TRACER TECHNIQUES. (3 cr; prereq ♯, 5-743, 5-746 or MdBc 5-750)

BioC 8-271. VITAMINS. (3 cr; prereq 5-743 or ♯) Schultze

HE 5-361. HUMAN NUTRITION. (5 cr per qtr; prereq 3-361, BioC 1-301, Phsl 3-051 or ♯)

HE 5-371. CLINICAL NUTRITION. (5 cr; prereq 5-361, BioC 5-002 or ¶BioC 5-002 or ♯)

HE 5-391. NUTRITION TOPICS. (1 cr) Doyle, Morse, Swan

HE 5-392. READINGS: NUTRITION. (2 cr; prereq 5-361) Nutrition Division staff

HE 5-393x. CLINICAL PROBLEMS: NUTRITION. (2-5 cr [2 cr at StP and/or 3 cr at Rochester]; prereq 5-361, BioC 5-002 or ¶BioC 5-002) Rey

HE 8-361/8-362. PRINCIPLES: HUMAN NUTRITION. (3 cr per qtr; prereq 5-361, ♯) Nutrition Division staff

HE 8-395x. SEMINAR: NUTRITION. (1 cr; prereq ♯) Nutrition Division staff

HE 8-396x.* HOME ECONOMICS PROBLEMS. (1-5 cr per qtr; prereq ♯) Nutrition Division staff

Nutr 8-745. SEMINAR. (1 cr [may be repeated for cr]; prereq ♯) Staff

PubH 5-380. APPLIED HUMAN NUTRITION. (3 cr; prereq ♯) J Anderson, Stief

OBSTETRICS AND GYNECOLOGY

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

OPERATIONS RESEARCH (OR)

Professor

John S. White (mechanical engineering), *director of graduate studies*
John E. Anderson (mechanical engineering)
Raymond O. Collier (psychological foundations)
Daniel L. Gerlough (civil and mineral engineering)
Thomas R. Hoffmann (management science)
Eugene A. Johnson (biometry)
E. Bruce Lee (electrical engineering)
Gayle W. McElrath (mechanical engineering)
Richard B. McHugh (biometry)
John Neter (management science)
Katsuhiko Ogata (mechanical engineering)
Edgar Reich (mathematics)
Milton Sobel (statistics)

Associate Professor

Carl R. Adams (management science)
Sant R. Arora (mechanical engineering)
Frederick N. Bailey (electrical engineering)
Norman L. Chervany (management science)
Jay Goldman (mathematics)
Roger G. Schroeder (management science)

Assistant Professor

Walter A. Fishel (agricultural and applied economics)
Robert G. Jeroslow (mathematics)
Stanley C. Johnson (mechanical engineering)
Peter J. M. Nicholson (computer information and control sciences)
Patrick J. Starr (mechanical engineering)

Prerequisites – For admission to the Master's program an adequate quantitative background including calculus, differential equations, linear algebra, and matrix theory. A qualifying examination may be required. For admission to the Ph.D. program a background in mathematics, statistics and introductory operations research comparable to that required for the Master's degree in operations research. A qualifying examination may be required.

Language Requirements – No foreign languages are required.

Master's Degree – Offered both under Plan A and Plan B. All candidates for the Master's degree are required to fulfill the following requirements:

1. Demonstrate proficiency in applied probability, statistics, stochastic systems and mathematical programming. A minimum basic core of graduate courses in the following areas is required
   - Mathematical programming and optimization techniques — 3 courses
   - Probability and statistics — 2 courses
   - Stochastic systems — 1 course
2. Demonstrate competency in computer programming at least at the level of FORTRAN.

Doctor's Degree – The program of study for all students will be developed in consultation with their major advisor and with the concurrence of the graduate faculty. A minimum "basic core" in the following areas is required for every student.

- Mathematical programming and optimization techniques — 4 courses
- Probability and statistics—5 courses
- Stochastic systems — 2 courses

Students are also required to demonstrate competence in the use of computers. After completion of the required course work, students must pass a written examination on the basic core subjects, and subsequently, the preliminary oral examination, in which they will be expected to show in considerable depth a knowledge of the core courses and the peripheral areas in which they have specialized and in which they plan to do research and develop their dissertation.

OPHTHALMOLOGY (Opth)

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

ORAL BIOLOGY (OBio)

Professor

Burton L. Shapiro, D.D.S., M.S.D., Ph.D., *chairman, director of graduate study*
Wallace D. Armstrong, M.D., Ph.D.
Robert J. Gorlin, D.D.S., M.S.
Robert J. Isaacson, D.D.S., M.S.D., Ph.D.
Lawrence H. Meskin, D.D.S., M.S.D., M.P.H., Ph.D.
Carl J. Witkop, D.D.S., M.S.

Associate Professor

Robert S. Redman, D.D.S., M.S.D., Ph.D.
Quenton T. Smith, M.S., Ph.D.

Assistant Professor

Susan A. Schafer, Ph.D.

Oral biology is the study of the oro-facial region, its development (including aging), structure, function, and pathology. Graduate programs in oral biology train individuals for academic and research careers concerned with problems of the mouth and its contained and related tissues, and thus prepare them for employment in dental schools, oral research centers, and other institutions engaged in similar activities. Students may choose to obtain clinical speciality training concurrently or at some other time. However, clinical training cannot be used to fulfill requirements for oral biology programs.

Prerequisites – 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 an individual who has not yet obtained the D.D.S. (D.M.D.) or M.D. degree and has demonstrated exceptional potential for graduate study may be admitted on a combined program. Individuals with bachelor's or master's degrees who can demonstrate sufficient background and interest in oral biology will also be considered for admission.

Language Requirement – Will be determined individually for each candidate in consultation with the adviser and the director of graduate studies. The need for language proficiency, the level of such proficiency and the choice of language(s) will depend on the area in which the student expects to concentrate efforts.

Master's Degree — Offered under plans A and B as described in the General Information section.

Doctor's Degree – During the first year all students must take for credit 8-010 and 8-011. During each quarter of the first year each student will work with a faculty member to acquire research experience through quarter-long apprenticeships. These assignments will be the product of negotiation among the director of graduate study, the student and the faculty members involved with a view that they reflect the student's interests and provide the student with breadth of exposure to faculty activities. Registration will be through 8-002. Also the student will be required to attend weekly seminars, 8-030. Other than these requirements programs will be individually designed by consultation among the student, the adviser and the director of graduate study. Together with the adviser, the graduate student will choose a minor or supporting field and choose those areas in the major field of oral biology that will best meet needs and interests.

8-001. RESEARCH IN ORAL BIOLOGY. (Cr ar) Staff

8-002. TUTORIAL IN ORAL BIOLOGY. (Cr ar, 2 hrs per wk = 1 cr [may be repeated]) Staff
Quarter long apprenticeship with faculty members to familiarize students with faculty research interests.

8-010. ORAL BIOLOGY I. (3 cr) Staff
Basic concepts of cell biology and human biology for dental specialist and/or oral research trainees.

8-011. ORAL BIOLOGY II. (3 cr; prereq 8-010 or ‡) Staff
Continuation of 8-010.

8-015. SALIVARY GLANDS AND THEIR SECRETIONS. (2 cr; prereq Anat 5-103 and Anat 5-104 or Anat 5-105 or ‡; offered odd numbered yrs) Redman
Comparative morphology and functions of salivary glands of man and laboratory animals. Synthesis and secretion of salivary proteins. Analysis of relationships of salivary constituents to glandular components and variations in secretory stimulation. Effects of salivary constituents on oral environment.

8-016. DEVELOPMENTAL BIOLOGY OF SALIVARY GLANDS. (2 cr; prereq 8-015 or ‡; offered even numbered yrs) Redman
Morphologic and biochemical description of the development of salivary glands, including initiation, morphodifferentiation and cytodifferentiation. Cell proliferation vs. cytodifferentiation. Relationships among gland development, gland function, and the development and environment of the animal. Comparison with development of other exocrine organs. Based largely on material from laboratory animals, but with frequent reference to available human material.

8-018. BIOLOGY OF MINERALIZED AND OTHER CONNECTIVE TISSUES. (3 cr; offered spring 1973) Smith
Lectures and discussions on developmental biology of connective tissues, the 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.

8-021, 8-022, 8-023, 8-024. TOPICS IN ORAL BIOLOGY. (1-3 cr [may be repeated for cr]; prereq ‡) Staff
Different topic or subject area each quarter, announced in advance. May include: saliva and salivary glands; pain and sensation; aging; biomaterials; hard tissue metabolism.

8-030. SEMINAR. (1 cr [may be repeated for cr]) Staff
Faculty and student participation in discussion of current topics in oral biology.

Additional major course work may be drawn from medical basic sciences and other individually appropriate areas.

ORTHOPEDIC SURGERY AND OTOLARYNGOLOGY

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

PATHOLOGY (Path)

Professor
Robert A. Good, M.D., Ph.D., *head, director of graduate study*
A. B. Baker, M.D., Ph.D.
Ellis S. Benson, M.D.
Jesse E. Edwards, M.D.
Robert Hebbel, M.D., Ph.D.
Paul H. Lober, M.D., Ph.D.
Takashi Okagaki, M.D.
Kenneth A. Osterberg, M.D.
Alexander C. Templeton, M.D.
Lee W. Wattenberg, M.D.
Edmond J. Yunis, M.D.

Associate Professor
W. Robert Anderson, M.D.
Barbara A. Burke, M.D.
John I. Coe, M.D.
Richard D. Estensen, M.D.
Donald F. Gleason, M.D., Ph.D.
Erhard Haus, M.D., Ph.D.
Osias Stutman, M.D.

Assistant Professor
Miguel M. Azar, M.D., Ph.D.
Yong Sung Choi, M.D., Ph.D.
Beulah H. Gray, Ph.D.
John H. Kersey, M.D.
Robert E. T. Rydell, M.D.

Instructor
Frederick H. Lott, M.D.

Prerequisites – Graduate students who desire to take their major work in pathology must present credits for the equivalent of the first 2 years' work of the Medical School of this University. A degree with designation, such as M.S. in pathology, is awarded only to those who have an M.D. degree.

Language Requirement – For the Master's degree, one foreign language. For the Ph.D. degree, either (a) two foreign languages or (b) one foreign language and the option of a collateral field of knowledge. French, German, and Russian are acceptable languages.

Master's Degree – Offered only under Plan A.

Master's Degree with Designation in Pathology – Given only after 3 years of work.

Doctor's Degree – The Ph.D. degree with designation in pathology may be awarded after completion of 3 or more years in graduate work and presentation of a thesis of high quality.

Note – Graduate study in pathology is also offered at the Mayo Graduate School of Medicine of the University of Minnesota. See the bulletin, *Graduate Programs in the Health Sciences.*

5-101. PATHOLOGY. (6 cr; prereq regis 1st yr med school, grad ‡) Good, Hebbel and staff
General pathology.

5-104x. AUTOPSIES. (Cr ar; prereq grad medical student or Phase B, D) Staff

5-105. DISEASES OF THE KIDNEY. (3 cr; prereq grad medical student or Phase B, D) Hebbel

5-106. DISEASES OF THE HEART. (1 cr; prereq grad medical student or Phase B, D) Edwards

5-107. INTRODUCTORY CYTOPATHOLOGY. (2 cr; prereq grad medical student or Phase B, D, others ‡)

5-110x. SEMINAR: PATHOLOGY. (1 cr per qtr; prereq Phase A) Good

5-111x. CONFERENCE ON AUTOPSIES. (1 cr per qtr; prereq grad medical student or Phase B, D) Staff

5-112. DIAGNOSIS OF TUMORS. (Cr ar; prereq grad medical student or Phase B, D) Hebbel

5-113x. SURGICAL PATHOLOGY. (Cr ar; prereq grad medical student or Phase B, D) Hebbel

5-120. DISEASES OF THE LUNGS. (1 cr; prereq grad medical student or Phase B, D) Staff

5-121. DISEASES OF THE ALIMENTARY TRACT. (1 cr; prereq grad medical student or Phase B, D) Hebbel

5-122. BASIC SCIENCE OF CANCER. (3 cr; prereq MdBc 5-100 or equiv) Wattenberg

5-124. VIRUSES IN THE PATHOGENESIS OF DISEASE. (Cr and hrs ar)

5-126. SEMINAR: ADVANCES IN IMMUNOBIOLOGY. (1 cr) Good

5-127. CLINICAL IMMUNOBIOLOGY. (Cr and hrs ar) Good, Holmes

5-128. EXPERIMENTAL IMMUNOPATHOLOGY. (2 cr; prereq grad medical or medical student) Staff

5-130. IMMUNOHEMATOLOGY. (2 cr; prereq grad medical student or ‡) Azar

5-132. MEMBRANES. (1 cr; prereq grad medical student and Phase D) Choi

5-140. SEMINAR: EXPERIMENTAL PATHOLOGY. (1 cr) Halberg

5-141. PROBLEMS IN EXPERIMENTAL PATHOLOGY. (Cr and hrs ar) Halberg

5-160. DISEASES OF THE LIVER. (1 cr; prereq grad medical student or Phase B, D)

5-161. FORENSIC PATHOLOGY. (2 cr; prereq 5-104 or equiv or △) Coe

8-201x. RESEARCH. (Cr and hrs ar; grad students with necessary preliminary training may elect research, either as majors or minors in pathology)

8-207. RESEARCH IN EXPERIMENTAL PATHOLOGY. (Cr and hrs ar) Halberg

8-701. ADVANCED NEUROPATHOLOGY. (Cr ar, §Neur 8-703) Baker

8-702. SURVEY OF NEUROPATHOLOGY. (Cr ar, §Neur 8-704)
Examination of specimens from current autopsies.

PEDIATRICS (Ped)

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

PHARMACEUTICS (Phm)

Professor

Edward G. Rippie, Ph.D., *head, director of graduate study* (pharmaceutics)
Hugh F. Kabat, Ph.D., *head, department of clinical pharmacy, and director of graduate study* (hospital pharmacy)

Associate Professor

Robert H. Miller, Ph.D.
John D. McRae, Ph. D.

Assistant Professor

Kenneth W. Miller, Ph.D.
Kenneth G. Nelson, Ph.D.

Pharmaceutics is concerned with the elucidation, analysis, and means of control of the physical chemical properties of the drug and its dosage forms as they influence its availability to the site of action in the living organism. Such studies include the investigation of the functional relationships existing between tissue or body fluid concentrations of drugs or related compounds and the rates or mechanisms of their absorption, distribution, metabolism, excretion, and pharmacological activity. Thus the area is broad, offering specialization ranging from highly physical to strongly biological orientations.

Program in Hospital Pharmacy

Prerequisites – A degree from a college of pharmacy and an exceptional scholarship record. Evidence of personal capability and fitness for work in the hospital field is also necessary in each case and will be considered an essential requirement for admission.

Language Requirement – Students taking the degree under Plan B (without thesis) are not required to offer a language; those taking a Plan A degree (with thesis) must offer one.

Minor Fields – The choice of minor fields of study may vary considerably depending on the research interest of the student. The selection of courses will be made after consultation with the student's adviser.

Master's Degree – Either Plan A or Plan B is acceptable.

Program in Pharmaceutics

Prerequisites – A degree from a college of pharmacy and an exceptional scholastic record. Consideration will also be given to applicants who are graduates of institutions other than colleges of pharmacy provided their undergraduate courses satisfy the prerequisities for the graduate courses in pharmaceutics.

The department presents a comprehensive program of coursework and research offerings leading to the M.S. and Ph.D. degrees. A basic background in the physical and biological sciences is provided as a firm foundation for the study of modern pharmaceutics. The broad scope of the program affords the student an exceptional opportunity to elect a course of study which best meets individual needs and interests. Minor fields which are particularly desirable include physical chemistry, chemical engineering, biochemistry, and pharmacology.

Language Requirement – For the Master's degree, either (a) one foreign language or (b) a collateral field of knowledge with the consent of the director of graduate study. For the Ph.D. degree, the option of (a) two foreign languages, (b) one foreign language and a collateral field of knowledge with the consent of the

director of graduate study, or (c) two collateral fields of knowledge with the consent of the director of graduate study.

Minor — The choice of the particular courses to be presented in fulfillment of a minor in graduate work will be made after consultation with the student's adviser.

Master's Degree — Offered under both Plan A and Plan B.

Doctor's Degree — Work leading to the Ph.D. degree is offered.

5-520.* VETERINARY SCIENCE. (3 cr; prereq Phsl 3-070, Phcl 5-102 or equiv)
(Same as VPP 5-520.) Specialization course. Professional interrelationships between pharmacists and veterinarians, disease problems of domestic animals, and animal pharmacology.

5-670/5-680. BIOPHARMACEUTICS — DRUG INFORMATION EVALUATION. (4 cr per qtr; prereq 5th yr, 5-640, Phcl 5-102; 3 lect hrs per wk, 1 workshop per wk [2 hrs]) K Miller
Consideration of the processes of drug absorption, distribution, metabolism, and excretion *in vivo*. Statistical methods and procedures for critical evaluation of current literature dealing with those subjects.

5-690.* COSMETICS AND DERMATOLOGICAL PREPARATIONS. (3 cr; prereq 5-640) R Miller
Pharmaceutical aspects of cosmetics and dermatological preparations.

5-692/5-694.* PHARMACEUTICAL MANUFACTURING. (3-5 cr per qtr; prereq 5-640, MedC 5-490, or ‡) R Miller
Production and control of pharmaceutical preparations on a pilot plant scale. Formula development and product stabilization.

5-696.* PREPARATION OF PARENTERAL PRODUCTS. (3 cr; prereq ‡) Nelson
Principles and procedures involved in manufacture of parenteral products.

5-699.* SPECIAL PROBLEMS IN PHARMACEUTICS. (Cr ar; prereq ‡) Staff
Problems in formulation, production, and evaluation of pharmaceutical products.

5-700. HOSPITAL PHARMACY ADMINISTRATION I. (2 cr; prereq ‡) Kabat
History, classification, organization, and functions of departments in a hospital in relation to pharmacy service.

5-701. HOSPITAL PHARMACY ADMINISTRATION II. (3 cr; prereq 5-700, ‡) Kabat
Development, organization, responsibility, and administration of hospital pharmacy services.

5-702. HOSPITAL PHARMACY SURVEY. (1 cr; prereq 5-701, ‡) Kabat

8-100.* SEMINAR: PHARMACEUTICS. (1 cr; required of majors in pharmaceutics) Staff

8-200.* RESEARCH PROBLEMS. (Cr ar; prereq MedC 5-490 or ‡) Staff
Experimental investigation of problems in pharmaceutics.

8-300/8-301. PHARMACEUTICAL DEVELOPMENT. (5 cr per qtr; prereq 5-694 or ‡; offered when demand warrants) R Miller
Theoretical and practical problems involved in new product development including F.D.A. regulations, new drug application procedures, patents, and production and control on a pilot plant scale.

8-310/8-311. EXTRACTION, DISTRIBUTION, AND PARTITION SYSTEMS. (3-5 cr per qtr; prereq MedC 5-494, Chem 5-503 or ‡; offered when demand warrants) R Miller
Special procedures for control of foods, drugs, and cosmetics, e.g., sampling techniques and design of experiments for control of shelf-life, storage conditions, loss of potency, etc.

8-400/8-401. ADVANCED ANALYTICAL METHODS. (3-4 cr per qtr; prereq MedC 5-494, Chem 5-503 or ‡; offered when demand warrants) Rippie
Theory and practice of extraction of liquids and solids, counter current distribution, solvent and solute effects and chromatography.

8-410. STABILIZATION OF PHARMACEUTICALS. (3 cr; prereq Chem 5-503) McRae
Application of physicochemical principles (e.g., chemical kinetics) to elucidate and minimize stability problems in pharmaceutical systems.

8-420.* PHARMACOKINETICS. (3-5 cr; prereq Math 1-444, 5-670 or ‡) K Miller
Principles of adsorption, distribution, metabolism, and excretion of drugs in the mammalian system as defined by kinetic theory.

8-430. DRUG TRANSPORT. (3 cr; prereq Chem 5-503) Nelson
Theory of diffusional transport of drug molecules with applications to pharmaceutical dosage forms.

PHARMACOGNOSY (Phcg)

Professor
E. John Staba, Ph.D., *chairman, director of graduate study*

Associate Professor
Yusuf Abul-Hajj, Ph.D.

Prerequisites – A degree from an accredited college of pharmacy and a superior scholastic record. Consideration will also be given to applicants who are graduates of institutions other than colleges of pharmacy.

Language Requirement – For the Master's degree, one foreign language is advised but not required. For the Ph.D., the requirement may be met either by (a) two foreign languages, (b) a higher order of proficiency in one foreign language, or (c) one foreign language selected from French, German, Japanese, or Russian plus a collateral field of study or a special research technique.

5-820. INTRODUCTORY PHARMACOGNOSY. (3 cr; prereq MicB 3-103 or ‡, MedC 5-440; 3 lect hrs per wk) Mullen
Study of the principles of immunology and allergy, the pathogenic microorganisms and the treatment of disease states with immunizing biologicals.

5-830. INTRODUCTORY PHARMACOGNOSY. (3 cr; prereq 5-820 or ‡; 3 lect hrs per wk) Staba
Production, constituents, metabolism, and therapeutic uses of drugs containing antibiotics, amino acids, and enzymes.

5-840. INTRODUCTORY PHARMACOGNOSY. (4 cr; prereq MedC 5-440; 3 lect and 3 lab hrs per wk) Abul-Hajj
Production, constituents, metabolism, and therapeutic uses of drugs containing hormones, vitamins, and alkaloids.

5-860. ANTIBIOTICS. (2 cr; prereq 5-830 or ‡) Staba
Natural antibiotic substances. Methods of production, biosynthesis, extraction, and assay; chemical, pharmaceutical, and chemotherapeutic properties.

5-870. VITAMINS AND HORMONES. (2 cr; prereq 5-840 or ‡) Abul-Hajj
Biosynthesis, chemistry, biochemical functions, mechanisms of actions, production, and uses.

5-875. ANTIBIOTICS, VITAMINS, AND HORMONES LABORATORY. (1 cr; prereq 5-830, 5-840, or ‡) Staff
Introduction to techniques used to produce, isolate, and observe biological effects of these substances.

5-899. SPECIAL PROBLEMS IN PHARMACOGNOSY. (Cr ar; prereq ‡) Staff
Microbiology, chemistry, or biology of medicinal natural products.

8-100. MEDICINAL PRODUCT ISOLATION AND IDENTIFICATION. (4 cr; prereq ‡; offered when feasible) Staff
Isolation and identification of a glycoside, pigment (flavonoid, tetracycline, etc.), and a heterocyclic compound (alkaloid, etc.) from either plants or animals.

8-200. MEDICINAL PRODUCT ISOLATION AND IDENTIFICATION. (4 cr; prereq ‡; offered when feasible) Staff
Isolation and identification of a triterpene or steroid, terpene (citral, geranoil, etc.), and a phenylpropide (coumarin, chlorogenic acid, etc.) from either plants or animals.

8-300. PHARMACEUTICAL FERMENTATION TECHNIQUES. (4 cr; prereq ‡)
Physical and nutritional factors involved in production and biotransformation of antibiotics, steroids, alkaloids, growth regulators, and other useful compounds by microorganisms, tissue cultures, and extracellular enzyme preparations.

8-400. SELECTED TOPICS. (3 cr on completion of 3 qtrs) Staff

8-500. PHARMACOGNOSY SEMINAR. (1 cr per qtr) Staff

8-900x. RESEARCH IN PHARMACOGNOSY. (Cr ar; prereq ‡) Staff

PHARMACOLOGY (Phcl)

Professor

Frederick E. Shideman, M.D., Ph.D., *head*
Jack W. Miller, Ph.D., *director of graduate study*
Norman O. Holte, D.D.S.
Xenia Machne, M.D.
Gilbert J. Mannering, Ph.D.
Akira E. Takemori, Ph.D.
Lawrence C. Weaver, Ph.D.
Wallace F. White, Ph.D.

Associate Professor

Marion W. Anders, Ph.D.
Nelson D. Goldberg, Ph.D.
Donald B. Hunninghake, M.D.
Bernard L. Mirkin, M.D., Ph.D.
Roy W. Pickens, Ph.D.
Ben G. Zimmerman, Ph.D.

Assistant Professor

James F. Cumming, M.D., Ph.D.
Patrick E. Hanna, Ph.D.
Aloysius J. Quebbemann, Ph.D.
Norman E. Sladek, Ph. D.
Sheldon B. Sparber, Ph.D.

Pharmacology is a broad science which considers the interactions between drugs and other chemicals and living organisms or life processes at all levels of organization. Facilities are available for most types of training and research in this field. For those primarily interested in toxicology or psychopharmacology appropriate programs are provided. Excellent opportunities exist for cooperative clinical research through members of the staff who hold joint appointments in clinical departments of the Medical School and are members of the Division of Clinical Pharmacology of the Department of Pharmacology.

Graduate training in the field of pharmacology is usually oriented toward the Ph.D. degree. The M.S. degree is offered only under special circumstances. Several graduate fellowships, research assistantships, teaching assistantships, or traineeships are usually available.

Prerequisites – In addition to fulfilling requirements for admission to the Graduate School, students should be well grounded in the biological and physical sciences.

Major – For a major the student is required to complete each of the medical courses prerequisite to, and including, the major courses in general pharmacology (8-211 through 8-218, 8-203 and 8-204). Prerequisite courses include physiology and biochemistry. Additional requirements are courses in histology, statistics, calculus, microbiology and such others as may be indicated by the major adviser.

Minor – To meet the requirements for a minor in pharmacology, the student must satisfactorily complete course work representing 22 credits. These courses must include 8-211 and no more than 8 credits of seminar of which at least 3 credits shall be 8-204.

Language Requirement – For the Master's degree, no foreign language is required. For the Ph.D. degree, either (a) one foreign language or (b) an additional program of course work approved by the department. Routinely acceptable languages for the Ph.D. degree are French, German, Italian, Russian, and Spanish.

Master's Degree – Offered only under Plan A.

Doctor's Degree – Work leading to Ph.D. degree is offered.

Note – Graduate study in pharmacology is also offered at the Mayo Graduate School of Medicine of the University of Minnesota. See the bulletin, *Graduate Programs in the Health Sciences.*

8-203. RESEARCH IN PHARMACOLOGY. (Cr and hrs ar; prereq ‡) Shideman, staff

8-204. SEMINAR: SELECTED TOPICS IN PHARMACOLOGY. (3 cr on completion of 3 qtrs; prereq 5-102 or ‡) Mirkin, staff

8-207. SEMINAR: PSYCHOPHARMACOLOGY. (3 cr on completion of 3 qtrs; prereq ‡) Sparber, staff
Selected topics on behavioral aspects of drug action.

8-211. PHYSIOLOGICAL DISPOSITION OF DRUGS. (3 cr; prereq MdBc 5-101 or equiv or ‡; offered 1973-74 and alt yrs) Mannering, staff
Lectures on principles underlying absorption, distribution, biotransformation, and excretion of drugs.

8-212, 8-213. PHARMACODYNAMICS. (2 cr per qtr; prereq 8-210 or ‡; offered 1972-73 and alt yrs) Takemori, staff
Lectures and laboratory experiments on methods employed for studying physiological, biochemical, and behavioral effects of drugs.

8-214. TOXICOLOGY. (3 cr; prereq MdBc 5-101 or equiv or ‡; offered 1973-74 and alt yrs) Anders, staff
Lectures on toxic effects and mechanisms of action of chemicals known to adversely affect the health of man and other animals.

8-215. CHEMOTHERAPY. (2 cr; prereq 8-210, MdBc 5-101 or equiv, MicB 5-105 or equiv or ‡; offered 1972-73 and alt yrs) Sladek, staff
Lectures on principles of chemotherapy with emphasis on mechanisms of selective toxicity.

8-216. ENDOCRINE PHARMACOLOGY. (2 cr; prereq Phsl 5-100 or equiv, MdBc 5-101 or equiv or ‡; offered 1973-74 and alt yrs) Goldberg, Hunninghake
Lectures on control of biosynthesis and secretion of hormones, their physiologic and metabolic actions; mechanisms of action of drugs which influence the endocrine system.

8-217. CARDIOVASCULAR-RENAL PHARMACOLOGY. (3 cr; prereq 8-210, Phsl 5-103, 5-104, or equiv or ‡; offered 1972-73 and alt yrs) Shideman, staff
Lectures on effects and mechanisms of action of drugs which predominantly affect the heart, blood vessels and kidneys.

8-218. NEUROPHARMACOLOGY. (4 cr; prereq 8-210, Phsl 5-103, Phsl 5-104, or equiv, MdBc 5-100 or equiv or ‡; offered 1973-74 and alt yrs) Zimmerman, staff
Lectures on effects and mechanisms of action of drugs on central and peripheral nervous systems.

8-219. BEHAVORIAL PHARMACOLOGY. (3 cr; prereq 8-210, Psy 5-017 or ‡) Pickens, staff
Analysis of the behavioral effects of drugs.

PHARMACY ADMINISTRATION (PhAd)

Professor

Hugh F. Kabat, Ph.D., *director of graduate study*
Lawrence C. Weaver, Ph.D.
Vernon E. Weckwerth, Ph.D.

Associate Professor

Theodore J. Litman, Ph.D.

Assistant Professor

William Hodapp, M.S.
Martin Jinks, Pharm.D.
Thomas Jones, M.H.A.
Karl Schuttenhelm, Pharm.D.

Graduate work is available to qualified pharmacists who wish to prepare themselves to investigate the relationships of various biological and physical factors in the social settings in which pharmaceutical functions exist. This flexible interdisciplinary program utilizes the resources of the University's many social science departments to prepare pharmacists to investigate drug use, abuse, and nonuse; to research the clinical setting in which pharmacy is practiced; and to direct educational programs for pharmacy practitioners and students.

Prerequisites — A degree from a college of pharmacy and an exceptional scholastic record.

Language Requirement — For the Master's degree, none. For the Ph.D. degree none; however, either a collateral field of knowledge or a special research technique is required.

Minor – The choice of minor and collateral fields and special research techniques may vary considerably depending on the research interest of the student but will be developed in consultation with graduate faculty advisers in that specific area.

Master's Degree – Offered under both Plan A and Plan B.

Doctor's Degree – Work leading to the Ph.D. degree is offered.

8-100. SEMINAR. (1 cr per yr) Staff

8-200. RESEARCH PROBLEMS. (Cr ar) Staff

8-235. LEGISLATIVE CONTROLS. (3 cr; prereq ‡)
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.

8-255. DRUG MARKETING. (3 cr; prereq ‡)
Historical development of distributive systems, underlying economic principles, marketing channels, agencies, institutions, functions, policies, and practices as they relate to the pharmaceutical industry.

8-270. CLINICAL CONFERENCES. (2 cr [may be repeated for 6 cr max]) Staff
Monitoring of patient drug therapy in a clinical setting.

8-290. CLINICAL CLERKSHIP. (5 cr; prereq 5-270) Staff
Supervised study of pharmaceutical services at University Hospitals or affiliated institutions.

8-300, 8-301, 8-302. CLINICAL THERAPEUTICS. (2 cr per qtr) Schuttenhelm
Clinical lectures on diagnosis and treatment of common diseases.

8-400. SPECIAL CLINICAL PROBLEMS. (Cr ar) Staff
Opportunities for study of 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.

8-500, 8-501. PHARMACY AND ITS ENVIRONMENT. (3 cr per qtr; prereq ‡; offered 1973-74 and alt yrs) Kabat
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 pharmacist as health practitioner: with the profession, in relation to other health practitioners, and in relation to the general public.

8-700. HOSPITAL PHARMACY ADMINISTRATION I. (2 cr) Jones
History, classification, organization, and functions of hospital departments in relation to the pharmacy service.

8-701. HOSPITAL PHARMACY ADMINISTRATION II. (3 cr; prereq 8-700, ‡)

8-702. HOSPITAL PHARMACY SURVEY. (1 cr; prereq 8-701, ‡) Kabat

PHILOSOPHY (Phil)

Professor

Homer E. Mason, *chairman*
May Brodbeck
Keith Gunderson
Herbert Hochberg
Grover E. Maxwell
D. Burnham Terrell

Associate Professor

William H. Hanson, *director of graduate study*
Norman O. Dahl
John Dolan
Jasper Hopkins
Douglas E. Lewis
Rolf E. Sartorius
C. Wade Savage

Assistant Professor

Richard B. Arnaud
Marcia M. Eaton
Vicki L. Harper
Michael Root

Graduate Major in Philosophy

Prerequisites — To be accepted as a graduate major in philosophy, applicants must present a satisfactory undergraduate record including 20 Upper Division credit hours in philosophy with a grade average of B or above. In special cases provisional registration may be arranged.

Subfields of Specialization — The following classification of philosophical studies is adopted for the purpose of these regulations: (a) history of philosophy; (b) logic; (c) metaphysics and epistemology; (d) ethics; (e) philosophy of science; (f) philosophy of religion; (g) aesthetics; (h) social and political philosophy.

There is no general language requirement for an M.A. or Ph.D. degree. Students will decide in consultation with their advisers whether a language or other research tool will be included in their degree program.

Master's Degree — Offered either under Plan A or Plan B. Candidates under either plan must satisfy a history of philosophy requirement. See *Instructions for Graduate Students* prepared by the graduate faculty in philosophy.

Doctor's Degree — Students shall, with the approval of their advisers, choose a thesis field. They are also responsible for preparing themselves adequately in the following four subfields, which are cardinal to all philosophical work: history of philosophy; metaphysics and epistemology; ethics; logic. Students may qualify for exemption from logic and history of philosophy examinations by suitable course work. See the *Instructions for Graduate Students,* prepared by the graduate faculty in philosophy, for further details about methods of fulfilling requirements, other specialized subfields in philosophy, and the option of a supporting program instead of a minor field.

Graduate Minor in Philosophy

Prerequisites — Registration as a graduate minor in philosophy is permitted only upon consultation with a graduate adviser in the department.

Master's Degree — The general requirements of the Graduate School must be satisfied.

Doctor's Degree — The general requirements of the Graduate School must be satisfied.

5-003. AMERICAN PHILOSOPHY FROM WILLIAM JAMES. (3 cr; prereq 1-002 or 1 qtr history of philosophy or ‡)
Among philosophers discussed: Peirce, James, Dewey, Lewis.

5-005. PLATO. (3 cr; prereq 3-001 or ‡) Hopkins, Harper
Philosophy of Plato based on analysis of major dialogues.

5-008. ARISTOTLE. (3 cr; prereq 1 qtr history of philosophy or ‡) Harper
Philosophy of Aristotle based on analysis of selected passages from his major works. Attention given to his relationship to Plato.

5-012. PLATO AND ARISTOTLE. (5 cr; prereq 3-001 or ‡; offered when feasible) Dahl, Harper
Comparative presentation of their metaphysical and epistemological views; special reference to problem of universals.

5-021. MEDIEVAL PHILOSOPHY. (5 cr; prereq 3-001, 3-002 or ‡) Hopkins
Selected topics in the writing of several medieval philosophers (e.g., Augustine, Anselm, Aquinas, Scotus, and Ockham).

5-033. RATIONALISM. (5 cr; prereq 3-003 or ‡; offered when feasible) Lewis
Philosophies of Descartes, Spinoza, and Leibnitz.

5-034. DESCARTES. (5 cr; prereq 3-003 or ‡) Lewis, Root
Analysis of philosophical works.

5-035. SPINOZA. (5 cr; prereq 3-003 or ‡; offered when feasible) Lewis
Philosophy of Spinoza, based primarily on analysis of his *Ethics*.

5-036. LEIBNITZ. (5 cr; prereq 3-003 or ‡; offered when feasible) Arnaud, Lewis
Philosophy of Leibnitz based on analysis of selected philosophical writings.

5-041. LOCKE. (5 cr; prereq 3-003 or ‡) Gunderson, Lewis, Terrell
Detailed study of the *Essay Concerning Human Understanding.*

5-042. BERKELEY. (3 cr; prereq 3-003 or ‡) Lewis, Terrell
Detailed study of Berkeley's philosophical works.

5-043. HUME. (5 cr; prereq 3-003 or ‡) Terrell
Detailed study of Hume's *Treatise and Inquiry.*

5-044. LATER EMPIRICISM. (5 cr; prereq 3-003 or ‡; offered when feasible) Terrell
Major developments in empiricist traditions, principally in Great Britain, from Hume to Russell.

5-046. KANT. (3 cr; prereq 3-003 or 3-004 or ‡) Arnaud, Mason
Philosophy of Kant based on analysis of selected passages from his major works.

5-052. BRENTANO. (5 cr; prereq 3-003 or ‡; offered when feasible) Terrell
Philosophy of Franz Brentano, and its significance in background of contemporary philosophy.

5-054. KIERKEGAARD. (5 cr; prereq 1 qtr history of philosophy or ‡) Mason
Detailed examination of major philosophical works.

5-101. METAPHYSICS. (5 cr; prereq 1 qtr history of philosophy, or ‡) Arnaud, Brodbeck, Hochberg
Recent attempts to discover general principles characteristic of reality.

5-105. THEORY OF KNOWLEDGE. (5 cr; prereq 1-001 or 3-201 or ‡) Arnaud, Maxwell
Logical structure and experiential roots of knowledge. Meaning, validity, truth, reason, reality.

5-201. ELEMENTS OF SYMBOLIC LOGIC I. (5 cr) Arnaud, Dolan
Development of a formalized language. Syntax and semantics of sentential and first-order predicate logic, deductive systems.

5-202. ELEMENTS OF SYMBOLIC LOGIC II. (5 cr; prereq 3-201 or 5-201) Arnaud, Dolan
Continuation of Phil 3-201 or 5-201.

5-203. INTERMEDIATE SYMBOLIC LOGIC. (5 cr; prereq 3-202 or 5-202) Brodbeck, Hanson
Axiomatic development of logic; properties of deductive systems.

5-211. NONCLASSICAL LOGICS. (5 cr; prereq 3-202 or 5-202 or Math 5-162 or ‡) Hanson
Introduction to modal, many-valued, and intuitionistic logics.

5-221. PHILOSOPHY OF LOGIC. (5 cr; prereq 3-202 or 5-202 or Math 5-162 or ‡) Brodbeck, Hochberg
Selected issues: logic and reality; relation of logic to mathematics; theory of descriptions, paradoxes; identity.

5-231. PHILOSOPHY OF LANGUAGE. (5 cr; prereq 1-001 or 3-201 or 10 upper division cr in philosophy or ‡; offered when feasible) Mason, Dolan, Root
Contemporary attempts to deal with philosophical problems about language. Special attention given to concept of meaning.

5-301. HISTORY OF ETHICS: BRITISH MORALISTS. (5 cr; prereq 3-301 or 1 qtr history of philosophy or ‡) Terrell
Ethical theory as developed in Great Britain from 17th through 19th centuries.

5-302. HISTORY OF ETHICS: SELECTED CLASSICAL MORALISTS. (5 cr; prereq 3-301 or 1 qtr history of philosophy or ‡) Dahl
Moral philosophy outside of British tradition (see 5-301). Specific topics announced in *Class Schedule.*

5-311. ETHICAL THEORY. (5 cr; prereq 3-301 or ‡) Dahl, Mason
Distinguishing characteristics of a moral judgment; examination of representative theories.

5-414. POLITICAL PHILOSOPHY. (5 cr; prereq 3-414 or ‡) Dolan, Sartorius

5-415. PHILOSOPHY OF LAW. (5 cr; prereq 3-301, 3-302 or 3-414 or social science major or ‡) Sartorius
Analytical accounts of law and legal obligation.

5-501. PRINCIPLES OF AESTHETICS. (5 cr; prereq 5 cr philosophy or ‡) Gunderson, Eaton
Sample topics: standards of evaluation; aesthetic experience; representation, meaning.

5-601. PHILOSOPHY OF SCIENCE. (5 cr; prereq 1-001 or 3-201, ‡) Maxwell
Meaning, methods, and implications of modern science. Basic concepts, presuppositions, and procedures.

5-611. PHILOSOPHY OF THE SOCIAL SCIENCES I. (5 cr; prereq 15 cr philosophy, or social sciences, or ‡) Brodbeck
Criteria for describing and explaining human actions; problems of objectivity, reduction, freedom.

5-612. PHILOSOPHY OF THE SOCIAL SCIENCES II. (5 cr; prereq 5-611; offered when feasible) Brodbeck
Intensive study of certain topics in 5-611, plus analysis of models and measurement.

5-621. PHILOSOPHY OF HISTORY. (5 cr; prereq 10 cr philosophy or 15 cr history) Mason, Hopkins
Various philosophical interpretations of history, with particular reference to philosophical aspects of historical methods.

5-631. LOGIC OF SCIENTIFIC REASONING. (5 cr, §3-631; prereq 1-001 or 3-201) Maxwell, Hanson
Introduction to principles of scientific method, including survey of various contemporary approaches to scientific inference.

5-701. SURVEY OF CONTEMPORARY PHILOSOPHY. (5 cr; prereq 3-003 or ‡) Staff
Current systematic and critical philosophies, as represented by their principal exponents.

5-720, 5-730, 5-740. STUDIES IN CONTEMPORARY PHILOSOPHERS. (5 cr per qtr; prereq 3-003 or ‡) Staff
Works of selected individual philosophers. Specific topics announced in *Class Schedule.*

5-760, 5-770. SELECTED TOPICS IN PHILOSOPHY. (5 cr per qtr; prereq 5 Upper Division credits in philosophy or ‡) Staff
Selected philosophical problems of contemporary interest. Specific topics announced in *Class Schedule.*

5-781. CONTEMPORARY EXISTENTIALISM. (5 cr; prereq 3-003 or 3-004 or 5-054 or ‡) Hopkins, Hochberg
Selected topics in writings of existentialist philosophers since Kierkegaard.

5-970, 5-990. DIRECTED STUDY AND RESEARCH. (1-5 cr per qtr; prereq ‡) Staff

8-090. SEMINAR IN HISTORY OF PHILOSOPHY. (3 cr; prereq ‡)

8-110, 8-120. SEMINAR: METAPHYSICS. (3 cr per qtr; prereq 5-101 or ‡) Staff
Topics in metaphysics. Consult *Class Schedule* for topics to be discussed during any given year.

8-130, 8-140. SEMINAR: EPISTEMOLOGY. (3 cr per qtr; prereq 5-105 or ‡) Staff
Problems in theory of knowledge. Consult *Class Schedule* for topics to be discussed during any given year.

8-180. SEMINAR: PHILOSOPHY OF LANGUAGE. (3 cr; prereq ‡) Staff

8-210. SEMINAR: LOGICAL THEORY. (3 cr; prereq 5-201, 5-202 or ‡) Staff
Selected topics in the philosophy of logic.

8-310, 8-320. SEMINAR: MORAL PHILOSOPHY. (3 cr per qtr; prereq 5-311) Staff
Systematic study of concepts and problems relating to ethical discourse.

8-410. SEMINAR: SOCIAL AND POLITICAL PHILOSOPHY. (3 cr; prereq ‡)
Especially for advanced political science, history, or sociology majors or minors.

8-510. SEMINAR: STUDIES IN AESTHETICS. (3 cr; prereq ‡)
Problems in aesthetics. Consult *Class Schedule* for topics to be discussed during any given year.

8-550. SEMINAR: PHILOSOPHY OF RELIGION. (3 cr; prereq 3-521 or ‡)
Conceptual structure of religion.

8-610. SEMINAR: PHILOSOPHY OF THE PHYSICAL SCIENCES. (3 cr; prereq ‡)

8-630. SEMINAR: LOGIC OF THE EXACT SCIENCES. (3 cr; prereq ‡)

8-640. SEMINAR: PHILOSOPHY OF PSYCHOLOGY. (3 cr; open to advanced grad students in philosophy or psychology with written consent)

8-650. SEMINAR: PHILOSOPHY OF THE SOCIAL SCIENCES. (3 cr; prereq ‡)

8-690. RESEARCH IN PHILOSOPHY OF SCIENCE. (3 cr; prereq ‡)

8-970/8-990. DIRECTED STUDY AND RESEARCH. (3 cr per qtr; prereq passed written prelim exam for Ph.D. in philosophy)

PHYSICAL MEDICINE AND REHABILITATION

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

PHYSICAL THERAPY (PMed)

Professor

Frederic J. Kottke, M.D., Ph.D., *head*
Essam A. Awad, M.D., Ph.D.
Glenn Gullickson, Jr., M.D., Ph.D.
William G. Kubicek, Ph.D.

Associate Professor

Thomas P. Anderson, M.D.
Gary T. Athelstan, Ph.D.
Theodore M. Cole, M.D.
Pearl P. Rosenberg, Ph.D.

Assistant Professor

Wilbur L. Moen, B.A., B.S., *director*
Helen V. Skowlund, M.S., *director of graduate study*
John D. Allison, M.S.
Jessie K. M. Easton, M.D.
Martin O. Mundale, M.S.
James F. Pohtilla, M.S.
Mary A. Price, M.D.

Instructor

Donna L. Pauley, B.S.

Graduate study in physical therapy and allied fields is available for qualified candidates who wish to prepare themselves for a career in teaching, investigation or administration. The curriculum is planned to meet Graduate School requirements and to provide students with course material and clinical experience to meet individual goals.

Qualified physical therapists desiring to prepare for a career in public health are advised to contact the School of Public Health for information regarding the M.S. and M.P.H. programs.

Prerequisites – 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. Candidates must also have attained a baccalaureate degree with sufficient scholarly attainment in the sciences to justify graduate work. Previous clinical experience in physical therapy is recommended.

Master of Science Degree – Offered under both Plan A and Plan B.

Minor — Students who major in physical therapy under Plan A may select a minor in anatomy, educational psychology, psychology, public health, education, or counseling.

Related Fields – Under Plan B not less than 18 of the 45 required credits should be in at least two related fields with a minimum of 6 credits in each. The related fields should be selected by students in consultation with their major adviser with consideration of their background and goals. Suggested fields include education, educational administration, history and philosophy of education, psychology, sociology, public health, child psychology, business administration, industrial relations.

Language Requirement – None.

Examinations – All candidates will be required to take a final oral or written examination, or both, at the discretion of the examining committee.

Minor in Physical Therapy — Offered only to qualified physical therapists majoring in an allied field. Choice of particular courses to be presented in fulfillment of requirements will be made after consultation with the student's adviser.

8-103f,w,s,su. PHYSICAL THERAPY CLINIC. (Cr and hrs ar; prereq physical therapist) Kottke, Halpern, Gullickson, Cole, Awad
Clinical physical therapy in adult and pediatric rehabilitation.

8-130x. CURRENT LITERATURE SEMINAR IN PHYSICAL THERAPY. (1 cr per qtr) Staff
Presentation and discussion of current literature in physical therapy and related medical fields.

8-161, 8-162. CLINICAL MEDICINE IN REHABILITATION. (3 cr per qtr) Kottke

8-170. SPECIAL TOPICS IN PHYSICAL THERAPY. (1 cr per qtr; prereq ‡) Graduate faculty
Advanced seminar. Topics vary from quarter to quarter.

8-171. ADMINISTRATION OF PHYSICAL THERAPY SERVICES. (Cr ar; prereq ‡) Pauley
Individual study of selected problems in administration of physical therapy in hospitals, clinics, and community agencies.

8-172, 8-173. EDUCATIONAL ADMINISTRATION IN PHYSICAL THERAPY. (Cr. ar; prereq ‡)
Philosophy and objectives of physical therapy education, administrative structure, curriculum and accreditation. 8-172: Lectures and discussion. 8-173: Clinical practice; analysis and construction of courses of study.

8-180, 8-181. PHYSIOLOGICAL BASES FOR THERAPEUTIC EXERCISE. (3 cr per qtr) Kottke
Lectures on therapeutic exercise plus assigned projects.

8-185f,w,s,su. PROBLEMS IN PHYSICAL THERAPY. (Cr ar; prereq physical therapist)

8-192. RESEARCH DESIGN IN PHYSICAL THERAPY. (3 cr; prereq ‡) Skowlund
Critical appraisal of current medical literature; fundamentals of research design and techniques of medical writing.

8-193. RESEARCH PROBLEMS IN PHYSICAL THERAPY. (Cr ar; prereq 8-192 or ‡) Allison, Mundale, Pohtilla, Skowlund
Methods of research appropriate to physical therapy. Experimental research study.

8-195. RESEARCH IN PHYSICAL THERAPY. (Cr ar; prereq ‡) Kottke, Skowlund, staff

8-211f,w,s,su. ELECTRONICS IN PHYSICAL MEDICINE. (2 cr)
Review of principles of electronic circuits, vacuum tubes, power supplies, and their application in physical medicine.

8-212f,w,s,su. ELECTROMYOGRAPHY. (Cr ar; prereq ‡)
Clinical and laboratory training in use and interpretation of electromyography.

8-230. LEADERSHIP TRAINING FOR INTERDISCIPLINARY SETTINGS. (1 cr; offered on P-N only) Rosenberg

PHYSICS (Phys)

Professor

Morton Hamermesh, *head*
Russell K. Hobbie, *director of undergraduate study*
Benjamin F. Bayman
J. Morris Blair
Laurence J. Cahill, Jr.
Keith S. Champlin
Lorne M. Chanin
Robert J. Collins
Hans W. J. Courant
George D. Freier
Stephen Gasiorowicz
Donald A. Geffen
George W. Greenlees
Norton M. Hintz
Walter H. Johnson, Jr.
Paul J. Kellogg
Homer T. Mantis
Edward P. Ney
Alfred O. C. Nier
Lewis H. Nosanow
Hendrick J. Oskam
William T. Peria
Hiroshi Suura
Yau-Chien Tang
C. J. Waddington
James H. Werntz, Jr.
John R. Winckler
Neville J. Woolf
William Zimmermann, Jr.

Associate Professor

Ronald E. Brown, *director of graduate study*
Ernest Coleman
Dietrich K. Dehnhard
Clayton F. Giese
Allen M. Goldman
J. Woods Halley
Roger S. Jones
John S. Lilley
Erwin Marquit
Robert O. Pepin
Carl H. Poppe
Peter G. Roll
Jonathan L. Rosner
Keith Ruddick
Philip Solomon
Wayne A. Stein
Roger H. Stuewer
Walter V. Weyhmann

Prerequisites – For major work, differential and integral calculus and 2 years of college physics. For minor work, differential and integral calculus and 1 year of college physics.

Language Requirement – M.S. or Ph.D. candidates must demonstrate proficiency in one foreign language by

a. Passing the Graduate School Foreign Language Test, or
b. Obtaining a certificate of proficiency from a University of Minnesota foreign language department, or
c. Presenting evidence that they have 1 year's college credit in the foreign language with a grade of B (or higher) as an average for the year, or
d. Presenting evidence that they have college credit in the foreign language for the third quarter of a 3-quarter sequence, or the second semester of a 2-semester sequence, or in a more advanced course, in each case with a grade of B (or higher).

If students use a or b to satisfy the language requirement, then it will be recorded in their Graduate School transcript that they have demonstrated proficiency in the foreign language. If students use c or d to satisfy the language requirement, no such record will be made in their Graduate School transcript.

The foreign language should be chosen by candidates and their adviser to be relevant to their future career. The physics department Graduate Study Committee must concur in this choice.

Master's Degree – Offered under either Plan A or Plan B. 5-051/5-052/5-053 or 5-151/5-152/5-153 are required. Alterations of this requirement may be made only after consultation with the chairman of the graduate faculty in physics.

Doctor's Degree – Candidates for the Ph.D. degree will be expected to pass qualifying examinations as determined by the chairman of the graduate faculty in physics before admission to the preliminary examination. As part of each program for the Ph.D., 5-051/5-052/5-053, 5-151/5-152/5-153, and one advanced seminar sequence are required.

Minor Requirement – M.S. or Ph.D. candidate satisfy their minor requirement by taking courses in one or two fields outside their field of specialization. Some or all of these courses may be within the physics department. The M.S. Plan A program requires 9 minor credits; the M.S. Plan B and Ph.D. programs require 18 credits in the minor or related fields. If these are distributed between two fields, there must be at least 6 credits in each.

Note — For courses in biophysics and geophysics, see index.

5-011/5-012/5-013.° MECHANICS, ELECTRICITY, AND MAGNETISM. (4 cr per qtr, §5-021/5-022, §5-023/5-024/5-025; prereq 3-011, Math 3-211, Math 3-221 or equiv)
Theoretical course.

5-021/5-022.° INTRODUCTION TO ANALYTIC MECHANICS. (4 cr per qtr, §5-011/5-012/5-013; prereq 3-011, Math 3-231 or equiv; 3 lect and 1 prob hr 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.

5-023/5-024/5-025.° INTRODUCTION TO ELECTRIC AND MAGNETIC FIELDS. (4 cr per qtr, §5-011/5-012/5-013; prereq 3-011, Math 3-231 or equiv)
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. In third quarter special topics of interest to instructor.

5-051/5-052/5-053.° CLASSICAL PHYSICS. (4 cr per qtr; prereq 5-013 or both 5-021, 5-025 or ‡, advanced calculus or ‡)
Classical mechanics, special theory of relativity, and classical electrodynamics. Application of advanced mathematical techniques to these subjects.

5-091. 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, ‡)
Principles of physics and acoustics related to musical sounds, musical instruments, and electronic production of musical sounds. Laboratory work an integral part of course.

5-101/5-102.° INTRODUCTION TO QUANTUM MECHANICS. (4 cr per qtr; prereq 3-512)
Mathematical techniques of quantum mechanics. Wave packets; Schrodinger equation, angular momentum; radial equation; spin; perturbation theory; collision theory.

5-120.° EXPERIMENTAL PHYSICS. (4 cr [may be repeated]; prereq 3-513, △)
Techniques and methods used in physics research laboratories. Experiments in high vacuum, mass spectroscopy; solid state, atomic and nuclear physics.

5-151/5-152/5-153.° QUANTUM MECHANICS. (4 cr per qtr; prereq 5-102 or equiv, advanced calculus or ‡)
Development from first principles. Schrodinger equation, angular momentum, scattering, matrix representations, spin, approximation methods, interaction with electromagnetic field, systems of identical particles, applications to atomic systems.

5-201/5-202.° THERMODYNAMICS, STATISTICAL MECHANICS. (4 cr per qtr; prereq 1-290 or 1-291 or 1-230, Math 3-211 or Math 3-411 or equiv)
Formulation of basic laws of thermodynamics concerning temperature, energy, and entropy; application to simple systems. Transport phenomena; principles of statistical mechanics.

5-203.° INTRODUCTION TO SOLID STATE PHYSICS. (4 cr; prereq 5-202 or ‡)
Structure, thermal, magnetic, and dielectric and electronic properties of crystalline solids.

5-231/5-232/5-233.° INTRODUCTION TO SOLID-STATE PHYSICS. (3-4 cr per qtr; for grad or advanced undergrad students in physics, science, and engineering)
5-231: Crystal structure and binding; diffraction; phonons; thermal and dielectric properties of insulators. 5-232: Free electron model; band structure; semiconductors; diamagnetism and paramagnetism; ferromagnetism and antiferromagnetism. 5-233: Optical phenomena, lasers; superconductivity; surface properties; ferroelectricity. Optional fourth lecture per week devoted to review of necessary quantum and thermal physics and to special topics.

5-301.° INTRODUCTION TO NUCLEAR PHYSICS. (4 cr; prereq 5-102 or equiv)
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.

5-351.° EXPERIMENTAL PARTICLE PHYSICS. (4 cr; prereq 3-513)
Interactions of particles and photons with matter and radiation. Detectors for particles and photons used in elementary particle, nuclear, and cosmic ray physics.

5-401.° INTRODUCTION TO CONTEMPORARY PROBLEMS IN COSMIC-RAY AND SPACE PHYSICS. (4 cr; primarily for students specializing in other branches of physics; prereq ‡)
Cosmic rays, their characteristics, and their motion in the interplanetary and interstellar medium. Topics in X-ray and radio astronomy.

5-441.° INTRODUCTORY METEOROLOGY. (4-5 cr; prereq 3-510, Math 3-231 or ‡)
Physical description of atmospheric phenomena, primarily large-scale. Theory and practice of meteorological observation, weather prediction, and interpretation of climatological data.

5-442.° DYNAMIC METEOROLOGY. (4 cr; prereq 5-441 or ‡)
Fluid dynamics of large scale atmospheric flow. Mathematical models of simple flow processes; modeling for numerical prediction; energetics, planetary boundary flow.

5-451.° CLOUD PHYSICS. (4 cr; prereq Math 3-211 or 3-411 or equiv, 1 yr general physics)
Composition of atmosphere, past, present, and future. Thermodynamics of atmosphere with condensable water. Properties and growth of drops and ice crystals. Particles in the atmosphere. Open laboratory work required.

5-452.° CLOUD SYSTEMS. (4 cr; prereq Math 3-211 or 3-411 or equiv, 1 yr general physics)
Circulation, energy balance of atmosphere. Radar techniques for analyzing cloud systems. Cloud structure and motion. Open laboratory required.

5-453.° ELECTRICAL PROPERTIES OF CLOUDS. (4 cr; prereq Math 3-211 or 3-411 or equiv, 1 yr general physics)
Structure, thermodynamic and electrical properties of water and ice. Ions in the atmosphere. Generation of charge and its effects on cloud processes. Generation of lightning and properties of lightning discharges. Open laboratory required.

5-804.* OPTICS LABORATORY. (4 cr; prereq 3-012 or 5-805 or ♯)
Optics experiments, emphasizing modern optics, properties of lasers, spatial filters, light modulation, microwaves, Kerr cell, holography, Faraday effect, Zeeman effect, optical pumping.

5-805.* CONTEMPORARY OPTICS. (4 cr; prereq 3-012 or ♯)
Current developments in optics. Theory of lasers and of their application in holography, nonlinear optics. Nonlinear optics. Optics of anisotropic media. Theory of image formation and spatial filtering. Properties of optical detectors.

5-851.* ELECTRONIC MEASUREMENT. (5 cr; prereq 3-011 or ♯)
Measurement of physical properties using electronic techniques. Energy and measurement; noise and bandwidth; processing of repetitive and random signals.

5-852.* ELECTRONIC CONTROL. (5 cr; prereq 3-011 or ♯)
Digital and analog control; digital logic; pneumatic, electromechanical and semiconductor systems; feedback; servosystems; mixed systems.

5-853.* ELECTRONIC COMPONENTS. (5 cr; prereq 3-011 or ♯)
Electronic components, their electrical behavior, and their use in circuit design.

5-901. HISTORY OF ANCIENT, MEDIEVAL, AND EARLY MODERN PHYSICS. (4 cr; prereq general physics or ♯; carries grad cr only for nonmajors)
Birth of science to establishment of scientific societies and scientific revolution in 17th century. Emphasis on conceptual changes throughout.

5-902. HISTORY OF 18TH- AND 19TH-CENTURY PHYSICS. (4 cr; prereq general physics or ♯; carries grad cr only for nonmajors)
Successes, failures of mechanical world picture. Field theory and electromagnetic synthesis. Energy conservation and thermodynamics. Atomic theories and statistical mechanics. The university as research center. Emphasis on conceptual changes throughout.

5-903. HISTORY OF MODERN PHYSICS. (4 cr; prereq general physics or ♯; carries grad cr only for nonmajors)
Discovery of electron, X-rays, radioactivity. Theory of relativity. Quantum theory. Discovery of neutron, physics and government, and other selected topics. Emphasis on conceptual changes throughout.

5-921.* HISTORY OF 19TH-CENTURY PHYSICS. (4 cr; prereq ♯)
Primary focus on wave theory, theories of ether; Faraday; spectral studies; Lorentz theory of electrons. Related topics as appropriate.

5-922.* HISTORY OF 20TH-CENTURY PHYSICS: QUANTUM MECHANICS. (4 cr; prereq ♯)
Selected original papers and secondary accounts, early developments; old quantum theory; matrix mechanics; wave mechanics; conclusions.

5-990.* ELEMENTARY PHYSICAL INVESTIGATION. (Cr ar; prereq △)
Problems, either experimental or theoretical, of special interest to student. Written report.

Special prerequisites are noted for certain courses below. Seminars, special topics courses, and research may be taken more than once for credit.

8-000.* SEMINAR: THEORETICAL PHYSICS. (Cr ar)

8-041/8-042/8-043.* PRINCIPLES OF MATHEMATICAL PHYSICS. (3 cr per qtr; prereq Math 5-459)

8-081/8-082.* GENERAL RELATIVITY. (3 cr per qtr; prereq 5-053 or ♯)
Introduction to the physical basis of general relativity, to its mathematical formulation, and to its cosmological implications.

8-121.* ADVANCED QUANTUM MECHANICS. (3 cr; prereq 5-153 or ♯)
Advanced topics in nonrelativistic quantum mechanics with emphasis on the use of second quantization to treat many-body and radiating systems. Diagrammatic and Green's function techniques introduced.

8-122.* RELATIVISTIC QUANTUM MECHANICS. (3 cr; prereq 8-121 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.

8-123.* RELATIVISTIC QUANTUM FIELD THEORY. (3 cr; prereq 8-122 or ♯)
Renormalization theory, analytic properties of amplitudes, reduction formulas and dispersion relations.

8-131.* SYMMETRY AND ITS APPLICATIONS TO PHYSICAL PROBLEMS. (3 cr; prereq ¶5-153 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.

8-161.* ATOMIC AND MOLECULAR STRUCTURE. (3 cr; prereq 5-153 or ‡)
Discussion of 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.

8-162.* INTRODUCTION TO PLASMA PHYSICS. (3 cr; prereq 5-053 or ‡)
Magnetohydrodynamics and properties of collisionless plasma, with applications to the magnetic field of the earth and sun and to trapping of a plasma. Transport phenomena and effect of collisions.

8-163/8-164.* PLASMA PHYSICS. (3 cr per qtr; prereq 8-162)
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.

8-165.* ADVANCED TOPICS IN PLASMA PHYSICS. (Cr ar)
Possible topics: theory of waves and instabilities in hot plasma, etc.

8-200.* SEMINAR: SOLID-STATE AND LOW-TEMPERATURE PHYSICS. (Cr ar)

8-211.* EQUILIBRIUM STATISTICAL MECHANICS. (3 cr; prereq 5-153 or ‡)
Equilibrium properties of macroscopic classical and quantum systems. Simple interacting systems, phase transitions, and effects of external fields.

8-212.* TRANSPORT THEORY. (3 cr; prereq 5-153 or ‡)
Transport and relaxation phenomena in classical and quantum systems. Irreversible thermodynamics, Boltzmann equation, and linear response theory.

8-216.* MANY-BODY THEORY. (3 cr; prereq 8-121 or ‡)
Infinite systems of bosons and fermions using Hartee and Hartee-Fock approximations; diagrammatic techniques and Green's function methods.

8-221/8-222/8-223.* SOLID-STATE PHYSICS. (3 cr per qtr; prereq ¶5-152/5-153, 5-203 or ‡)
(Same as EE 8-150, 8-151) Fundamental properties of crystals; dynamics of the lattice and of electrons in a periodic structure. Effects of electric and magnetic fields on metals.

8-232.* MAGNETISM. (3 cr; prereq 8-222 or ‡)
(Same as EE 8-152) Properties of magnetic materials in relation to exchange interactions and elementary spin excitations.

8-233.* SUPERCONDUCTIVITY. (3 cr; prereq ‡)
Properties of superconductors discussed and analyzed using the concept of a macroscopic wave function; relation of this approach to the microscopic theory.

8-234.* TECHNIQUES OF LOW-TEMPERATURE PHYSICS. (3 cr; prereq ‡)
Introduction to low-temperature phenomena and techniques used to obtain these temperatures.

8-235.* LIQUID AND SOLID HELIUM. (3 cr; prereq ‡)
Introduction to experiment and theory concerning the behavior of liquid and solid helium. Superfluidity of He^4, Fermi liquid theory of He^3, and He^3-He^4 mixtures and solid helium.

8-236.* MAGNETIC RESONANCE IN SOLIDS. (3 cr; prereq ‡)
Discussion of behavior of spins in static and time-varying fields with applications to study of solids. Interactions between spins, relaxation processes, and atomic diffusion.

8-238.* ADVANCED TOPICS IN SOLID-STATE AND LOW-TEMPERATURE PHYSICS. (Cr ar)
Possible topics: theory of superconductivity, theory of superfluidity, properties of systems at millidegree temperatures, collective effects in magnetic systems, etc.

8-300.* SEMINAR: NUCLEAR PHYSICS. (Cr ar)

8-311/8-312/8-313.* NUCLEAR PHYSICS. (3 cr per qtr; prereq 5-153 or ¶5-151/5-152/5-153, 5-301 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.

8-321.* ADVANCED TOPICS IN NUCLEAR PHYSICS. (Cr ar)
Possible topics: theory of nuclear matter, beta- and gamma-ray spectroscopy, nuclear fission, etc.

8-360.* SEMINAR: MASS SPECTROSCOPY. (Cr ar)

8-370.* SEMINAR: ELEMENTARY PARTICLE PHYSICS. (Cr ar)

8-371.* INTRODUCTION TO ELEMENTARY PARTICLE PHYSICS. (3 cr; prereq 5-152, or ‡)
Discussion and analysis of experiments used to study properties of elementary particles and theoretical ideas currently being used to interpret experimental results.

8-372/8-373.* ELEMENTARY PARTICLE PHYSICS. (3 cr per qtr; prereq 8-123 or ‡)
Properties of stable and unstable elementary particles and their strong and weak interactions. Scattering and production of particles at high and low energies. Electromagnetic form factors. Experimental evidence on the nature of the weak interactions: symmetry violations and selection rules on the decays of the strange particles. Role of currents in the weak interactions.

8-380.* ADVANCED TOPICS IN ELEMENTARY PARTICLE PHYSICS. (Cr ar; prereq ‡)
Discussion of topics of current interest.

8-400.* SEMINAR: COSMIC-RAY AND SPACE PHYSICS. (Cr ar)

8-411/8-412.* COSMIC-RAY AND SPACE PHYSICS. (3 cr per qtr; prereq 5-102, 5-053, or ‡)
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, structure and evolution of the galaxy, motion of particles in the galactic and intergalactic medium, and topics in X-ray and radio astronomy.

8-440.* SEMINAR: ATMOSPHERIC PHYSICS. (Cr ar)

8-445.* 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.

8-481/8-482/8-483.* ASTROPHYSICS. (3 cr; prereq ‡)
Stellar structure, stellar evolution, and various topics in cosmic astrophysics. Electron and nuclear degeneracy, stellar opacity, nuclear physics of energy generation, equations of stellar structure and their solutions, theoretical basis for the Hertzsprung-Russell diagram, cosmic electromagnetic radiation, and cosmology.

8-484.* ORIGIN AND EVOLUTION OF THE SOLAR SYSTEM. (3 cr; prereq ‡)
Origin and early development, primarily in terms of the record in meteorites, but including relevant data from the sun and planets and from certain astronomical observations. Boundary conditions or rough constraints on dispersed dust-gas cloud. Topics include: stellar nucleosynthesis and composition of the initial cloud; collapse of the cloud and the problem of angular momentum transfer; accretion problem; elemental and isotopic abundances, and fractionation processes; nucleosynthesis in the solar nebula; interaction of the solar wind with dust; thermal history of meteoritic and planetary material; time-scales for formation and isolation of large solid bodies.

8-900.* SEMINAR: HISTORY OF 20TH-CENTURY PHYSICS. (1 cr per qtr; prereq ‡)

8-950.* SEMINAR: PROBLEMS OF PHYSICS TEACHING AND HIGHER EDUCATION. (1 cr per qtr; 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 will be drawn from seminar participants and physics faculty, from other parts of the University, and occasionally from outside. Students enrolled for credit will be required to carry out a small instructional development project under faculty guidance. Designed especially to orient beginning graduate teaching associates, and to provide background and experience to those preparing for a career in physics teaching at any level.

8-990.* RESEARCH IN PHYSICS. (Cr ar)

PHYSIOLOGICAL HYGIENE (PubH)

Minor — It is suggested that students who major in physiological hygiene present a minor in one of the following fields: epidemiology, physiological chemistry, psychology, or internal medicine.

Language Requirement — For the Master's degree, French or German. In exceptional cases Spanish or Russian may be substituted by petition. For the Ph.D. degree, two foreign languages (French and German).

Master's Degree – Offered only under Plan A. Attention of the student is also directed to the field of nutrition.

Doctor's Degree – Members of the physiological hygiene staff who are appointed to the graduate faculty in physiology or medical biochemistry or nutrition may advise students majoring in those fields. In addition, in exceptional cases, physiological hygiene may be employed as the major field. The program of students in this field will not include physiology as a minor field and will incorporate an interdisciplinary group of subjects within the major. Plans of study of these students should be drawn up early in their course of study and submitted to the dean of the Graduate School.

5-380. APPLIED HUMAN NUTRITION. (3 cr; prereq ‡) J Anderson, Grande, Stief
See Public Health for description.

5-385. PHYSIOLOGY OF EXERCISE. (Cr ar; prereq Phsl 5-110 or equiv, ‡; offered when demand warrants) Taylor
Muscular efficiency, training, deconditioning, effects of exercise on physiological systems.

5-386. PUBLIC HEALTH ASPECTS OF CARDIOVASCULAR DISEASE. (3 cr; prereq ‡) Blackburn, Grande, Taylor
See Public Health for description.

8-385. SEMINAR: PHYSIOLOGICAL HYGIENE. (1 cr) Staff
Nutrition, tests, and measurements of human physical fitness, gerontology, adaptation in health and disease, body composition, circulatory dynamics, and related topics.

8-386. READINGS IN PROBLEMS OF PHYSIOLOGICAL HYGIENE. (Cr ar; prereq ‡) Staff

8-387. RESEARCH IN PHYSIOLOGICAL HYGIENE AND RELATED AREAS. (Cr ar) Staff

PHYSIOLOGY (Phsl)

Professor

Eugene D. Grim, Ph.D., *head, director of graduate study*
Marvin B. Bacaner, M.D.
H. Mead Cavert, M.D., Ph.D.
Irwin J. Fox, M.D., Ph.D.
Francisco Grande, M.D.
Franz Halberg, M.D.
Rodney B. Harvey, M.D., Ph.D.
John A. Johnson, M.D., Ph. D.
Ancel Keys, Ph.D.
William G. Kubicek, Ph.D.
Nathan Lifson, M.D., Ph.D.
Victor Lorber, M.D., Ph.D.
Ernst Simonson, M.D.
Henry L. Taylor, Ph.D.
Carlo A. Terzuolo, M.D.
Maurice B. Visscher, M.D., Ph.D.

Associate Professor

Jui S. Lee, Ph.D.
Richard E. Poppele, Ph.D.
Richard L. Purple, Ph.D.
Aldo Rescigno, Laurea in Physics

Assistant Professor

Robert L. Evans, Ph.D.
Gordon Kepner, Ph.D.
Charles Knox, Ph.D.
Richard Kronenberg, M.D., Ph.D.
David G. Levitt, M.D., Ph.D.
David E. Schafer, Ph.D.
Richard J. Stish, B.E.E.
O. Douglas Wangensteen, Ph.D.

Lecturer

Maurice W. Meyer, Ph.D.

Prerequisites – For a major or minor in physiology, acceptable background in mathematics, physics, chemistry, and morphology.

Language Requirement – For the Master's degree, the language requirement is waived. For the Ph.D. degree, the student, in consultation with the adviser, will elect to demonstrate a reading knowledge in one foreign language or to complete a collateral field of knowledge.

Doctor's Degree – Work for the Ph.D. degree is offered to candidates whose background of training is approved by the graduate faculty. The requirements for the minor program can be satisfied either by the use of a conventional minor or, in appropriate instances, the use of a supporting program.

Note – Graduate study in physiology is also offered at the Mayo Graduate School of Medicine of the University of Minnesota. See the bulletin, *Graduate Programs in the Health Sciences.*

8-101w. HUMAN PHYSIOLOGY. (8 cr; primarily for dental students; prereq courses in biochemistry, human or mammalian anatomy) Staff

8-102f. HUMAN PHYSIOLOGY. (5 cr; primarily for medical-surgical nursing students; prereq course in biochemistry, human or mammalian anatomy) Staff

8-103f. GENERAL PHYSIOLOGY. (3 cr; prereq 8-100 or equiv; offered 1972 and alt yrs) Grim, Johnson, Levitt, Lifson
Topics on mechanisms of transport and energy transformation in living organisms.

8-104w. NEUROPHYSIOLOGY. (7 cr; prereq 8-100 or equiv, neuroanatomy, ‡; offered 1973 and alt yrs) Poppele, Purple, Terzuolo

8-105s. CARDIOVASCULAR PHYSIOLOGY. (4 cr; prereq 8-100 or equiv; offered 1973 and alt yrs) Bacaner, Fox, Lorber, Visscher

8-106f. RESPIRATORY PHYSIOLOGY. (3 cr; prereq 8-100 or equiv; offered 1973 and alt yrs) Kronenberg, Wangensteen

8-107w. ALIMENTARY PHYSIOLOGY. (3 cr; prereq 8-100 or equiv; offered 1972 and alt yrs) Grim

8-108s. NEPHROLOGY. (3 cr; prereq 8-100 or equiv; offered 1972 and alt yrs) Harvey

8-109f,w,s. SYSTEMS ANALYSIS FOR BIOLOGISTS. (3 cr; prereq calculus through introduction to differential equations, physical chemistry, or ‡) Rescigno

8-110s. HUMAN PHYSIOLOGY. (11 cr; primarily for medical students; prereq anatomy, biochemistry; 4 hrs lect, 6 hrs lab per wk; course extends 4 weeks beyond end of spring quarter) Staff

8-113. PROBLEMS IN PHYSIOLOGY. (Cr ar [may be taken 1 or more qtrs]; prereq 8-100 or equiv)
Arranged with qualified students. Topics assigned for laboratory study, conferences, and reading.

8-116. BIOPHYSICAL APPROACHES TO PHYSIOLOGY. (4 cr; prereq 3-055 or ‡) Kepner

8-201f,w,s. LITERATURE SEMINAR. (1-2 cr ar; prereq 8-110 or equiv)

8-202.* READINGS IN PHYSIOLOGY. (Cr and hrs ar)
Topics selected for each student; written reviews prepared and discussed.

8-203.* RESEARCH IN PHYSIOLOGY. (Cr and hrs ar)

8-204. HISTORY OF PHYSIOLOGY.** (Cr and hrs ar) Visscher, Wilson

8-210. SELECTED TOPICS IN PERMEABILITY.** (Cr and hrs ar; prereq 8-103 or equiv, ‡) Grim, Lifson, Johnson
Advanced seminar.

8-211. SELECTED TOPICS IN HEART AND CIRCULATION.** (Cr and hrs ar; prereq 8-105 or equiv, ‡) Visscher, Bacaner, Fox
One or more seminars in the advanced physiology of heart and circulation.

8-212. SELECTED TOPICS IN RESPIRATION.** (Cr and hrs ar; prereq 8-106 or equiv, ‡)
Advanced seminar.

8-213. SELECTED TOPICS IN ALIMENTARY PHYSIOLOGY.** (Cr and hrs ar; prereq 8-107 or equiv, ‡) Grim, Lifson

8-214. SELECTED TOPICS IN NEPHROLOGY.** (3 cr; prereq 8-108 or equiv) Harvey
Advanced seminar.

8-216. SELECTED TOPICS IN NEUROPHYSIOLOGY.** (Cr and hrs ar; prereq 8-104 or equiv, ‡) Terzuolo, Poppele, Purple
Advanced seminar.

8-220. METHODS OF ANALYSIS.** (3 cr; prereq calculus through introduction to differential equations, physical chemistry, or ‡) Rescigno
Topics selected from: control theory, compartment analysis, tracer analysis, thermodynamics of irreversible processes, construction and use of models. Applications in physiology.

8-227. METHODS IN PHYSIOLOGY.** (3 cr; prereq 8-100 or equiv, ‡) Stish

8-230, 8-231. TRANSPORT PROCESS IN BIOLOGY.** (3 cr per qtr; prereq 8-103 or equiv) Grim, Johnson, Lifson
Relatively systematic coverage of biological transport processes.

**Students should consult the department for offerings during any specific quarter.

8-234. RESPIRATION, ACID-BASE CHEMISTRY, AND ELECTROLYTE METABOLISM.** (3 cr; prereq 8-106 or equiv)

8-235. BIOENERGETICS OF CARDIAC CONTRACTION.** (3 cr; prereq 8-105 or equiv) Cavert, Lorber

8-236. HEMODYNAMIC MEASUREMENTS.** (3 cr; prereq 8-100 or equiv within past 8 yrs) Evans

Lectures, experiments, and problems dealing with pulsatile blood flows.

8-238. NEURAL AND HUMORAL CONTROL OF CIRCULATION.** (3 cr; prereq 8-105 or equiv) Grande

8-239w. PHYSIOLOGY OF LYMPHATIC SYSTEM AND MICROCIRCULATION.** (Cr ar) Lee, Meyer

PLANT BREEDING

Professor

Donald C. Rasmusson (agronomy and plant genetics), *director of graduate study*
Ralph E. Comstock (genetics and cell biology)
David W. Davis (horticultural science)
Laddie J. Elling (agronomy and plant genetics)
Frank D. Enfield (genetics and cell biology)
Arne W. Hovin (agronomy and plant genetics)
Herbert W. Johnson (agronomy and plant genetics)
Jean W. Lambert (agronomy and plant genetics)
Florian I. Lauer (horticultural science)

Associate Professor

Peter D. Ascher (horticultural science)
Donald K. Barnes (agronomy and plant genetics)
Verne E. Comstock (agronomy and plant genetics)
Robert E. Heiner (agronomy and plant genetics)
Robert Mullin (horticultural science)
Ronald L. Phillips (agronomy and plant genetics)
James C. Sentz (agronomy and plant genetics)
Robert E. Stucker (agronomy and plant genetics)
Cecil Stushnoff (horticultural science)
Deon D. Stuthman (agronomy and plant genetics)

Assistant Professor

Carl A. Mohn (forestry)
David E. Polson (agronomy and plant genetics)

Graduate study in plant breeding leading to the Master's and Ph.D. degrees is available through the graduate faculty in several departments: agronomy and plant genetics, forestry, genetics and cell biology, and horticultural science. For information about the plant breeding degree and assistantship opportunities, applicants are encouraged to write to the department of their choice.

Prerequisites – A good background in biological and other sciences.

Language Requirements – Foreign languages not required.

Courses frequently included in course programs are listed below. Courses in biometrics, biochemistry, genetics, plant physiology and plant pathology and others may be included in M.S. or Ph.D. programs.

Note – For descriptions of courses, consult listings of appropriate departments.

Agro 5-020.* INTRODUCTION TO PLANT BREEDING. (3 cr; prereq GCB 3-022 or equiv) Stuthman

Agro 8-200. PRINCIPLES OF PLANT BREEDING I. (3 cr; prereq 5-020, GCB 5-033 or ‡) Rasmusson

Agro 8-210. PRINCIPLES OF PLANT BREEDING II. (3 cr; prereq 8-200 or ‡) Stucker

Agro 8-220. APPLICATION OF QUANTITATIVE GENETICS TO PLANT BREEDING. (3 cr; prereq 8-210, GCB 5-042; offered 1973-74 and alt yrs) Stucker

Agro 8-230. CYTOGENETICS. (4 cr; prereq GCB 5-031, Biol 5-601 or ‡; 2 lab hrs per wk) Phillips

**Students should consult the department for offerings during any specific quarter.

Agro 8-270. SEMINAR: PLANT BREEDING. (1 cr per qtr) Staff

Agro 8-280. TOPICS IN PLANT BREEDING. (2 cr; prereq 8-210 or ‡; offered 1972-73 and alt yrs) Rasmusson

Agro 8-290. TOPICS IN PLANT GENETICS. (2 cr; prereq GCB 5-031 or ‡; offered 1973-74 and alt yrs) Staff

Agro 8-310.* ORIENTATION TO PLANT BREEDING METHODS. (1 cr; prereq 5-020 or ‡) Lambert

Agro 8-320. METHODS IN PLANT GENETICS. (2 cr; prereq GCB 5-031 or ‡; offered 1972-73 and alt yrs) Staff

Agro 8-330. RESEARCH IN PLANT GENETICS. (Cr ar) Staff

For 5-152.* FOREST GENETICS. (3 cr; prereq ‡) Mohn

GCB 5-031. INTERMEDIATE GENETICS I. (3 cr; prereq Biol 3-032, GCB 3-022, and BioC 5-002 or BioC 5-742, or ‡) Genetics staff

GCB 5-033. INTERMEDIATE GENETICS III. (3 cr; prereq GCB 3-022 or Biol 3-032...a course in genetics, a course in biometry or statistics, or ‡) Enfield

GCB 5-042. POPULATION, QUANTITATIVE GENETICS. (3 cr; prereq GCB 5-033...Stat 5-301 recommended) Comstock

Hort 8-021.* BREEDING OF SEXUALLY PROPAGATED HORTICULTURAL CROPS. (3 cr; prereq Agro 5-020; offered 1972-73 and alt yrs) Davis

Hort 8-022. BREEDING ASEXUALLY PROPAGATED CROPS. (3 cr; prereq Agro 5-020) Lauer, Stushnoff

Hort 8-023. EVOLUTION OF CROP PLANTS. (3 cr; offered 1972-73 and alt yrs) Ascher

Zool 5-171. GENETICS AND SPECIATION. (3 cr; prereq 15 cr biology including GCB 3-025) Merrell

PLANT PATHOLOGY (PlPa)

Professor

Francis A. Wood, *head, director of graduate study*
Neil A. Anderson
Clyde M. Christensen
Carl J. Eide
David W. French
Bill W. Kennedy
Milton Kernkamp
Thor Kommedahl
Chester J. Mirocha
Matthew B. Moore
John B. Rowell
Roy D. Wilcoxson

Associate Professor

Ernest E. Banttari
David H. MacDonald

Assistant Professor

William R. Bushnell

Prerequisites — To major in plant pathology, a general background in the biological sciences, chemistry, and mathematics is necessary; and it is expected that students will correct course work deficiencies within a year after they become candidates for an advanced degree.

To minor in plant pathology, students must have approval of the director of graduate study.

Course Requirements — In addition to courses in plant pathology, courses in other fields of agricultural or biological science may be applied toward an advanced degree for a major. Students majoring in the department will continue studies in residence during at least one summer.

Language Requirements — Although proficiency in a foreign language is usually not required for either degree, it may be needed to adequately prepare candidates to conduct research on a specific problem or in a certain geographical area.

Master's Degree — Offered under Plan A; rarely under Plan B.

Doctor's Degree — Work leading to the Ph.D. degree is offered.

5-002.* INTRODUCTORY PLANT PATHOLOGY FOR ADVANCED STUDENTS. (3 cr, §1-001, or §3-050; prereq 14 cr plant sciences or ‡) French, Moore, MacDonald
(See PlPa 1-001 or 3-050.) General plant pathology.

5-013. PLANT PATHOLOGY. (2 cr; prereq 5-002, 5-105 or equiv; offered 1973-74 and alt yrs) Kommedahl and staff
Diseases of ornamental plants, vegetable crops, fruit crops, field crops, and trees. Lectures, conferences, laboratory, and field work. Laboratory and field work continues throughout the summer.

5-051. ADVANCED FOREST PATHOLOGY. (3 cr; prereq 3-050 or equiv; offered 1973-74 and alt yrs) French
Basic concepts in the etiology, epidemiology, and pathogenesis of tree diseases and wood deterioration. Group discussions with some guest lecturers.

5-100. FUNGUS DISEASES OF PLANTS. (4 cr; prereq 1-001 or 5-002 or equiv; offered 1973-74 and alt yrs) Kommendahl
Fungus diseases of field crops, fruit crops, vegetable crops, ornamental plants and trees. Lectures, discussions and demonstrations.

5-102. INTRODUCTORY MYCOLOGY. (6 cr; prereq 9 cr botany or ‡; offered during Lake Itasca Biology Session) French and staff
General characteristics of fungi, especially those used in identification; cultural and taxonomic procedures and practices.

5-103. AQUATIC FUNGI. (5 cr; limited to 12 students; prereq 3 cr mycology or ‡; offered during Lake Itasca Biology Session) Staff
Collection, culture, taxonomy, and morphology of freshwater fungi.

5-105. INTRODUCTION TO THE STUDY OF FUNGI. (3 cr; prereq 9 cr botany or Biol 1-002 or ‡) Christensen
Structure, habits, classification, and identification of fungi.

5-106, 5-107.* MYCOLOGY. (3 cr per qtr; prereq 1-001 or 3-050 or MicB 3-103; offered 1973-74 and alt yrs) Anderson
Lectures and laboratory exercises on the taxonomy, identification, life histories, genetics, and ecology of the fungi.

5-109.* PHYSIOLOGY AND BIOCHEMISTRY OF FUNGI. (3 cr; prereq ‡; offered 1972-73 and alt yrs) Mirocha
Physiological and biochemical processes in fungi with major emphasis on elucidation of metabolic pathways.

5-132. BIOLOGY OF FUNGI. (3 cr; prereq Biol 1-002, Chem 3-202 or BioC 1-301 or ‡; offered 1972-73 and alt yrs)
Survey of fungi; their morphology, taxonomy, genetics, physiology, biochemistry, and ecology.

5-133. BIOLOGY OF FUNGI LABORATORY. (1 cr; prereq ¶5-132)
Exercises with fungi, their growth and ecology.

5-200. POISONOUS PLANTS. (2 cr, §VM 5-220; prereq ‡)
Systematic study of important plants poisonous to animals. Special emphasis on identification, toxicology, diagnosis and treatment.

5-215. INSECTS IN RELATION TO PLANT DISEASES. (4 cr, §Ent 5-215; prereq 5 cr entomology, 5 cr plant pathology, or equiv, or ‡) Peterson, Wilcoxson
Insect transmission and dissemination of plant pathogens; plant-insect relationships; habits of principal insect vectors — practical control methods.

5-220. PLANT SCIENCES AND THE WORLD FOOD SUPPLY PROBLEM. (4 cr, §AgEc 5-790, §AnSc 5-780, §HE 5-381, §Soc 5-675, §VM 5-790; prereq sr or grad or ‡) Calpouzos
Lectures and reading on the problem of adequately feeding the world's growing population by means of international research in plant and soil sciences.

5-300.* VIRUS DISEASES OF PLANTS. (3 cr; prereq 1-001 or 3-050 or 5-002, offered 1973-74 and alt yrs) Banttari
Nature of plant viruses and types of diseases they cause; emphasis on methods for studying virus diseases.

5-400.* BACTERIAL DISEASES OF PLANTS. (3 cr; prereq 1-001, 3-050 or 5-002, offered 1972-73 and alt yrs) Kennedy
Bacteria as plant pathogens; representative types with particular reference to techniques used in studying bacterial diseases of plants.

5-500.* PLANT NEMATOLOGY. (4 cr; prereq 1-001 or 3-050 or 5-002, Biol 1-002 or ‡; offered in 1972-73 and alt yrs) MacDonald
Nematode taxonomy, morphology, life cycles; biology and control; nematodes as plant pathogens and their effects on plants.

5-702. CONTROL AND PREVENTION OF PLANT DISEASES. (3 cr; prereq 1-001 or 3-050 or ‡; offered 1973-74 and alt yrs) Kennedy
Comprehensive survey of principles and practices relating to plant disease control with emphasis on quarantine, eradication, cultural practices and fungicides.

8-090.* RESEARCH IN PLANT PATHOLOGY. (Cr ar) Staff
Special assignment of work in laboratory and field problems in pathological research.

8-110x.* PROBLEMS IN MYCOLOGY. (Cr ar; for minor or major; prereq 5-106, 5-107) Anderson, Christensen, French
Research on taxonomy of natural groups, fungus, flora of particular regions, localities, or habitats; investigation of fungi involved in industrial or natural processes; morphology or physiology of special forms.

8-111. GENETICS OF PLANT PATHOGENS. (3 cr; prereq 1-001 or 3-050, or equiv, GCB 3-022; offered 1972-73 and alt yrs) Anderson, Kernkamp
Physiologic specialization, sexuality, hybridization, mutation, and similar phenomena in plant pathogens; practical implications.

8-112. ECOLOGY OF PLANT PATHOGENS. (3 cr; prereq 1-001 or 3-050 or 5-002, 5-132 or equiv; offered 1972-73 and alt yrs) Wilcoxson
Effect of environment on plant pathogens and plant disease epidemics.

8-301.* RESEARCH IN PLANT VIROLOGY. (Cr ar; prereq 5-300 or ‡) Banttari
Identification, transmission, purification, serological or histological studies involving viruses, their host plants and vectors.

8-401.* RESEARCH IN PLANT BACTERIOLOGY. (Cr ar; prereq 5-400 or ‡) Kennedy
Special assignments on problems of current interest; investigations related to ecology and interaction among bacterial plant pathogens and their hosts.

8-501.* CURRENT TOPICS AND PROBLEMS IN PLANT NEMATOLOGY. (Cr ar; prereq 5-500 or ‡) MacDonald
Discussions and library, laboratory, and field work pertaining to plant parasitic and other soil and fresh water nematodes.

8-600x.* SEMINAR: PLANT PATHOLOGY. (1 cr) Staff
Critical review of progress and problems in plant pathology.

8-610. PHYSIOLOGY OF HOST-PARASITE RELATIONSHIPS. (3 cr; prereq 5-132, 5-002, BioC 5-001 or ‡; offered 1973-74 and alt yrs) Mirocha
Physiological and biochemical changes in plants that occur during the infection process and disease development. Nature of resistance, susceptibility, and parasitism.

8-620. PRINCIPLES OF PLANT PATHOLOGY. (3 cr; prereq 1-001 or 3-050, 5-107 or equiv, MicB 3-103, 6 addtl cr plant pathology; offered in 1973-74) Eide
Systematic consideration of basic factors governing development of plant diseases.

PLANT PHYSIOLOGY (PlPh)

Professor

Dale N. Moss, *director of graduate study*
Russell S. Adams
Robert N. Andersen
Richard Behrens
Alfred C. Caldwell
Albert W. Frenkel
Herbert Jonas
Albert J. Linck
Robert E. Nylund
Douglas C. Pratt
John B. Rowell
Lawrence H. Smith
Edward I. Sucoff
Conrad J. Weiser

Associate Professor

William A. Brun
William P. Cunningham
Williard L. Koukkari
Pen H. Li
Chester J. Mirocha
Thomas K. Soulen
Eduard J. Stadelmann
Harold F. Wilkins

Assistant Professor

Mark L. Brenner
William R. Bushnell
David E. Polson
Paul E. Read

This program is offered by a graduate faculty from a number of departments in several colleges throughout the University. Graduate study in the field of plant

physiology is available for qualified candidates who wish to prepare for teaching and research positions in colleges, universities, government service, and industry. Students majoring in plant physiology may be part of any one of several plant science departments, depending upon their adviser's affiliation.

Prerequisites – A general background in basic science and in mathematics is necessary for the major, and it is expected that students will make up deficiencies early in their graduate program.

Course Requirements – Programs in both the major and minor will include most of the courses listed in Group A (core courses) below, or their equivalent. Courses listed in Group B (core supplement courses) provide additional training in depth and scope in the area of plant physiology. Courses listed in Group C (specialized courses) provide specialized training in disciplines relating to plant physiology. In addition to the courses listed below, courses in other appropriate fields such as anatomy, cytology, ecology, genetics, taxonomy and biochemistry may be accepted as part of the major with consent of the adviser.

Language Requirements – No foreign language is required for the M.S. or Ph.D. degrees.

Master's Degree – Offered under both Plan A and Plan B.

Doctor's Degree – Work leading to the Ph.D. degree is offered.

Group A (Core Courses)

5-182s.* PLANT METABOLISM. (3 cr; prereq a course in biochemistry; §Bot 5-182) Soulen
Plant metabolism including photosynthesis, respiration and the synthesis of macromolecules by plants. Structure-function relations at the plant, cell, and sub-cellular level. Energy flow in the plant system and regulation of plant metabolism.

5-183w.* WATER, MINERALS, AND TRANSLOCATION. (4 cr; prereq course in biology, physics, and in organic chemistry or biochemistry; §Bot 5-183) Stadelmann, Smith
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.

5-184f.* PLANT GROWTH AND DEVELOPMENT. (3 cr; prereq course in biology and course in organic chemistry; §Bot 5-184) Brun, staff
Growth of higher plants including division and differentiation of cells, development of plant organs, the effects of external factors on plant growth, photosynthesis and respiration in relation to plant development, and the nature and action of plant growth substances.

5-702w, 5-703f. MEASUREMENT OF PLANT-ENVIRONMENT INTERACTIONS. (2-4 cr; prereq ‡)
Laboratory courses dealing with measurements using intact plants, including water balance, and gas exchange between plants and the environment.
- **5-702. Gas Exchange by Plants.** (2 cr; prereq ‡) Moss
- **5-703. Internal Water Balance.** (2 cr; prereq ‡; offered 1972-73 and alt yrs) Stadelmann, Sucoff

5-721s, 5-723w, 5-724s, 5-725s, 5-726w, 5-727w. METHODS OF PLANT ANALYSIS. (1-6 cr; enrollment limited, prereq Chem 3-100, Chem 3-101, 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:
- **5-721. The Primary Plant Metabolites.** (Cr ar; offered 1972-73 and alt yrs) Li
- **5-723. Plant Hormones and Tissue Culture.** (Cr ar) Brenner
- **5-724. Photosynthesis and Photosynthetic Pigments.** (Cr ar; offered 1972-73 and alt yrs) Frenkel
- **5-725. Plant Nucleic Acids.** (Cr ar; offered 1973-74 and alt yrs) Li
- **5-726. Analysis of Cell Structure.** (Cr ar; offered 1972-73 and alt yrs) Stadelmann
- **5-727. Phytochrome, Photomorphogenesis and the Physiology of Flowering.** (Cr ar; offered 1972-73 and alt yrs) Koukkari

8-251f,w. SEMINAR. (1 cr) Staff

Group B (Core-Supplement Courses)

5-141w. SURVEY OF PLANT PHYSIOLOGY. (3 cr, §Bot 5-141; prereq Bot 1-001, Biol 1-002 or 3-012, 1 yr physics, course in organic chemistry or biochemistry) Frenkel
Critical study of the physiological processes that occur in living plants, with emphasis on higher plants. Growth and development, energy relations, mineral nutrition, water relations, respiration, photosynthesis, and nitrogen metabolism.

5-142w. PLANT PHYSIOLOGY LABORATORY. (2 cr; prereq 5-141 or ¶5-141; §Bot 5-142) Frenkel
A laboratory course to accompany PlPh 5-141.

5-167s.* PHYSIOLOGY OF THE PLANT CELL. (3 cr; prereq plant anatomy, inorganic and organic chemistry or biochemistry; offered 1972-73 and 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.

5-168f.* EXPERIMENTAL PROTOPLASMATOLOGY. (3 cr; prereq ‡; offered 1973-74 and alt yrs) Stadelmann
Physical and physicochemical properties of living protoplasm in plant cells, including viscosity, wall attachment, permeability, primary and secondary fluorescence, vital staining.

5-185f.* PHYSIOLOGY OF PHOTOSYNTHETIC MICROORGANISMS. (3 cr; prereq ‡; offered 1972-73 and alt yrs)
Application of spectrophotometry, manometry and other techniques toward elucidation of physiological behavior, chemical makeup and intermediary metabolism of algae and photosynthetic bacteria.

5-188f,w,s.* RESEARCH PERSPECTIVES IN PLANT PHYSIOLOGY. (1-4 cr; prereq Chem 3-100, Chem 3-101, 8 cr in biochemistry, ‡) Moss, Staff
A laboratory course in which the student undertakes a well-defined research problem of limited scope.

5-970f,w,s.* SPECIAL PROBLEMS IN PLANT PHYSIOLOGY. (Cr ar) Staff
Research, readings, instruction.

8-281s.* GROWTH AND DIFFERENTIATION OF PLANTS. (3 cr; prereq 5-184; offered 1973-74 and alt yrs) Brenner
Nature and characterization of plant growth, with analysis of the physiological changes which occur during growth and differentiation of plants; hormonal control of growth processes.

8-282f.* ADVANCED TOPICS IN PLANT METABOLISM. (3 cr; prereq 5-182; offered 1973-74 and alt yrs) Staff
Treatment in depth of one or more topics selected from the following: respiratory pathways, including modifications; organic acid metabolism, nitrogen metabolism; sulfur metabolism. Content of course will vary with instructor and may include topics not listed.

8-285f. PHOTOSYNTHESIS. (3 cr; prereq 5-182; offered 1973-74 and alt yrs) Frenkel
Detailed survey of the present state of knowledge of photosynthesis.

8-286f. RADIOISOTOPE TECHNIQUES APPLIED TO BIOLOGY. (3 cr; enrollment limited; prereq ‡)
Lecture and laboratory course on uses of radioisotopes in biological research; problems in their use and measurement.

Group C (Specialized Courses)

For complete descriptions see the appropriate field of instruction elsewhere in this bulletin.

Agro 5-030. WEED CONTROL

Agro 5-050. PHYSIOLOGY OF FIELD CROPS

FBio 8-101. RESEARCH PROBLEMS: FOREST-TREE PHYSIOLOGY

Hort 5-040. PLANT GROWTH REGULATORS

Hort 5-041. ENVIRONMENTAL REQUIREMENTS OF HORTICULTURAL PLANTS

Hort 8-045. PLANT HARDINESS

Hort 8-052. ADVANCED PROBLEMS IN PHYSIOLOGY OF HORTICULTURAL CROPS

MicB 5-321. PHYSIOLOGY OF BACTERIA

MicB 8-121. ADVANCED MICROBIOLOGY LABORATORY

PlPa 5-109. PHYSIOLOGY AND BIOCHEMISTRY OF FUNGI

PlPa 8-610. PHYSIOLOGY OF HOST-PARASITE RELATIONSHIPS

Soil 5-240. MICROCLIMATOLOGY

Soil 5-340. ORGANIC AND PESTICIDAL RESIDUES

PLASTIC SURGERY

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

POLITICAL SCIENCE (Pol)

Professor

Charles H. Backstrom
Davis B. Bobrow
Harold W. Chase
William H. Flanigan
Edwin Fogelman
Robert T. Holt
Samuel Krislov
Charles H. McLaughlin
Robert E. Riggs
Mulford Q. Sibley
Frank J. Sorauf
John E. Turner

Associate Professor

Thomas M. Scott, *chairman*
W. Phillips Shively, *director of graduate study*
Roger W. Benjamin

Assistant Professor

Joanne A. Arnaud
Terence W. Ball
Richard N. Blue
Robert E. Crew, Jr.
Robert B. Eyestone
P. Terrence Hopmann
Sheilah R. Koeppen
Robert B. Kvavik
August H. Nimtz, Jr.
Ellen B. Pirro
Enid B. Schoettle
Suzanne K. Sebert
L. Earl Shaw, Jr.
Charles E. Walcott
Gary W. Wynia

The graduate faculty of the Department of Political Science offers instruction leading to the M.A. and Ph.D. degrees. It is directed toward educating career political scientists for teaching and research. Priority is given to students pursuing the Ph.D. degree. Students primarily interested in public service should also investigate the program of the School of Public Affairs. Instruction for graduate majors is conducted separately from undergraduate instruction and course requirements for graduate degrees with a major in political science must be satisfied with courses open only to graduate students (8-000 level courses). Those who are inadequately prepared to enter particular seminars may in some cases be asked to complete prerequisite undergraduate courses. All major programs, and all minor programs for the Ph.D., must be approved by a graduate adviser of the department.

A detailed explanatory statement of prerequisites, subfields and subareas, and requirements for the M.A. and Ph.D. degrees may be obtained from the Director of Graduate Studies, Department of Political Science, University of Minnesota, Minneapolis, Minnesota 55455.

General Requirements – All candidates for graduate degrees with a major in political science must complete 8-101 and 8-102 (Scope and Methods of Political Science and Methods of Justification in Political Science, respectively), or present evidence of satisfactory completion of similar courses at another approved institution. Whenever possible 8-101 and 8-102 should be completed during the first year of graduate study.

Subfields of Study – The curriculum in political science is divided into six subfields. Four of these are concentration subfields from which students select two – one subfield of primary concentration and one subfield of secondary concentration.

The four concentration subfields are:

1. Political theory
2. Political processes and behavior
3. International politics
4. Law and public policy

The remaining two subfields are elective subfields and may not be used for concentration. The elective subfields are:

5. Area courses
6. Methodology

Two traditional subfields in political science, American and comparative politics, are not included in this list. Where appropriate, all of the courses contained herein apply examples from an American and a foreign perspective. Thus the comparative approach to the study of politics is an integral part of the entire curriculum. Students who wish to emphasize the comparative approach may select area courses as electives and in effect construct their own comparative subfield. The existing literature in political processes and behavior, and in law and public policy is so heavily based on the American experience that it is also possible to develop a more explicitly American focus.

Master of Arts Program

Plan A Program – Work leading to the Master's degree under Plan A consists of at least three quarters of graduate study, including: (a) at least 18 credits in political science in addition to 8-101 and 8-102; (b) at least 9 credits in the *minor* department; (c) a substantial thesis based upon independent research; (d) successful completion of a written examination in two subfields presented and a final oral examination covering these subfields and the thesis.

Plan B Program – Candidates for the Master's degree without thesis must complete: (a) at least 18 credits of course work in political science seminars chosen from two subfields in addition to 8-101 and 8-102; (b) a minimum of 18 credits of course work in at least two related disciplines; (c) research papers as specified in the requirements of the Graduate School (i.e., three research papers done for seminars representing 9 credits of course work); (d) a final written examination covering the two subfields presented and an oral examination covering these and the research papers. Courses elected in political science together with those in other disciplines should constitute an integrated plan of study. Normally, at least two of the required research papers, when submitted in 3 credit courses, should be prepared for courses in political science. Of the 18 credits outside political science, students may elect to take a maximum of two political science courses, in area courses or methodology, as part of that supporting program (with the exception of 8-101 and 8-102). For example, students deciding to take a supporting program in East Asian studies could take courses in anthropology, history, and geography plus 8-604 (Japan) and 8-605 (China). 8-604 and 8-605 in this example would not be part of the major program.

Note — (1) Candidates for the Master's degree must satisfy a foreign language *OR* research tool requirement either by passing the relevant requirement through one foreign language department *OR* by demonstrating competence in a research tool. Nine credits in 5-000 or 8-000 level courses will normally be considered

demonstrated competence in research tools. (2) Master's degree candidates will be examined in two subfields of political science. In each subfield they will write a four-hour examination. In addition, students must successfully complete a final oral examination covering their subfields and thesis (Plan A) or Plan B papers (Plan B).

Students working for the Master's degree may not register for course work in political science beyond the Master's requirements until they are admitted to the Ph.D. program by the department.

Special M.A. Program – Students who enter with the intention of seeking a terminal M.A. degree may elect to follow a special course program in which some 5-000 level courses in political science are accepted for Master's degree credit. *This special program is designed to meet the needs of high school teachers, and must be approved by the student's adviser and the Graduate Work Committee of the Department.*

It should be understood that this special M.A. program will not prepare students for the department's Ph.D. program. Students who are uncertain at the start of their graduate work as to their plans to pursue a Ph.D. program are advised *not* to elect this special terminal M.A. program. Students in this special program are not required to take either 8-101, 8-102, or the first year exam. They will, however, take an M.A. examination at the completion of course and research requirements for the M.A. degree. These students normally will follow the Plan B program to the M.A. degree.

Plan A with Minor in Political Science – Candidates for graduate degrees with political science as a minor must take a group of related courses lying in either one or two subfields and totaling 9 credits. Either 8-000 level or 5-000 level courses may be used.

Ph.D. Program

Courses in the Major – Students will be required to have at least 57 credits (or the equivalent of 19 seminars at three credits per seminar) in political science. They will prepare themselves in two subfields of concentration (one primary and one secondary) over which they will be examined in the preliminary written examinations.

Normally the minimum of 19 seminars will be distributed as follows:

6 seminars in the first subfield
4 seminars in the second subfield
2 seminars in scope and methods (8-101 and 8-102) taken during the first year
2 research seminars
5 seminars elective (students are advised to take two of these seminars or their equivalent, in methodology and to take the other three outside of their two subfields of concentration; in any event, at least three of these elective seminars *must* be outside of the two subfields of concentration).

Minor or Supporting Program – The Graduate School requires students to complete a minor *OR* supporting program which consists of at least one-sixth of the total program taken in courses numbered over 5-000. Normally, this means 18 credits. A minor consists of work done in a single department, while a supporting program consists of courses taken in several disciplines which relate to and support the major.

If students choose the supporting program, they may elect to take a maximum of two political science courses, in area courses or methodology, as part of that supporting program (with the exception of 8-101 and 8-102). For example, students deciding to take a supporting program in East Asian studies to support their major

could take courses in anthropology, history and geography plus 8-604 (Japan) and 8-605 (China). 8-604 and 8-605 in this example would not be part of the major program and thus not part of the required 19 seminars.

Foreign Languages and Research Tools – Students must satisfy a foreign language and/or research tool requirement, by completing one of the following four options:

1. Students must pass the reading exam offered by the relevant language department in two foreign languages. (Course work may not be offered in lieu of passing the exams, although the various language departments do offer courses for graduate students whose final exams can be taken for the purpose of meeting this requirement.)

OR

2. Students may show advanced competence in a single language *which is related to their research interests.* Advanced competence will normally mean demonstrating that the language can be used in field research. Such general proficiency must be certified and recorded on the student's transcript by the foreign language department involved.

OR

3. Students must pass the *reading exam* offered by the relevant language department and demonstrate competence in a research tool. Nine credits in a 5-000 level course or the equivalent will normally be considered demonstrated competence in a research tool.

OR

4. Students must show advanced competence in a research tool normally equivalent to at least 18 credits in 5-000 level courses.

The option that students choose and the specific way of meeting that option *must be approved by the adviser and the director of graduate study.*

Examinations – Preliminary written and oral examinations are given during the fall and spring quarters. All course work in political science must be completed prior to the preliminary written examination. After successfully passing the written preliminary exam, students must schedule the preliminary oral exam within the same quarter. The Department of Political Science requires that all course work, including minor or supporting program and language or research tool, be completed prior to the preliminary oral examination.

Preliminary written examinations cover the student's two subfields of concentration in political science. Examinations in the minor or related field will be governed by Graduate School rules. Generally, students are examined in their minor field by their minor department, while students presenting supporting programs are not examined. However, all students are examined in their minor or supporting program in the preliminary oral.

Ph.D. Candidacy and Thesis – Candidacy for the Ph.D. degree is achieved by successful completion of prescribed course work, and of written and oral preliminary examinations.

The Ph.D. degree is awarded after submission of an acceptable dissertation embodying independent research and a final oral examination by a committee appointed by the graduate dean devoted to the thesis and to relevant aspects of the area in which it is written. This final oral examination may not be scheduled in the same quarter as the preliminary oral examination.

Additional Components of the Program

Research Seminars — Students are required to complete two research seminars, one in each of the first two years of graduate study. There will be separate first year and second year research seminars for students in each subfield of concentration. One faculty member will be assigned to coordinate both first and second year research seminars within a given subfield of concentration.

The purpose of the research seminars is to give students an opportunity to plan and carry out a research project on a subject of interest to them. Students are encouraged to use the research seminar requirement to explore areas where they have not done a great amount of work. Students will work closely with a faculty research adviser, and the seminar will also give them the opportunity to present their work to fellow graduate students and receive comments and criticism from them. The final seminar grade and written evaluation of the seminar paper will be given by a faculty research adviser. To encourage creative use of the research seminars, students will be evaluated on the basis of the progress or improvement in research abilities that their paper demonstrates.

Progress Toward the Degree – The graduate program provides two "tracks" toward the Ph.D. and several opportunities to judge progress along these tracks.

Students entering the program without an M.A. from another institution will start on the "M.A. track" in the fall quarter of their first year. On the M.A. track they will follow the normal route to the Ph.D., getting an M.A. first, applying for admission to the Ph.D. program, and then completing the Ph.D. requirements.

At the end of the winter quarter of their first year students on the "M.A. track" may, in consultation with their adviser, apply for consideration for the "Ph.D. track." Such students will take a "first year exam" early in the spring quarter of their first year, and on the basis of this exam, the first year research paper, and other evaluative materials, they may be placed directly on the "Ph.D. track," bypassing the M.A. exams and procedures entirely.

The School of Public Affairs – The School of Public Affairs, which is administratively separate from the Department of Political Science, offers a number of courses of interest to graduate students in political science. Courses in the School of Public Affairs may be used to form a minor or part of a supporting program for graduate majors in political science.

Several graduate level courses are cross listed between public affairs and political science. These courses may be used either as part of a minor or supporting program or as part of the major requirements, but not both. When planning a program including any of these courses, students should decide how they want to count them toward their total degree requirement.

Curriculum – In the following course listing, 5-000-level courses are open to upper division and graduate students. Although graduate credit may be obtained in these courses, it cannot be offered in fulfillment of course requirements for graduate majors in political science; it is acceptable to the extent stated above in satisfying requirements for a minor field or supporting program, or as additional work prerequisite to 8-000-level seminars. The 8-000-level courses include seminars which may be offered in satisfaction of course requirements for majors.

Methodology

8-101.* SCOPE AND METHODS OF POLITICAL SCIENCE. (3 cr; prereq #) Staff
The field of political science; relation to other sciences; types of approach; research methods and techniques; bibliography.

8-102.* METHODS OF JUSTIFICATION IN POLITICAL SCIENCE. (3 cr; prereq 8-101) Staff
The nature of justification in political philosophy and political ideology. Selected problems in the justification of political phenomenon or policies. Political science as a policy science and the role of political scientists in formulating public policy.

8-105. METHODS OF DATA ANALYSIS I. (3 cr) Benjamin, Flanigan
Data collection and observation techniques; measurement techniques; measures of association.

8-106. METHODS OF DATA ANALYSIS II. (3 cr) Benjamin, Flanigan
Concepts of variance; multiple regression analysis; causal modeling; factor analysis; elements of probability and sampling theory.

8-111. COMPARATIVE METHODS. (3 cr; prereq ‡) Holt
Logic of comparative research design; conceptual requirements of cross-cultural research.

8-160.* SEMINAR: SELECTED TOPICS IN METHODS OF POLITICAL SCIENCE. (3 cr; prereq ‡) Staff
Supervised research or research training in selected topics or problems.

Political Theory

5-659.* AMERICAN POLITICAL THOUGHT. (4 cr; prereq 1-051 or 9 cr social science or ‡) Ball, Shaw, Sibley
Colonial times to present; Puritanism; Constitution; utopianism; Calhoun; history of anarchist, socialist, populist, and syndicalist thought; social Darwinism; conservatism; political thought in law and literature.

5-661. PROBLEMS OF DEMOCRACY. (4 cr; prereq 1-051 or 9 cr social science or ‡) Aranson, Ball, Shaw
Postulates and implications; moral foundations, democratic theory, and economic order; liberty and authority; equality; representation; spiritual order; critics of democracy.

5-662.* RECENT POLITICAL THOUGHT. (4 cr; open to jr, sr only; prereq 1-051 or 9 cr social science or ‡) Arnaud, Ball, Shaw
Main currents from Marx to present; including socialist, anarchist, liberal and conservative thought; problems such as alienation and political obligation.

5-663. POLITICAL THEORY AND UTOPIA. (4 cr; prereq 1-051 or 9 cr social science or ‡) Sibley
Selected great utopias from view point of the political theorist; idea of planning in ideal state, achievement of utopia, stability and change in the great utopias; problem of authority and law; anarchist, socialist, and conservative utopias.

5-664. DEVELOPMENT OF POLITICAL THOUGHT: ANCIENT. (4 cr; prereq 1-051 or 9 cr social science or ‡) Ball, Sibley
Hebrew ideas, Moses to the second Isaiah; classical Greek thought; Plato and Aristotle; primitive natural law; cynics and stoics; theory in Roman Republic and Empire; first century Christianity.

5-665. DEVELOPMENT OF POLITICAL THOUGHT: THE MIDDLE AGES. (4 cr; prereq 1-051 or 9 cr social science or ‡) Ball, Sibley
Early Christianity and the church fathers; moral theory and political theory; empire and church in ideology; Roman and canon law; theory of persecution; St. Thomas; 14th- and 15th-century conceptions.

5-666.* EARLY MODERN POLITICAL THOUGHT. (4 cr; prereq 1-051 or 9 cr social science or ‡) Ball, Sibley
Machiavelli, idea of sovereignty; Protestant conceptions; English Civil War; Hobbes, Spinoza, Locke; idea of progress; Godwin, Burke, Rousseau, rise of romanticism; German idealism.

5-667. RECENT EMPIRICAL THEORY. (4 cr; prereq 1-051 or ‡; offered 1973-74 and alt yrs) Aranson, Fogelman
Examination of selected empirical theories, such as theories of power, systems theory, game theory, structural functionalism, conflict theory and others. Emphasis on usefulness of these formulations in political analysis.

8-201, 8-202, 8-203.* TOPICS IN THE DEVELOPMENT OF POLITICAL THOUGHT. (3 cr per qtr; prereq 5-664 for 8-201, 5-665 for 8-202, 5-666 or 5-662 for 8-203 or equiv or ‡) Sibley
Selected topics examined each quarter. In general these will relate in 8-201 to ancient, in 8-202 to medieval, in 8-203 to modern political thought. Specific areas of concentration vary from year to year, e.g., Plato's outlook, development of natural law views, 13th-century political theory, development of modern anarchism, utilitarianism, Marxism, Hegelianism.

8-211/8-212.* TWENTIETH-CENTURY POLITICAL THOUGHT. (3 cr per qtr; prereq 5-662 or equiv or ‡) Staff
Selected aspects of 20th-century political thought; specific subjects will vary from year to year, e.g., traditional theory and its critics, socialist perspectives, conservatism and the radical right, the scientific revolution and politics, the Christian revolution and politics.

8-215, 8-216.* AMERICAN POLITICAL THOUGHT. (3 cr per qtr; prereq 5-659 or equiv, grad major in American studies, or ‡) Ball, Shaw, Sibley
Examination of major issues and thinkers (statesmen, novelists, academics, etc.). Relation of political thought to problems of American culture.

8-221/8-222.* CONTEMPORARY POLITICAL THEORY. (3 cr per qtr; prereq ‡) Fogelman
Intensive examination of selected empirical theories from the standpoint of usefulness for political analysis: communication theory, game theory, systems theory, decision-making theory, conflict theory, structural-functional theory, etc.

8-228.* THEORY OF PLURALISTIC POLITICS. (3 cr; prereq 5-441 or equiv) Blue
Application of the comparative method to analysis of democratic systems; prerequisites for modern democracy; origin and development; socio-economic basis of politics; organization of power; role of parties and interest groups; patterns of voting behavior; nature and role of elites.

8-229.* THEORY OF AUTHORITARIAN POLITICS. (3 cr; prereq 5-443 or 5-454 or equiv) Turner
Application of the comparative method to analysis of totalitarianism; origin and development; socio-economic basis of power and authority; institutional features; nature and role of ideologies; evolution of elite structures; role and functions of the party; economic and social policies; limitations upon totalitarianism.

8-231.* THEORY OF POLITICAL DEVELOPMENT. (3 cr; prereq 5-773 or equiv or ‡) Holt
Application of the comparative method to analysis of political development, especially of contemporary underdeveloped areas; factors leading to different theories of development.

8-240.* INDIVIDUAL READING AND RESEARCH IN POLITICAL THOUGHT. (3 cr per qtr; prereq ‡) Staff

8-250.* RESEARCH SEMINAR: POLITICAL THEORY. (3 cr; prereq ‡) Staff
Supervised research and research training in selected topics and problems.

8-260.* SEMINAR: SELECTED TOPICS IN POLITICAL THEORY. (3 cr; prereq ‡) Staff
Readings and research in special advanced topics or problems.

International Relations

5-876. FOREIGN POLICY, DECISION-MAKING. (4 cr) Bobrow, Hopmann, Pirro, Schoettle
Analysis of the processes through which states make and implement foreign policy decisions, with examples from foreign policies of several states including the United States.

5-877. COMPARATIVE FOREIGN POLICY. (4 cr) Bobrow, Hopmann
Comparative analysis of foreign policies of major states; national and international determinants of foreign policy behavior.

5-881. INTERNATIONAL LAW I. (5 cr) McLaughlin
Growth and character of international law system; use of legal materials, and evidence; relation to municipal law; subjects (individuals, states, international agencies); treaties and other international agreements; principles and problems of jurisdiction.

5-882. INTERNATIONAL LAW II. (5 cr) McLaughlin
Diplomatic agents and consuls—their functions and jurisdictional immunities; rights of aliens; law developed by international organizations; pacific settlements of disputes; hostile measures short of war; intervention; war and neutrality.

5-884. INTERNATIONAL POLITICS I. (4 cr) Bobrow, Hopmann, Pirro
Structure of the international system: balance of power, bipolar, and other types of international systems; theories of stability, change, conflict and cooperation.

5-885. INTERNATIONAL POLITICS II. (4 cr; prereq 5-884 strongly recommended) Bobrow, Hopmann, Pirro
Interaction in international systems including integration and disintegration; alliances and other regional systems; methods of analysis in international politics.

5-887. INTERNATIONAL SECURITY ORGANIZATION I. (4 cr) Riggs
The United Nations and its antecedents; decision-making in international organizations; global and regional organization for international security, disarmament and dispute settlement.

5-888. WORLD ORGANIZATION FOR FUNCTIONAL COOPERATION. (4 cr) Riggs
Global and regional organization for economic, social, cultural, and humanitarian cooperation; comparison of functional and political organizations; economic and political integration; problems of international administration.

8-401/8-402.* SEMINAR: INTERNATIONAL POLITICS. (3 cr per qtr; prereq 5-884 or 5-885 or ‡) Hopmann, Pirro
Major approaches and concepts employed in study of international political relations; international communications; international conflict; problems of research and development of theory.

8-408/8-409.* SEMINAR: INTERNATIONAL ORGANIZATION. (3 cr per qtr; prereq 5-887 or 5-889 or ‡) Riggs
Examination of universal and regional international organizations; organizational decision making and international administration; political and economic integration.

8-412/8-413.* SEMINAR: INTERNATIONAL LAW. (3 cr per qtr; prereq 5-881 or equiv) McLaughlin
Historical development of the relationship of economic, social, and political systems to systems of international law; analysis of relevant juristic concepts.

8-416.* SEMINAR: FOREIGN POLICY MAKING. (3 cr; prereq 5-876 or 5-877 or ‡) Schoettle, Bobrow
Patterns of postwar diplomacy in bilateral relations, conferences, international agencies; problems of agency coordination, selection and training of personnel in foreign affairs administration.

8-417.* SEMINAR: FOREIGN POLICY. (3 cr; prereq 5-877 or ‡) Bobrow, Hopmann
Principal approaches to analysis of foreign policy; case studies in decision making in foreign relations; problems in defense and deterrence.

8-440.* INDIVIDUAL READING AND RESEARCH IN INTERNATIONAL RELATIONS. (3 cr per qtr; prereq ‡) Staff

8-450.* RESEARCH SEMINAR: INTERNATIONAL POLITICS. (3 cr; prereq ‡) Hopmann
Supervised group research and research training in selected topics or problems.

8-460.* SEMINAR: SELECTED TOPICS IN INTERNATIONAL POLITICS. (3 cr; prereq ‡)
Readings and research in special advanced topics or problems.

Political Processes and Behavior

5-303. THE AMERICAN DEMOCRACY. (4 cr; prereq 1-001 or ‡)
Integrated overview of American political system, its institutions and processes. Political decision-making, influence, and elites in American society. Evaluation and critical examination of practice and reality of democracy in the United States.

5-304. ORGANIZATIONAL BEHAVIOR. (4 cr; prereq 1-001) Jernberg, Walcott
Operation and significance of complex, formal organizations in the political system; with emphasis on public bureaucracy. Communication and influence processes; decision-making innovation; relation of organization to environment.

5-306. EXECUTIVE AND THE BUREAUCRACY. (4 cr; prereq 1-001 or ‡) Schoettle, Walcott
The executive branch, including the presidency and administrative and regulatory bureaucracies; emphasis on interaction of formal structures and political actors; major topics include recruitment, development of institutional structures, advisory systems, legislative relations, budgetary and policy control.

5-308. LEGISLATIVE PROCESS. (4 cr; prereq 1-001 or ‡) Backstrom, Eyestone, Shaw
The American Congress and state legislatures; internal organization, the committee system, party leadership; relationships with executives and administrative agencies; legislative policy-making interest group, party and constituency influences on the legislative process.

5-309.* THE JUDICIAL PROCESS. (4 cr; prereq 1-001 or ‡) Krislov, Sorauf
Structure of the American judiciary; selection of judges; the process of litigation; influences on judicial decisions; impact of and compliance with decisions; role of the Supreme Court in the American political system.

5-315. STATE GOVERNMENT. (4 cr; prereq 1-001 or ‡) Backstrom, Crew
Description and analysis of political institutions and behavior in American states; involves interstate comparisons and comparisons between state and national political systems.

5-321. AMERICAN ECONOMIC POLICY. (4 cr; prereq 1-001 or ‡) Eyestone
Analysis of economic policy-making processes; examination of several major policy issues such as fiscal and monetary policy, subsidies, economic regulation, and direct controls; assessment of governmental impact on the private economic sector.

5-322. AMERICAN SOCIAL POLICY. (4 cr; prereq 1-001 or ‡) Eyestone
American government actions affecting the distribution of social benefits such as health care, education, and housing; and social burdens such as taxation and regulation of social conduct. Focus on relationships between government action and social problems, with attention to possibilities for change.

5-323. AMERICAN DEFENSE POLICY. (4 cr; prereq 1-001 or ‡) Bobrow, Schoettle
Examination of several major substantive policy issues, such as: American strategic theory and general war capabilities; limited war theory and capabilities; arms control and disarmament. Analysis of defense policy-making processes in the Executive Branch, the Congress, and the private sector. Assessment of implications of American defense policies for foreign and domestic policy.

5-327. LOCAL GOVERNMENT. (4 cr; prereq 1-001 or ‡) Backstrom, Scott
Development of local political systems in the United States: relationships of governmental and political structures to economic and social characteristics of communities; analysis of role of local government in the federal systems; analysis of influence decision-making pattern in various types of communities.

5-328. METROPOLITAN GOVERNMENT AND POLITICS. (4 cr; prereq 1-001 or ‡) Nimtz, Scott
Analysis of contemporary metropolitanism; development and definition of major metropolitan problems; analysis of governmental-political responses to such problems including development of federal and state programs; discussion of politics of metropolitan reform efforts.

5-737. POLITICAL PARTIES. (4 cr; prereq 1-001 or ‡) Backstrom, Crew
Role and functions of the party in American government; party composition and organization; process of nomination and policy formulation; regulation of party organization and activities.

5-738. AMERICAN POLITICAL CAMPAIGNS AND ELECTIONS. (4 cr; prereq 1-001 or ‡) Crew, Sebert
Examination of national, state, and local campaigns and elections, including field work in local political parties and election campaigns.

5-739. POLITICS OF ETHNIC COMMUNITIES. (4 cr; prereq 6 cr social science) Koeppen, Nimtz
Cross-cultural study of politics of ethnic communities with special emphasis on politics of black communities in the United States. Topics on community politics and their local and national political systems.

5-767. PUBLIC OPINION AND VOTING BEHAVIOR. (5 cr; prereq 1-001 or ‡) Flanigan, Koeppen, Shively
Analysis of major factors influencing electoral decisions; study of political attitude formation and change.

5-768. POLITICAL CULTURE: SOCIAL BASIS OF POLITICAL BEHAVIOR. (5 cr; prereq 1-001 or ‡; 5-767 recommended) Flanigan, Koeppen, Shively
Social and environmental influences on political attitudes and political participation; political elites and politics of mass society.

5-769. POLITICAL LEADERSHIP. (4 cr; prereq 1-051; offered 1973-74 and alt yrs) Benjamin, Nimtz, Wynia
Comparative political leadership emphasizing political recruitment patterns, executive and legislative behavior and political power structures in industrial and nonindustrial states.

5-771. COMPARATIVE PUBLIC POLICY. (4 cr; prereq 1-051 or ‡; offered 1973-74 and alt yrs) Marmor, Wynia
Analysis of policy-making and administrative implementation in high and low income countries; emphasis on content and impact of economic development and social welfare policies.

5-772. COMPARATIVE POLITICAL ORGANIZATION. (4 cr; prereq 1-051 or ‡; offered 1973-74 and alt yrs) Kvavik, Nimtz
Analysis of political group activity in different polities; emphasis on individual behavior in group systems affecting public policy.

5-773. POLITICAL DEVELOPMENT. (4 cr; prereq 1-051 or ‡; offered 1973-74 and alt yrs) Benjamin, Holt, Wynia
Analysis of political problems of new nations; particular emphasis on political consequences of breakdown of traditional society and problems of developing new institutional forms and procedures.

5-774. COMPARATIVE POLITICAL PARTICIPATION. (4 cr; prereq 1-051 or ‡; offered 1973-74 and alt yrs) Blue, Nimtz, Shively
Comparative study of the relationship of mass political behavior to governmental activity.

8-301.* 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.

8-303.* SEMINAR: POLITICAL PARTIES. (3 cr; prereq ‡) 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.

8-305.* SEMINAR: INTEREST GROUPS. (3 cr; prereq ‡) Flanigan, Kvavik, Walcott
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.

8-307.* SEMINAR: POLITICAL LEADERSHIP AND DECISION MAKING. (3 cr; prereq ‡; offered 1973-74 and alt yrs) Flanigan, Benjamin
Theories of political leadership; social and cultural support of leaders; description and analysis of leadership recruitment and rejection; decision making, choice, and bargaining in political organizations.

8-309.* SEMINAR: POLITICAL PSYCHOLOGY AND SOCIALIZATION. (3 cr; prereq ‡; offered 1972-73 and alt yrs) Koeppen
Theories of political psychology, opinion formation and attitude change; political style and ideology; processes of individual political development and socialization.

8-312.* SEMINAR: LEGISLATIVE PROCESS. (3 cr; prereq ‡) Backstrom
National and state legislatures; their internal organization; party organizations and influences with legislatures; interest groups and other external influences; legislative roles and behavior; policy-making processes in American legislatures.

8-313.* SEMINAR: EXECUTIVE PROCESS. (3 cr; prereq ‡) Krislov
The political executive, cabinets, and staff aids; relations with legislatures; the executive as party and popular leader; the executive and administrative agencies.

8-314.* SEMINAR: JUDICIAL PROCESS. (3 cr; prereq ‡) Sorauf, Krislov
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.

8-317. SEMINAR: 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, organizations.

8-321.* SEMINAR: LOCAL GOVERNMENT AND 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; policy making at the local level; studies in policy problems; the emerging metropolis.

8-323.* SEMINAR: COMMUNITY POWER SYSTEMS. (3 cr; prereq ‡) Backstrom, Scott
Structure of influence in communities; methods and approaches to study of community power; determinants of power in the community.

8-325.* SEMINAR: COMPARATIVE STATE POLITICS. (3 cr; prereq ‡) Crew
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.

8-340.* INDIVIDUAL READING AND RESEARCH IN POLITICS AND BEHAVIOR. (3 cr per qtr; prereq ‡) Staff

8-350.* RESEARCH SEMINAR: POLITICAL PROCESSES AND BEHAVIOR. (3 cr; prereq ‡) Staff
Supervised research and research training in selected topics or problems.

8-360.* SEMINAR: SELECTED TOPICS IN POLITICAL PROCESSES AND BEHAVIOR. (3 cr; prereq ‡) Staff
Readings and research in special topics or problems.

Law and Public Policy

5-309. JUDICIAL PROCESS. (4 cr; prereq 1-001 or ‡)
See political processes and behavior subfield for description.

5-501, 5-502. PRINCIPLES OF AMERICAN CONSTITUTION I, II. (5 cr per qtr; prereq 1-001 or equiv)
Nature of constitutions, judicial review, organization and powers of national government; national, state and interstate relations; civil rights and civil liberties.

5-881/5-882. INTERNATIONAL LAW I, II. (5 cr) McLaughlin
See international politics subfield for description.

8-314.° SEMINAR: JUDICIAL PROCESS.
See political processes and behavior subfield for description.

8-412/8-413.° SEMINAR: INTERNATIONAL LAW.
See international politics subfield for description.

8-501.° RESEARCH SEMINAR: JUDICIAL PROCESS AND ADMINISTRATIVE LAW. (3 cr; prereq ‡) Krislov, Sorauf
Supervised research and research training in selected topics or problems.

8-504/8-505.° SEMINAR: CONSTITUTIONAL LAW. (3 cr per qtr; prereq 5-501, 5-502 or ‡) Chase

8-508.° FUNDAMENTAL CONCEPTS OF PUBLIC LAW. (3 cr; prereq ‡) Krislov
State and law; coercion and consent; concepts of right and obligation; basis of property; contract, tort; vehicles of legal growth—legislation, administrative regulation, judicial action; separation and distribution of power; domestic jurisdiction and the international legal community.

8-509.° JURISPRUDENCE. (3 cr per qtr; prereq 8-508 basic course in either constitutional, administrative, or international law) McLaughlin
Legal systems in relation to social systems. Examination of interests protected; extent of state intervention; institutional devices and procedures for doing justice and maintaining order; vehicles of legal change and growth; basic legal concepts in kin-organized societies, political societies based on status, politico-economic societies based on contract, modern industrialized democratic societies. Limits of social control by law.

8-516.° SEMINAR: PUBLIC POLICY. (3 cr; prereq ‡) Eyestone
Politics of the policy-making process; interest group, client, and constituent pressures; decision making and bargaining in policy making; topics in major areas of regulation, planning, fiscal, and welfare policy.

8-518. SEMINAR: POLICY EVALUATION. (3 cr; prereq ‡) Bobrow
Critical review and application of techniques available for policy evaluation prior to and after policy adoption.

8-521.° SEMINAR: INTERGOVERNMENTAL RELATIONS. (3 cr; prereq ‡)
American federal system; state-local relationships; inter-unit cooperation and conflict; metropolitan dispersal and integration.

8-540.° INDIVIDUAL READING AND RESEARCH IN PUBLIC LAW. (3 cr per qtr; prereq ‡) Staff

8-550.° RESEARCH SEMINAR: CONSTITUTIONAL LAW. (3 cr; prereq ‡) Staff
Supervised research and research training in selected topics or problems.

8-560.° SEMINAR: SELECTED TOPICS IN LAW AND PUBLIC POLICY. (3 cr; prereq ‡) Staff
Readings and research in special advanced topics or problems.

Area Courses

5-441.° EUROPEAN GOVERNMENT AND POLITICS. (5 cr; prereq 1-051 or 12 cr social science or ‡) Arnaud, Holt, Shively, staff
Political institutions in their social setting; problems of power and responsibility, governmental stability; political decision making, government and the economic order.

5-443. GOVERNMENT AND POLITICS OF THE SOVIET UNION. (4 cr; prereq 1-051 or 12 cr social science or ‡) Turner
Analysis of the rise of Bolshevism; sources and nature of its ideology; history and institutional character of the Soviet regime; sources of power; role of the party and functional groups; patterns of change.

5-444. GOVERNMENT AND POLITICS OF SCANDINAVIAN COUNTRIES. (4 cr; prereq 12 cr in social science) Kvavik
Survey of Scandinavian political institutions and behavior; special attention given the Scandinavian pattern of party politics, functions of interest groups and legislative behavior. Comparative analysis of voting patterns and voter alignments.

5-446. GOVERNMENT AND POLITICS OF SOUTH ASIA. (5 cr; prereq 3 cr Upper Division work in social sciences) Blue
Governmental institutions in their historical and social setting. Emphasis on dynamic processes of modernization within a democratic institutional framework. Special attention given to problems of implementing public policies involving social and economic development, including agrarian reform, population control, and industrial growth.

5-448. GOVERNMENT AND POLITICS OF AFRICAN COUNTRIES. (4 cr; prereq 1-051 or 12 cr social science or ‡) Nimtz, Pirro
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.

5-453.° JAPANESE GOVERNMENT AND POLITICS. (4 cr; prereq 1-051 or 12 cr in social science or ‡) Benjamin
Constitutional and political development in Japan; political ideas, government, political parties, and problems.

5-454. CHINESE GOVERNMENT AND POLITICS. (4 cr; prereq 1-051 or 12 cr in social science or ‡) Benjamin, Turner
Analysis of 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.

5-455. LATIN AMERICAN GOVERNMENT AND POLITICS. (5 cr; prereq 1-001 or ‡) Wynia
General analysis of Latin American political heritage, political processes and contemporary public policy issues; examination of selected countries with emphasis on their resolution of problems of social, economic and political change.

5-896. PROSEMINAR: EAST AND SOUTH ASIA.
See international politics subfield for description.

8-601/8-602.° GOVERNMENT AND POLITICS IN WESTERN EUROPE. (3 cr per qtr; prereq 5-441 or equiv) Shively
Analysis of political institutions; political development; social structures; ideologies; parties and pressure groups; voting behavior.

8-608.° GOVERNMENT AND POLITICS OF THE U.S.S.R. (3 cr; prereq 5-443 or equiv) Turner
Analysis of 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.

8-609.° GOVERNMENT AND POLITICS OF JAPAN. (3 cr; prereq 5-453 or equiv) Turner
Analysis of Japanese political institutions in their social setting; political development; ideologies; organization of political power; parties and pressure groups; socio-economic basis of political action.

8-612.° GOVERNMENT AND POLITICS OF CHINA. (3 cr; prereq 5-454 or equiv) Turner
Analysis of Chinese political institutions in their social setting; political development; ideologies; organization of political power; parties and pressure groups, socio-economic basis of political action.

8-615.° GOVERNMENT AND POLITICS OF INDIA AND SOUTHEAST ASIA. (3 cr; prereq 5-446 or equiv or ‡) Blue
Analysis of political institutions of 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.

8-619.° GOVERNMENT AND POLITICS IN LATIN AMERICA. (3 cr; prereq 5-455 or equiv or ‡) Wynia
Analysis of political institutions and processes, with emphasis upon selected countries; social and economic basis of politics; parties and interest groups; political instability and change.

8-626. SCANDINAVIAN GOVERNMENT AND POLITICS. (3 cr) Kvavik
Analysis of political institutions of the Scandinavian countries, socio-economic basis of politics, parties and interest groups; patterns of voting behavior.

8-631. GOVERNMENT AND POLITICS OF AFRICA. (3 cr; prereq 5-448 or equiv or ‡) Nimtz
Analysis of political systems and processes of African countries with particular emphasis on local politics and problems of political change, political ideology, and political leadership.

PSYCHIATRY

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

PSYCHOLOGY (Psy)

Professor

John G. Darley, *chairman, director of graduate study*
Ralph F. Berdie
Ellen S. Berscheid
Peter F. Briggs
James N. Butcher
David P. Campbell
John P. Campbell
Rene V. Dawis
Marvin D. Dunnette
George W. England
Paul W. Fox
Norman Garmezy
Irving I. Gottesman
A. Jack Hafner
Gordon T. Heistad
Vivian H. Hewer
James J. Jenkins
David L. LaBerge
Lloyd H. Lofquist
David T. Lykken
Kenneth MacCorquodale
Paul E. Meehl
Manfred J. Meier
Gerhard Neubeck
J. Bruce Overmier
Dallis K. Perry
Herbert L. Pick, Jr.
Wentworth Quast
Alan H. Roberts
Warren W. Roberts
Wallace A. Russell
Vera M. Schletzer
William Schofield
LeVerne F. Snoxell
Edward O. Swanson
Auke Tellegen
Travis I. Thompson
Milton A. Trapold
David M. Wark
Harold L. Williams
Robert D. Wirt

Associate Professor

Gary T. Athelstan
Thomas J. Bouchard, Jr.
John P. Brantner
Dwight A. Burkhardt
Marian D. Hall
Robert G. Harlow
Rodney G. Loper
Carl P. Malmquist
Jack N. Peterman
Roy W. Pickens
James B. Preus
Pearl P. Rosenberg
Paul C. Rosenblatt
Ivan Ross
Sandra W. Scarr
Robert E. Shaw
Lloyd K. Sines
Stanley R. Strong
David J. Weiss
William F. Weitzel

Assistant Professor

Vernon T. Devine
Patricia S. Faunce
Carol H. Pazandak
Sheldon B. Sparber

For information about the several fields of study within psychology and about financial aid and special admissions requirements, applicants should write directly to the chairman of the Department of Psychology. All applicants for graduate work in psychology must submit departmental application forms in addition to Graduate School forms. If students have not received these forms within 3 weeks of the time they receive this bulletin, they should request them from the chairman of the Department of Psychology. The application deadline is February 1 for all programs; applications for fall quarter received after this deadline will be considered only if space is still available. Applications for admission in other terms will be accepted in all areas except clinical psychology; however, new students are generally admitted only in fall quarter.

Prerequisites — Courses in psychology are open to all regularly enrolled graduate students who can meet course prerequisites as listed in the *Class Schedule.* Before being accepted as a candidate for a graduate degree with a major or minor in psychology, students shall satisfy their adviser that they are fully prepared to

undertake graduate work in the subfields of proposed specialization. In certain cases completion of preparatory courses in the fundamental sciences may be accepted as part of the prerequisites.

Major and Minor – All candidates should consult advisers in both the major and minor fields.

In general it is expected that all graduate students in psychology, major and minor, shall have 15 quarter credits of prerequisite work in psychology, beyond the introductory course, including a course in statistics. An equally relevant factor is breadth of background in such areas as natural science, mathematics, and related social sciences.

Language Requirement – For the Master's degree, no foreign language. For the Ph.D. degree, language requirements, if any, are at the discretion of the adviser.

5-011. THEORIES OF LEARNING. (4 cr; prereq 3-011 except for students in Sequence A and grad students) LaBerge
Major theories of learning; basic issues of learning and performance in man and animals.

5-012/5-013†. PSYCHOLOGY OF LEARNING. (4 cr per qtr; prereq 3-011 except for students in Sequence A and grad students) Overmier
Survey of experimental literature on classical conditioning and all types of instrumental learning. Critical evaluation of theories relevant to these types of learning.

5-014. HUMAN LEARNING A. (4 cr; prereq 3-011 except for students in Sequence A and grad students) Fox
Examination of major processes and variables involved in human learning; verbal and motor learning. Topics: information feedback, skill acquisition, retention and long-term memory, facilitation and interference, abilities and performance prediction.

5-015. HUMAN LEARNING B. (4 cr; prereq 3-011 except for students in Sequence A and grad students) LaBerge
Major processes involved in human learning; verbal and perceptual learning. Topics: discrimination learning, choice and probability learning, concept formation, and programmed learning.

5-017. ANALYSIS OF BEHAVIOR I. (4 cr; prereq 3-011 except for students in Sequence A and grad students) MacCorquodale
Systematic formulation of topics of psychology based upon a Skinnerian analysis. Scientific method, learning, motivation, and emotion.

5-018. ANALYSIS OF BEHAVIOR II. (4 cr; prereq 5-017 or ‡) MacCorquodale
Account of individual's verbal behavior in terms of past history and current circumstances.

5-019. ANALYSIS OF COMPLEX BEHAVIOR. (4 cr; prereq 5-017 or ‡) Thompson
Experimental analysis of complex behavior repertoiries based upon the systematic formulation presented in 5-017. Extension of these principles to development of an approximate system of analysis of large, continuous samples of behavior. Social as well as other complex sequences of human and other animal behavior.

5-021. QUANTITATIVE MODELS FOR LEARNING. (4 cr; prereq 5-861 or ‡)
Introduction to mathematical models for learning: stochastic operator models, stimulus sampling theory, models for stimulus detection and recognition.

5-031. PERCEPTION. (4 cr; prereq 3-031, 3-801 or ‡) Pick
Critical analysis of methods of investigation and data obtained in study of selected problems of perception: psychophysical methods, form perception, space perception, constancy, spatially coordinated behavior and attention. Emphasis primarily but not exclusively on visual perception.

5-041/5-042.† PSYCHOLOGY OF MOTIVATION. (4 cr per qtr; prereq 9 cr; not offered 1972-73) Russell
Classical and contemporary theories of motivation. Elaboration of basic drives into motives, acquisition of new drives and goals; dynamics of the elaborated drive structure. Motivation in complex situations involving set, level of aspiration, Zeigarnik effect, frustration, etc.

5-054. PSYCHOLOGY OF LANGUAGE. (4 cr; prereq 3-011 except for students in Sequence A and grad students) Jenkins
An introduction to the theories and experimental evidence involved in past and present conceptions of psychology of language.

5-061. FUNDAMENTALS OF PHYSIOLOGICAL PSYCHOLOGY. (4 cr; prereq 1-001, 1-005 or Biol 1-011 or ‡) W Roberts
Physiological and neuroanatomical mechanisms underlying behavior of higher vertebrates. Sleep, wakefulness, and attention processes. Effects of drugs on behavior.

5-062. NEUROPSYCHOLOGY OF MOTIVATION AND LEARNING. (4 cr; prereq 5-061 or ‡) W Roberts
Brain mechanisms of aggression, fear, pain, hunger, thirst, reproductive behavior, learning, and discrimination processes.

5-071. ANIMAL PSYCHOLOGY. (3 cr; prereq 1-001, 1-005 or equiv in another science; not offered 1972-73)
Historical, philosophical, and biological foundations; consciousness; motivation; learning; reasoning; judgment; abnormal behavior; social influences.

5-101. PERSONALITY. (4 cr; prereq 5-862 or ¶5-862, honors cand or grad) Tellegen
Review of personality theories as alternative orienting viewpoints. Trait-oriented discussion of findings and conceptual and methodological problems of contemporary personality research.

5-125/5-126†. DIFFERENTIAL PSYCHOLOGY. (4 cr per qtr; prereq 5-862, or ‡, honors cand or grad) Bouchard, Dunnette
Introduction to methodology. Quantitative studies of nature of psychological traits and influence of age, sex, heredity, and environment in causation of individual differences in ability and temperament.

5-134. INTRODUCTION TO BEHAVIORAL GENETICS. (4 cr; prereq 5-126) Gottesman
Survey of methodology appropriate to analyzing contribution of genetic and environmental factors to variance observed in normal and abnormal traits in man and animals. Emphasis on intelligence, neuroses, and psychoses. For all examples, the independent variable will be the genotype of an organism.

5-201. SOCIAL PSYCHOLOGY. (4 cr; prereq 1-001, 1-005, 8 cr social science) Berscheid
Survey of theories and evidence. Effects of other persons, mass communications, social class, and group membership upon the individual's attitudes and behavior.

5-501. VOCATIONAL PSYCHOLOGY. (4 cr per qtr; prereq 3-801 or equiv) Dawis
Analysis of individuals and work environments with reference to selection of, adjustment to, and behavior in work; history, theories, and current developments in vocational psychology.

5-604/5-605†. ABNORMAL PSYCHOLOGY. (4 cr per qtr; prereq honors major or grad or ‡) Devine
Comprehensive review of behavioral disorders. Etiology and treatment considerations are emphasized.

5-641. CRIMINAL PSYCHOPATHOLOGY. (3 cr, §CJS 5-301; prereq 5-605, sr grad, or ‡) Malmquist
Survey of psychiatric and psychological aspects of antisocial and criminal behavior.

5-701. PERSONNEL AND INDUSTRIAL PSYCHOLOGY. (4 cr; prereq 1-001, one course in statistics or ‡) J Campbell, Dunnette
Application of principles of individual differences and psychological measurement to problems of recruiting, selecting, evaluating, and training members of ongoing organizations. Topics include: Job behavior description, performance measurement, selection and placement strategies, minority group employment, measurement of job satisfaction, strategies for training and development.

5-702. PSYCHOLOGY OF INDIVIDUAL BEHAVIOR IN ORGANIZATIONS. (4 cr; prereq 5-701 or 9 cr psychology or ‡) J Campbell, Dunnette
Application of psychological research and methodology to study of human behavior in ongoing organizations. Topics include: motivation, attitude measurement, problems solving and decision making, effects of organizational structure and climate, problems of leadership, supervision, and interpersonal relations.

5-703. SOCIAL PSYCHOLOGY OF ORGANIZATIONS. (4 cr; prereq 9 cr in psychology or ‡) Bouchard
Survey of theoretical and methodological issues in study of dyads and small groups in organizational environments. Social processes as constraints on organizational functioning. Experimental approaches to study of group processes in organizational settings.

5-751. PSYCHOLOGY OF ADVERTISING. (4 cr, §Jour 5-251; prereq 1-001) Peterman
Examination of psychological principles, research techniques, and applications in advertising and selling. Analysis of relevant consumer attitudes and behavior. Psychological mechanisms upon which effectiveness of advertisements and commercials depend.

5-861. QUANTITATIVE METHODS IN PSYCHOLOGY. (4 cr; prereq ‡)
Elementary set theory, probability theory, matrix algebra, difference equations, with applications to construction and evaluation of behavior models.

5-862. PSYCHOLOGICAL MEASUREMENT: THEORY AND METHODS. (4 cr; prereq honors cand or grad, 3-801 or equiv) Weiss
Types of measurement (tests, scales, inventories, Q-sort) and their construction; theory and measurement of reliability and validity.

5-871. MULTIVARIATE METHODS OF DATA ANALYSIS. (4 cr; prereq 5-862 or ‡) Weiss
Multivariate prediction and discrimination (linear and nonlinear models); multivariate covariation analysis, including cluster and factor analysis.

5-938. FORENSIC PSYCHOLOGY. (3 cr, §Law 5-846 [Seminar: Psychology, Psychiatry and the Law]; prereq 1-001, sr or grad, ‡) Livermore, Meehl, Malmquist
A lawyer, psychologist, and psychiatrist consider selected problems of the relation between the behavioral sciences and law as a mode of social control. Topics include: rules and empirical facts, utilities and disutilities of the criminal sanction, the insanity defense, civil commitment of the mentally ill, law and morals, diagnosis and prediction, the psychologist as expert witness, psychological determinism and responsibility.

8-001. HISTORY OF PSYCHOLOGY. (3 cr; prereq grad standing in psychology or educational psychology or child psychology or ‡) Russell
Historical development of major movements and issues in psychology. Significant major European and American trends exemplified by selected readings from primary sources.

8-004. SEMINAR: PHILOSOPHICAL PSYCHOLOGY. (3 cr; prereq course in logic or philosophy, Ph.D. candidate in psychology, ‡) Meehl
Discussion of selected philosophical and methodological problems chosen by the class.

8-021, 8-022, 8-023. SEMINAR: MATHEMATICAL BEHAVIOR THEORY. (3 cr; prereq ‡) LaBerge
Foundations of mathematical behavior theory; current research.

8-034. SENSORY NEUROPSYCHOLOGY. (3 cr; prereq 5-061) Burkhardt
Examination of the mechanisms of sensation in man and animals, with emphasis on relationships between sensory psychophysics and the neuroelectric activity of vision, hearing, somesthesis, and taste.

8-035. VISION. (3 cr; prereq 8-034) Burkhardt
Critical examination of selected topics in contemporary vision research. Representative topics: neuroelectric activity, color, binocular and spatial vision, adaptation.

8-051. MATHEMATICAL FOUNDATIONS OF COGNITIVE PSYCHOLOGY. (3 cr; prereq course in logic or abstract algebra or ‡) Shaw
Introduction to methods of algebraic structure theory as applied to problems in cognition, perception, and memory.

8-054/8-055/8-056. SEMINAR: PSYCHOLOGY OF LANGUAGE. (3 cr per qtr; prereq ‡) Jenkins

8-064. BEHAVORIAL PHARMACOLOGY. (3 cr, §Phcl 8-219; prereq Phcl 8-210, Psy 5-017 or ‡) Pickens and staff
Analysis of the behavioral effects of drugs.

8-070. SEMINAR: PSYCHOPHARMACOLOGY. (1 cr; prereq ‡) Thompson, Heistad, and pharmacology staff
Selected topics in drug-behavior research.

8-104. PSYCHOANALYTIC THEORY. (3 cr; prereq 5-605)
Discussion of classical psychoanalysis.

8-114/8-115†. THE SCIENTIFIC STUDY OF PSYCHOPATHOLOGY. (3 cr per qtr; prereq ‡) Garmezy
Theory and research in psychopathology; critical evaluation of current experimentation in various behavior disorders.

8-116, 8-117. RESEARCH SEMINAR: PSYCHOPATHOLOGY. (3 cr per qtr; prereq 5-605 or equiv, 1 yr grad study or ‡) Garmezy
Review of theoretical and empirical status of specific problem areas in psychopathology.

8-201/8-202. ADVANCED SOCIAL PSYCHOLOGY. (3 cr per qtr; prereq ‡; offered 1972-73 and alt yrs) Berscheid
Discussion of theory and research concerning social influence processes.

8-207/8-208. ADVANCED SOCIAL PSYCHOLOGY. (3 cr per qtr; prereq ‡; offered 1973-74 and alt yrs) Berscheid
Research methodology in social psychology.

8-214, 8-215, 8-216. THE SOCIAL PSYCHOLOGY OF MARRIAGE. (Cr ar; prereq ‡) Neubeck, Hey
Same as Soc 8-521, 8-522, 8-523.

8-501. COUNSELING PSYCHOLOGY I: HISTORY AND THEORIES. (3 cr; prereq ‡) Dawis
General theories of counseling psychology, their psychological assumptions and implications for practice; origins and development of vocational counseling.

8-502. COUNSELING PSYCHOLOGY II: THE CLINICAL USE OF PSYCHOLOGICAL TESTS. (3 cr; prereq 5-862 or ‡) Athelstan
Construction, selection, interpretation of selected instruments measuring intelligence, academic ability, special aptitudes, interest, and personality.

8-503. COUNSELING PSYCHOLOGY III: INTERVIEWING. (3 cr; prereq 8-501, 8-502 or ‡)
Dynamics of the counseling interview, stressing strategies of behavior change in the interview, stages of interview development, interviewing techniques, and sources and uses of information in the interview.

8-514/8-515/8-516. PRACTICUM IN STUDENT COUNSELING. (3 cr per qtr; prereq 8-501, 8-502, 8-503, or equiv) Hewer, Loper
Counseling experience with students in an academic setting; emphasis is on the educational, vocational, and personal problems of college students.

8-517/8-518/8-519. PRACTICUM IN REHABILITATION COUNSELING. (3 cr per qtr; prereq 8-503 or ‡) Dawis, Athelstan
Counseling experience with physically and emotionally disabled clients in approved public and private rehabilitation agencies.

8-520x. FIELD WORK IN APPLIED PSYCHOLOGY. (Cr ar; prereq ‡) Berdie, Darley, Schofield, Williams, Wirt, others

8-524, 8-525, 8-526. SEMINAR: STUDENT PERSONNEL WORK. (Cr ar; prereq ‡) Counseling staff
Topics and problems relating to content, development, and coordination of comprehensive college student personnel programs.

8-527/8-528/8-529. SEMINAR: VOCATIONAL REHABILITATION COUNSELING. (1 cr per qtr; prereq ‡) Dawis
Topics and problems in vocational counseling of disabled and hospitalized persons. Specific disabilities and vocational implications. Role and responsibilities of the rehabilitation counselor.

8-531/8-532/8-533. ADVANCED SEMINAR: VOCATIONAL REHABILITATION COUNSELING. (1 cr per qtr; prereq 8-529) Lofquist
Advanced topics, research, and special disability problems in vocational counseling of disabled and hospitalized persons.

8-541, 8-542, 8-543. SEMINAR: PRACTICES, APPROACHES, AND ISSUES IN COUNSELING PSYCHOLOGY. (1 cr per qtr; prereq grad student in counseling psychology or ‡)
Lectures and discussions on a wide variety of applications of counseling, counseling theory, techniques, and research, and issues in the field. In each area, experts share ideas and lead discussions.

8-544/8-545/8-546. SEMINAR: RESEARCH IN COUNSELING PSYCHOLOGY. (1 cr per qtr; prereq ‡) Berdie
Presentation and discussion of research in counseling psychology with emphasis on process and outcome research.

8-551/8-552/8-553. MARRIAGE COUNSELING. (6 cr per qtr; prereq 8-214, 8-215, 8-216) Neubeck
Practicum at on- and off-campus marriage counseling agencies.

8-607. CLINICAL CHILD PSYCHOLOGY. (3 cr; prereq ‡) Wirt
Theories of psychodiagnosis: case history, prediction, and psychotherapy in clinical work with children.

8-611, 8-612, 8-613, 8-614. PROFESSIONAL METHODS IN CLINICAL PSYCHOLOGY I: ASSESSMENT. (2 cr per qtr; prereq students in clinical psychology program, ¶ClPy 8-206 or ‡) Butcher and others
Presentation of theory and practice in clinical application of assessment techniques. Observation, administration, scoring, and interpretation is the focus of the laboratory experience.

8-620x. CLERKSHIP IN CLINICAL PSYCHOLOGY. (Cr ar; prereq ‡) Williams
Field experience in professional work in clinical settings.

8-621, 8-622, 8-623. PROFESSIONAL METHODS IN CLINICAL PSYCHOLOGY II: THEORIES OF INTERVENTION. (2 cr per qtr; prereq Ph.D. cand in clinical psychology, 8-611, 8-612, 8-613, 8-614, or ‡) Williams, Butcher and others
Lectures and demonstrations of contemporary theories of individual and group methods of psychological intervention in psychiatric and related disorders.

8-630x. PRACTICUM IN CLINICAL CHILD PSYCHOLOGY. (3 cr per qtr; prereq ‡) Clinical psychology staff
Supervised experience in psychodiagnostic work with emotionally disturbed children and their families.

8-631, 8-632, 8-633. PROFESSIONAL METHODS IN CLINICAL PSYCHOLOGY III: TECHNIQUES OF INTERVENTION. (2 cr per qtr; prereq Ph.D. cand in clinical psychology, 8-611, 8-612, 8-613, 8-614, or ‡) Williams and others
Lectures, demonstrations, and supervised experience in the application of techniques in individual and group treatment methods with psychologically disturbed persons.

8-640x. SEMINAR: TOPICS IN CLINICAL PSYCHOLOGY. (Cr ar; prereq ‡) Clinical psychology staff
Discussion of various topics in clinical psychology chosen by the class in relation to interests of particular instructors.

8-644/8-645/8-646. 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.

8-647, 8-648, 8-649. SEMINAR: ADVANCED CHILD CLINICAL PSYCHOLOGY. (1 cr per qtr; prereq ‡) Hafner, Quast
Problems and topics including brain dysfunction in children; behavior management of neurologically handicapped children; parent counseling.

8-650. TREATMENT OF DISTURBED CHILDREN. (3 cr; limited to Ph.D. cands; prereq ‡) Wirt
Supervised experience.

8-670x. INTERNSHIP IN CLINICAL PSYCHOLOGY. (2-4 cr per qtr; prereq Ph.D. cand in clinical psychology program and permission of director of clinical psychology training program) Clinical psychology staff

8-701/8-702. SEMINAR: INDUSTRIAL AND ORGANIZATIONAL PSYCHOLOGY. (3 cr per qtr; prereq ‡) J Campbell, Dunnette

8-703, 8-704. SEMINAR: INDUSTRIAL AND ORGANIZATIONAL PSYCHOLOGY. (3 cr per qtr; prereq ‡; offered 1973-74 and alt yrs) J Campbell, Dunnette

8-831/8-832†. COMPUTER UTILIZATION. (3 cr per qtr; prereq ‡) Weiss
Use of time-shared and batch mode computers. Implications of computer technology for psychological research and other special applications. FORTRAN programming; use of various FORTRAN compilers. File creation and manipulation. Use and development of library subroutines and programs.

8-881/8-882/8-883†. SEMINAR: PSYCHOMETRIC METHODS. (1 cr per qtr; prereq ‡) Weiss
Reviews and individual research on current topics in psychological measurement, statistics, and research design.

8-900x. SEMINAR IN BEHAVORIAL GENETICS. (2 cr; prereq ‡) Gottesman, others
Advanced topics in human and animal behavioral genetics will be discussed in seminar fashion with joint faculty and student participation in team teaching. Focus on current literature, doctoral thesis research in progress, and faculty research.

8-970. SEMINAR: SPECIAL AREAS OF PSYCHOLOGY AND RELATED SCIENCES. (Cr ar; offered irregularly according to announcements in Official Daily Bulletin)
Based on a syllabus of required and optional reading.

8-980x. DIRECTED TEACHING IN PSYCHOLOGY. (Cr ar; prereq ‡) Staff
Supervised experience in the teaching of psychology.

8-990x. RESEARCH PROBLEMS. (Cr ar) Graduate staff

PUBLIC AFFAIRS (PA)

Professor

John E. Brandl, *director*
Carl A. Auerbach
Charles H. Backstrom
Davis B. Bobrow
John R. Borchert
Harold W. Chase
Willard W. Cochrane
Walter W. Heller
Arthur Naftalin
Orville C. Peterson
John G. Turnbull
George A. Warp
Vernon E. Weckwerth

Associate Professor

James E. Jernberg, *director of graduate study*
John S. Adams
J. Edward Anderson
Nancy N. Anderson
Edward M. Foster
Stephen A. Hoenack
Theodore R. Marmor
Thomas J. Muench

Assistant Professor

Victor L. Arnold
Enid C. B. Schoettle

Instructor

Gail R. Benjamin

Lecturer

G. Theodore Mitau

Graduate work in the School of Public Affairs is designed to prepare public policy analysts, decision makers, and administrators for high level positions in public service.

Prerequisites – An applicant for the degree program should have some background in the social sciences or be able to demonstrate an aptitude for analytical work in the social sciences. Furthermore, the required core courses in policy analysis and in quantitative methods assume knowledge of mathematics through the rudiments of the differential calculus. In some cases admission may be conditionally granted with the expectation that identified deficiencies be satisfied through courses taken before commencing course work in the school, self-study, or a full-time introductory program offered by the School of Public Affairs in the month preceding the start of the academic year. Students will be notified of the details of this program in the event they are advised to attend.

Master's Degree – The graduate program of the school leads to the master of arts degree in public affairs. The requirements for the degree are those cited in the Graduate School bulletin with the following important exceptions:

1. A single integrated course of study is substituted for the traditional major and minor fields of work.
2. Students work under the Plan B option, which requires three major papers rather than a thesis.
3. The program requires a minimum of 54 quarter credits in graduate work plus an arranged internship or field work experience. The internship or field work requirement can be waived for persons having relevant experience.

A student can expect to fulfill the requirements for the degree in two academic years and one summer of full-time graduate study. In certain circumstances it may be possible to complete the work in less than two years. It is also possible to pursue work on a part-time basis.

Program of Study – The program curriculum consists of a core of required courses, two areas of concentration, electives, and the internship or field work experience. The program is distributed as follows:

Core Courses	18 credits
1st concentration (at least)	12 credits
2nd concentration (at least)	12 credits
Electives (up to)	12 credits
	54 credits

Plus an arranged internship or field work project.

Internships – Full-time students will ordinarily participate in an arranged internship with one or more public agencies in their interest area as part of their total program.

Further Information – For further information concerning graduate work in the School of Public Affairs write to the School of Public Affairs, 314 Social Sciences Building, University of Minnesota, Minneapolis, Minnesota 55455.

Core Courses

8-201, 8-202.* POLICY ANALYSIS I, II. (6 cr per qtr; prereq △ for 8-201...8-201, △ for 8-202)
Microeconomic analysis of public policy in political and social context. Cost-effectiveness and cost-benefit analysis and their role in the process of policy making.

8-205, 8-206. QUANTITATIVE METHODS FOR POLICY ANALYSIS. (3 cr per qtr; △)
Provides the basic tools for empirical analysis in the evaluation of public policy alternatives. Basic statistics, econometrics, design of experiments, and communication of computers are presented, along with varied examples of the role these techniques can play in public policy decision making.

Fields of Interest and Concentrations

DOMESTIC POLICY

8-130.* SEMINAR: SCIENCE, TECHNOLOGY, AND PUBLIC POLICY. (3 cr; prereq ‡)
Analysis and discussion of major public policy issues in the areas of science and technology, including assessment of effectiveness of existing programs; consideration of policy alternatives and analysis of their consequences.

8-131.* RESEARCH SEMINAR: SCIENCE, TECHNOLOGY, AND PUBLIC POLICY. (3 cr; prereq 8-130 or ‡)
Identification of current public policy issues which have science and/or technology as major considerations, selection of topic, development of a research design, collection of data, and preparation of a report.

8-140.* SEMINAR: NATURAL ENVIRONMENT POLICY. (3 cr; prereq ‡)
Analysis and discussion of major public policy issues concerning the natural environment, including water and air pollution; assessment of the effectiveness of existing programs; consideration of policy alternatives and analysis of their consequences.

8-241.* AGRICULTURAL ADMINISTRATION. (3 cr; prereq 8-270 or equiv, ‡)
Contemporary administrative theories and processes applied to planning, organization, management, and evaluation of public agricultural programs, especially in developing countries.

8-261.* SOCIAL WELFARE ADMINISTRATION. (3 cr)
Critical analysis of administration of social welfare programs; development of Social Security Act; intergovernmental context of administrative issues and problems; relation of program concepts to administrative feasibility; and accommodation of social welfare programs to general management functions of government.

8-315.* PUBLIC MANPOWER POLICY. (3 cr)
Analysis of the major issues and problems of public policy and management concerning the organization and operation of public manpower systems.

8-601, 8-602, 8-603.* ISSUES IN AGING. (3 cr per qtr; prereq aging administrators or ‡)
Intensive reading and discussion on issues related to being old in America and public policy regarding the aged; includes social science research findings and analyses of current programs. Interdisciplinary; projects possible.

8-606, 8-610, 8-620, 8-630.* SEMINAR: HUMAN RESOURCES PUBLIC POLICY.
Analysis and discussion of major issues in various areas of human resources public policy, including assessment of effectiveness of existing programs; consideration of policy alternatives and analysis of their consequences.

8-606.* Seminar: Aging Policy. (3 cr; prereq ‡)

8-610.* Seminar: Health Care Policy. (3 cr; prereq ‡)

8-620.* Seminar: Education Policy. (3 cr; prereq ‡)

8-630.* Seminar: Income Maintenance Policy. (3 cr; prereq ‡)

8-690.* HUMAN SERVICE DELIVERY SYSTEMS. (3 cr; prereq ‡)
Analysis of public policies regarding the provision of various services such as health, education, employment, day care, and housing, with emphasis on the structure and performance of delivery systems, both public and private. In depth studies of current issues and workings of various delivery systems. Interdisciplinary faculty.

PLANNING

A planning program is being created within the School of Public Affairs and will be operative by Fall 1972. Students will be provided with the analytical skills needed to investigate how policy and spatial systems, especially urban, work so that the consequences of intervention can be anticipated and controlled. While precise course offerings have not been defined at the time of printing, they will likely include the following areas:

1. Planning perspectives on urban systems, e.g., the legal basis of planning
2. Analytical methods for planning research (beyond the core courses)
3. Research seminars in specialized areas

A more detailed description of the planning program is available upon request from the School of Public Affairs.

URBAN AFFAIRS

8-501.* SEMINAR: LOCAL ADMINISTRATION. (3 cr)
Intensive study of program development and administration; functions of law enforcement, traffic, fire, health and hospitals, welfare, parks and recreation, education and libraries, public works, public utilities, planning, housing, and urban renewal.

8-502.* SEMINAR: LOCAL ADMINISTRATION. (3 cr)
Administrative relationships and processes in local government; accountability of administration; administrative measurement; personnel and financial administration; purchasing and contracting; legal service; administrative planning and research; reporting and public relations.

8-511.* LAW AND URBAN AFFAIRS. (3 cr)
Selected concepts, procedures, and other aspects of local government law of particular concern to local administrators and others interested in conduct of urban affairs.

8-521. URBAN DEVELOPMENT. (3 cr; prereq 8-501 or ‡)
Role and methods of the urban administrator in effecting change and in mobilizing both public and private community resources for urban development.

8-525, 8-526.* SEMINAR: URBAN PUBLIC POLICY. (3 cr per qtr; prereq ‡)
Examination of the processes whereby governments formulate, implement, and evaluate programs designed to deal with major social and economic problems, with special reference to the organization and financing of state and local governments in the fields of welfare, education, planning and zoning, law enforcement, housing, urban renewal, and pollution control.

8-750, 8-751, 8-752.†* FIELD WORK IN PUBLIC AFFAIRS. (3 cr per qtr; prereq ‡)
Individual study of a current public problem, combining seminar discussion and experience working with an agency involved in formulating or administering government policy. Plan B paper required.

INTERNATIONAL AFFAIRS

The field of international affairs seeks to integrate the best available techniques for the analysis and understanding of international policy, and draws upon the faculty and resources of several departments. Concentrations in international conflict and conflict resolution, international development and development administration, and comparative international policy are available. Courses are offered by either the school or cooperating departments.

8-401.* DEVELOPMENT ADMINISTRATION. (3 cr; prereq ‡)
Administration of economic, social, and political developments in low income countries; administrative development; public service manpower for development; national plan formulation and implementation; rural and urban development; social services; public enterprise; governmental stimulation and regulation of private enterprise.

8-402.* TOPICS IN DEVELOPMENT ADMINISTRATION. (3 cr; prereq ‡)
Advanced analysis of selected topics.

8-403.* SEMINAR: COMPARATIVE PUBLIC ADMINISTRATION. (3 cr; prereq ‡)
Examination of approaches to study of comparative public administration; critical analysis of methodological studies; development and testing of hypotheses from empirical data concerning several governments.

A more detailed description of the international affairs program is available upon request from the school.

POLICY PROCESSES

8-051.* ADMINISTRATIVE HISTORY. (3 cr; prereq 8-270 or equiv)
Origins and development of administrative institutions and practices. Applicability of historical approach to current administrative problems.

8-203.* SELECTED TOPICS IN SYSTEMS ANALYSIS. (3 cr; prereq 8-202, △)
Selected topics in microeconomics applied to systems problems of government. Market and non-market resource allocation; cost-effectiveness and cost-benefit analysis; budgeting.

8-204.* THE PUBLIC ECONOMY. (3 cr per qtr; prereq ‡)
Government role in and impact on the economy; determinants of national income, employment, and price level; fiscal and monetary policy.

8-207.* APPLICATION OF QUANTITATIVE METHODS FOR POLICY ANALYSIS. (3 cr; ‡)
(Continuation of 8-205 and 8-206.) Practical application of empirical analysis in evaluation of public policy alternatives. Some empirical analysis of public policy problems using actual data on real problems.

8-208.* LARGE SCALE SOCIAL EXPERIMENTATION. (3 cr; prereq ‡)
Controlled social experimentation as an emergent tool in designing and evaluating alternatives of existing public policy. Focus on issues of problem specification, experimental design and administration.

8-209.* SIMULATION MODELS AND POLICY ANALYSIS. (3 cr; prereq ‡)
Construction, validation, use, and limitations of small simulation models in the analysis of social policy issues, e.g., resource requirements for alternate policies. Applications of existing large simulation models, e.g., Jay Forrester's Urban Dynamics model and Guy Orcutt's Microanalysis model in evaluation of future social states.

8-210.* ADMINISTRATIVE AGENCIES IN THE POLITICAL PROCESS. (3 cr)
Processes related to agency goal achievement and survival, including the securing of resources (e.g., authority, money, support). Relationships with chief executives, legislatures, courts, interested publics, other agencies, and analysis of the freedom and constraints resulting from the relationships.

8-211.* ADMINISTRATIVE THEORY AND BEHAVIOR. (3 cr; prereq 8-210, ‡)
Nature of administration; role of the administrator; theories of complex organizations and administration; administrative leadership; analysis of compliance, organizational effectiveness.

8-311.* LEGAL ENVIRONMENT OF PUBLIC ADMINISTRATION. (3 cr)
Survey of concepts, procedures, and other aspects of public law of particular concern to public administration.

8-321.* INTERGOVERNMENTAL ADMINISTRATIVE RELATIONS. (3 cr; prereq ‡)
Seminar examination and analysis of the evolution of intergovernmental relations in the United States and of special administrative problems and issues—with particular attention to the fields of housing, urban development, health, education, and welfare.

8-325.* CONFRONTATION, PARTICIPATION, AND GOVERNMENT DECISION MAKING. (3 cr; prereq ‡)
Examination of the various methods and styles developed to influence government decision making and compliance with government decisions. Study of the interaction of government officials and the public. Comparative analysis of the impact that backgrounds, resources, environmental conditions, role expectations, behavior strategies and mechanisms have on relationships between public officials and citizens; consequences of relationships for proposals for change.

8-330. INFORMATION AND INCENTIVES FOR IMPROVED DECISION MAKING IN BUREAUS. (3 cr; prereq ‡)
Discussion of the various problems and methods associated with improving the responsiveness of large bureaucracies to the demands of their existing and potential constituencies. One topic emphasized: What is the desirability of using decentralized incentives for improving responsiveness of bureaus to their clients' demands, as opposed to using central

directives aimed at achieving the same goal? Consideration given to the problem of designing a management information system to improve decentralized decision-making in large organizations. Course emphasis varies from year to year. Educational organizations, health care delivery, law enforcement, provision of welfare services. Consult instructor.

GENERAL

8-114. CURRENT ISSUES OF PUBLIC ADMINISTRATION AND POLICY DEVELOPMENT IN MINNESOTA. (3 cr; offered during summer session)
Background study through lectures, panel discussions, and seminar sessions of vital issues of public policy and administration which currently confront Minnesota's governmental units.

8-115. CURRENT ISSUES OF PUBLIC ADMINISTRATION AND POLICY DEVELOPMENT IN MINNESOTA. (3 cr; offered during summer session)
Lectures, panel discussions, and seminar sessions on selected public policy issues which currently confront Minnesota's governmental units.

8-771, 8-781, 8-791. ADMINISTRATIVE INTERNSHIP. (Cr ar; prereq △)
Supervised field work in an approved local, state, or federal government agency; preparation of an acceptable formal report.

8-871, 8-881, 8-891. RESEARCH SEMINAR: PUBLIC POLICY ADMINISTRATION. (3 cr per qtr; prereq ‡)
8-871: Examination of research methods and techniques. 8-881 and 8-891: Identification of research needs in an area of public administration; selection of a topic, development of a research design, collection of data, and preparation of a substantial report.

8-971, 8-981, 8-991. INDIVIDUAL READINGS, RESEARCH IN PUBLIC POLICY ANALYSIS, ADMINISTRATION. (Cr ar; prereq ‡)

PUBLIC HEALTH (PubH)**

Professor

Jacob E. Bearman, Ph.D.
Richard G. Bond, M.S., M.P.H.
Donald W. Cowan, M.D., M.S.
Velvl W. Greene, Ph.D.
George S. Michaelsen, M.S.
Theodore A. Olson, Ph.D.
Harold J. Paulus, Ph.D.
Leonard M. Schuman, M.D., M.S.
James W. Stephan, M.B.S.
Conrad P. Straub, M.C.E., Ph.D.

Associate Professor

Lee D. Stauffer, M.P.H., *dean, director of graduate study*
Eleanor M. Anderson, M.P.H.
Donald E. Barber, M.P.H., Ph.D.
Norman A. Craig, M.P.H.
Delphie J. Fredlund, M.P.H.
Rexford D. Singer, B.S.C.E., M.S.
Alma G. Sparrow, M.S., M.P.H.
Ruth Edna Stief, M.P.H.
George E. Williams, M.D.

Assistant Professor

Knowlton J. Caplan, M.S.
E. Charlotte Carver, M.P.H.
Dorothy E. Downey, M.P.H.
Barbara J. Leonard, M.S.
Orlando R. Ruschmeyer, Ph.D.
Margaret R. Sloan, M.S.

Lecturer

Henry Bauer, Ph.D.
Lee E. Schacht, Ph.D.

Language Requirement – For the Master's degree, knowledge of a foreign language may be waived on recommendation of the adviser. For the Ph.D. degree, reading knowledge of two foreign languages or of one foreign language and option of a special research technique or a collateral field of knowledge. Acceptable languages are French, German, Norwegian, Russian, Spanish, or Swedish.

Minor – For the Master's degree, 5-375, 5-007, and courses in biometry and either epidemiology or public health administration.

For the Ph.D. degree, 5-375, 5-007 and 20 additional credits selected on the basis of the candidate's field of major study.

** Inquiries concerning other work in public health, including courses of study leading to the degrees of M.P.H., master of public health, and M.H.A., master of hospital administration, should be addressed to: Dean of the School of Public Health, 1325 Mayo Memorial Building, University of Minnesota, Minneapolis, Minnesota 55455.

Master's Degree — Offered under both Plan A and Plan B. All candidates for this degree must take 5-375, 5-007, and 5-751.

Public Health Nursing – Programs under Plan B have public health (including public health nursing) as the major with social science as one related field and the other selected with reference to the student's specific goal. These programs admit qualified nurses with interest in supervision or teaching. It is possible for individual student programs to include extra emphasis in leadership, teaching, supervision/administration, *nurse associate* programs in pediatrics, adult and geriatric health, school nursing, and maternity and family planning.

Physical and Occupational Therapy — The program under Plan B is designed for experienced physical and occupational therapists interested in a professional career in public health or other community agencies. Certain required courses are supplemented by electives based on the student's special interests and individual goals.

Doctor's Degree – Work leading to the Ph.D. degree is offered for majors in biometry, environmental health, epidemiology, hospital and health care administration, and physiological hygiene. For further information on these programs, see the index.

General

5-005.* **TOPICS IN PUBLIC HEALTH.** (Cr ar; prereq ‡) Staff
Selected readings in public health with discussion based on these readings.

5-006. **INTRODUCTION TO COMMUNITY HEALTH.** (5 cr, §3-003; prereq courses in personal health and microbiology, nursing students, nurses or other health professionals) Greene
(Same as Nurs 5-625.) Lectures, discussions, seminars, personalized readings on critical and current issues in community health emphasizing public health programs and controversies.

5-007. **HEALTH LEADERSHIP AND EFFECTING CHANGE.** (3 cr) E Anderson, Sloan, Veninga
Identification of leadership qualities and their resulting effect on organizational behavior. Identification of various theories of change and their practical application to the field of health. Discussion of the changing role of the health professional.

8-001. **SEMINAR: PUBLIC HEALTH.** (Cr ar)

8-002. **FIELD OBSERVATION OF SELECTED PUBLIC HEALTH PRACTICES.** (Cr ar; prereq ‡)

8-003. **RESEARCH.** (Cr ar)
Opportunities will be offered by the School of Public Health and by various cooperating organizations for qualified students to pursue research work.

Mental Health

5-030. **MENTAL HEALTH PROGRAM.** (1 cr; prereq 5-700 or ‡) Williams
Community program for promotion of mental health and care of mentally ill persons.

5-031. **MENTAL HEALTH.** (3 cr; prereq ‡) Williams
Emotional factors underlying wholesome family relations or interfering with successful adjustment in family and community.

5-032. **EDUCATIONAL ASPECTS OF DRUG USE AND ABUSE.** (3 cr, §Hlth 5-400; prereq education sr, certified teacher, school nurse) Fredlund, Schwanke
Basic background information on alcohol and other drugs and chemicals with emphasis on curriculum concepts, teaching methodology, materials, and referral procedures appropriate for elementary, junior, and senior high school.

5-034. **TOPICS IN ALCOHOL AND DRUG ABUSE.** (Cr ar; prereq ‡) Staff
Selected readings in alcohol and drug abuse with discussion based on these readings.

Health Education

5-040. DEATH EDUCATION IN CONTEMPORARY SOCIETY. (3 cr, §Hlth 5-402; limited to 30 students; prereq education sr, certified teacher, school nurse, mortuary science major or ‡) Fredlund
Basic background information on concepts and attitudes toward death, grief and bereavement with emphasis on instructional aspects for elementary and secondary schools and the role of the school in suicide prevention.

5-054. FOUNDATIONS IN COMMUNITY HEALTH EDUCATION PRACTICE. (5 cr; prereq ‡) Introduction to health education principles and methods; role and function of health education specialist; communication theory and process; application of communication models to health education practice.

5-055. ORGANIZATION THEORY AND HEALTH EDUCATION PLANNING (5 cr; prereq 5-004)
Elements of comprehensive educational planning; theory and process of health education planning; organization theory; consideration of leadership roles, norms and decision making as related to community health education; examination of theories of organization.

5-056. ORGANIZATION, ADMINISTRATION, AND EVALUATION OF COMMUNITY HEALTH EDUCATION. (5 cr; prereq 5-054, 5-055)
Methods and procedures for organizing and administering health education services; consultant functions; methods for selecting and applying criteria for effective evaluation of health education efforts.

5-064. GROUP PROCESS IN COMMUNITY HEALTH EDUCATION. (2 cr; prereq 5-054 or 5-080, ‡) Craig
Group methodology in problem solving; principles, concepts, and process of group dynamics as a method to community health education.

5-065. HEALTH EDUCATION PREPARATION OF HEALTH AND ALLIED PERSONNEL. (2 cr; prereq ¶5-056, ‡) Craig
Methods, procedures, and techniques for planning, implementing, and evaluating programs for in-service and short-course preparation in health education for health and allied personnel.

5-066. HEALTH EDUCATION AND CONTEMPORARY HEALTH CARE SYSTEMS. (2 cr; prereq ¶5-056, ‡) Craig
Role of health education specialist in traditional and developing health services; factors affecting health education practice in special settings such as hospitals, schools, and industry and in subject matter areas such as mental health, dental health, injury control.

5-067. COMPARATIVE COMMUNITY HEALTH EDUCATION, URBAN AND RURAL. (3 cr; prereq ‡) Craig
Factors affecting community organization in urban and rural settings; population characteristics, agencies, institutional patterns as determinants of health behavior; process of community organization for health.

5-068. COMMUNITY HEALTH EDUCATION PRACTICE. (10 cr; prereq 5-063, ‡) Craig
Approximately 10 weeks of supervised community health education practice.

5-069. COMMUNITY HEALTH EDUCATION LABORATORY. (6 cr; ‡) Craig, Veninga
Offers experience as health educator in selected community health agencies.

5-070. COMMUNICATION SKILLS FOR HEALTH PROFESSIONALS. (3 cr) Veninga
Identification of basic skills in interpersonal and interprofessional relationships. Development of (1) skills in one-to-one communication, (2) skills in small group interaction, and (3) skills necessary to affect change within human relationships, conflict resolution, and teamwork.

5-072. COMMUNITY AND SCHOOL HEALTH EDUCATION. (3 cr; ‡) Craig, Slocum, staff
Comparative approaches to health education in school and community, current and potential relationships, mutual identification and use of educational resources, procedures for effective coordination, role of school health educator and community health education specialist.

5-080. INTRODUCTION TO PUBLIC HEALTH EDUCATION. (2 cr; prereq ‡) Craig
Planning educational components of community health programs; group procedures; community organization; methods and materials.

5-082. ADVANCED STUDIES IN HEALTH EDUCATION. (3 cr; prereq 5-080, or ‡) Craig
Case studies; planning and educational processes as applied within specific public health disciplines.

5-098. TOPICS IN PUBLIC HEALTH EDUCATION. (Cr ar; prereq ‡) Staff

Environmental Health

5-150. TOPICS IN ENVIRONMENTAL HEALTH. (Cr ar; prereq ‡) Staff
Selected readings and discussions of problems in environmental health.

5-151.* ENVIRONMENTAL HEALTH. (3 cr; prereq ‡) Bond, staff
Methods for promoting man's health and comfort by controlling environment.

5-152. ENVIRONMENTAL HEALTH. (2 cr; prereq ‡) Straub, Singer
General principles of environmental health problems; problems encountered by official health agencies.

5-153.* INSTITUTIONAL ENVIRONMENTAL HEALTH. (3 cr; prereq hospital administration student or ‡) Michaelsen, staff
Sanitation and safety practices in hospitals and other institutions.

5-154. ENVIRONMENTAL HEALTH PROGRAMS. (3 cr; prereq ‡) Bond, staff
Public health supervision of activities in urban and rural sanitation.

5-159.* SEMINAR: ENVIRONMENTAL HEALTH. (Cr ar; prereq ‡) Olson

5-161.* ADMINISTRATION OF ENVIRONMENTAL HEALTH PROGRAMS. (3 cr, §5-154; prereq ‡) Bond
Administrative organization of environmental health activities.

5-170. TOPICS IN ENVIRONMENTAL BIOLOGY. (Cr ar; prereq ‡) Staff
Selected readings in environmental biology with discussion of control techniques.

5-171.* ENVIRONMENTAL MICROBIOLOGY. (3 cr; prereq 5-151, MicB 3-103 or ‡) Greene
Survival, dissemination, transportation, and significance of microorganisms in the environment; application of principles to environmental health problems.

5-172. ENVIRONMENTAL MICROBIOLOGY LABORATORY. (2 cr, §5-233; prereq ¶5-171, ‡) Greene, Vesley
Laboratory and field exercises in microbiological sampling, detection, enumeration and control.

5-177. ENVIRONMENTAL BIOLOGY. (3 cr; prereq ‡) Olson, Ruschmeyer
Introduction to plant and animal forms important in environmental health and biological aspects of water supply, waste treatment, stream pollution, and special phenomena related to human disease transmission.

5-178. VECTORS AND PARASITES IN HUMAN DISEASES. (3 cr; prereq ‡) Olson, Ruschmeyer
Basic biological concepts of parasitic diseases, vectors, and application of vector control methods in environmental health programs.

5-179. PUBLIC HEALTH BIOLOGY-FIELD INVESTIGATIONS. (3 cr; prereq ‡) Olson, Ruschmeyer
Field studies and laboratory analyses related to special problems in assessment of water supplies, waste treatment facilities, and stream pollution surveys.

5-181. INTRODUCTION TO THE AIR POLLUTION PROBLEM. (3 cr; prereq ‡) Paulus
History, sources, controls, effects; surveys, legal aspects; administration of programs.

5-182. AIR POLLUTION CONTROLS AND SURVEYS. (3 cr; prereq 5-181 or ‡) Paulus
Public health engineering approach to air pollution controls and surveys.

5-183. PROBLEMS OF AIR POLLUTION CONTROL. (Cr ar; prereq 5-181, ‡) Paulus
Special supervised studies involving laboratory and field investigation procedures; pertinent literature review.

5-184. AIR ANALYSIS I. (3 cr; prereq 5-181, 5-183, or 5-211, ‡) Paulus
Laboratory and field exercises including air flow measurement, calibration of instruments, analysis of gases, stack sampling, dust counting and sizing, and industrial plant visits.

5-185. AIR ANALYSIS II. (3 cr; prereq 5-184) Paulus, Caplan
Laboratory and field exercises including odor evaluation, stack sampling, operation of sampling station and air pollution surveys.

5-190. TOPICS: INJURY CONTROL. (Cr ar; prereq ‡) Michaelsen, Scheffler
Directed readings and reports on selected problem areas in injury control.

5-191. PRINCIPLES AND METHODS OF INJURY CONTROL. (Cr ar; prereq ‡) Michaelsen, Scheffler
Accidents as a community public health problem; current concepts of etiology and methodology of control.

5-192. HOSPITAL SAFETY. (3 cr; prereq ‡) Michaelsen, Scheffler
Theories and practices in accident and fire prevention and control for hospitals and other medical care facilities.

5-193. CHEMICAL LABORATORY SAFETY. (1 cr; prereq ‡) Scheffler
Principles of accident and fire prevention in chemical laboratories.

5-194. OCCUPATIONAL SAFETY. (2 cr; prereq ‡) Michaelsen, Scheffler
Occupational safety procedures, environmental controls to reduce injuries on and off the job, safety program development and administration.

5-200. TOPICS IN RADIOLOGICAL HEALTH. (Cr ar; prereq ‡) Staff
Selected readings in radiological health with discussion based on these readings.

5-201. MEASUREMENT AND APPLICATION OF IONIZING RADIATION. (3 cr [lect and lab], 2 cr [lect only]; prereq ‡) Barber
Introduction to principles of measurement and use of radiative sources; emphasis on health hazards.

5-202. ENVIRONMENTAL RADIOACTIVITY. (3 cr; prereq ‡) Barber, Straub
Sources, measurement, evaluation, and control of environmental radioactivity; hazards to general population.

5-203. LOW-LEVEL RADIOACTIVITY MEASUREMENTS. (3 cr; prereq ‡) Barber
Lecture and laboratory on the assay of low levels of radioactivity in environmental samples.

5-207. RADIATION PROTECTION CRITERIA FOR HOSPITALS. (2 cr; prereq ‡) Barber, Wollan
Methods of design, shielding, equipping, and operation of isotope laboratories, X-ray, and other ionizing radiation facilities.

5-209. SEMINAR: HEALTH PHYSICS. (1 cr; prereq ‡) Barber
Review and discussion of current health physics problems.

5-210. TOPICS IN OCCUPATIONAL HEALTH. (Cr ar; prereq ‡) Staff
Selected readings in occupational health with discussions based on these readings.

5-211.* INDUSTRIAL HYGIENE ENGINEERING. (4 cr; prereq ‡) Michaelsen, Caplan
Field and laboratory methods used by industrial hygiene engineers in study and control of occupational health hazards.

5-212. VENTILATION CONTROL OF ENVIRONMENTAL HAZARDS. (3 cr; prereq 5-211, ‡) Caplan
Theory and application of exhaust ventilation in control of airborne environmental hazards; principles of exhaust hoods, air moving devices, gas cleaning devices; demonstration of measurement techniques; relationship of hazard and process to ventilation design criteria.

5-213. PUBLIC HEALTH ASPECTS OF TOXIC PRODUCTS. (2 cr; prereq 5-215) Caplan, Long
Problems of protecting industrial workers and private consumers from useful but potentially harmful products; product testing programs and administration; labeling problems.

5-214. AGRICULTURAL OCCUPATIONAL HEALTH. (3 cr; prereq 5-211 or ‡) Harein
Occupational health problems of agricultural workers, practical and available preventive measures, educational and administrative needs.

5-215. ENVIRONMENTAL TOXICOLOGY. (3 cr, prereq 5-181 or 5-211, ‡) Caplan, Long
Basic toxicology and physiology with emphasis on environmental contaminants. Special consideration is given to inhalation toxicology of the work environment and air pollution.

5-216. HEALTH ASPECTS OF AIR CONTROL IN HOSPITALS. (2 cr, §5-232; prereq ‡) Michaelsen
Basic considerations in control of natural and mechanical air flow in hospitals to avoid spread of infection, to control odors, and to promote patient care.

5-220. TOPICS IN FOOD SANITATION. (Cr ar; prereq ‡) Staff
Review of literature and practice to identify association of food sanitation problems to public health.

5-221. INSTITUTIONAL FOOD PROTECTION PROGRAMS. (2 cr; prereq ‡) Bond, Jopke
Public health implications in food preparation and service; regulatory controls by official public health agencies.

5-222.* FOOD SANITATION. (3 cr; prereq ‡) Olson
Review of current literature on sanitary problems in production, processing, and distribution of milk, meat, shellfish, and other foods; methods of supervision.

5-230. TOPICS IN INSTITUTIONAL ENVIRONMENTAL HEALTH. (Cr ar; prereq ‡) Staff
Review of literature and practice to identify institutional environmental health problems.

5-231. ENVIRONMENTAL HEALTH AND SAFETY IN HEALTH CARE FACILITIES I. (4 cr; prereq ‡) Michaelsen, Vesley, Greene
Environmental health concepts and problems related to isolation techniques; cleaning, disinfection and sterilization; laundry processes; food service; physical plants; interdepartmental relationships.

5-232. ENVIRONMENTAL HEALTH AND SAFETY IN HEALTH CARE FACILITIES II. (4 cr, §5-216; prereq ‡) Michaelsen, DeRoos
Ventilation; water supply; plumbing; solid and liquid waste systems; and other environmental engineering problems.

5-233. ENVIRONMENTAL HEALTH AND SAFETY IN HEALTH CARE FACILITIES III. (4 cr, §5-172; prereq ‡) Vesley, Greene
Microbiological sampling and control; laboratory and field practice in solving environmental health problems.

5-239. HOSPITAL ENGINEERING PROBLEMS. (Cr ar; prereq ‡) Michaelsen, visiting lecturers
Application of environmental engineering, sanitation and maintenance principles to planning, administration, and operation of hospitals.

5-241. ENVIRONMENTAL HEALTH ASPECTS OF WATER SUPPLY. (3 cr; prereq ‡) Straub, Singer
Role of water in health of man; physical, chemical, and biological characteristics; evaluation of source, treatment, and distribution systems.

5-244. ENVIRONMENTAL HEALTH ASPECTS OF WASTE WATER SYSTEMS. (3 cr; prereq ‡) Straub, Singer
Role of liquid wastes in health of man; physical, chemical and biological characteristics; evaluation of source, treatment, and disposal facilities.

8-150. RESEARCH: ENVIRONMENTAL HEALTH. (Cr ar) Staff
Opportunities will be offered for qualified students to pursue research in the public health importance of environmental stresses on the health of man.

8-170. RESEARCH: ENVIRONMENTAL BIOLOGY. (Cr ar; prereq ‡) Olson, Greene

8-180. RESEARCH: AIR POLLUTION. (Cr ar; prereq ‡) Paulus

8-190. RESEARCH: INJURY CONTROL. (Cr ar; prereq ‡) Michaelsen

8-200. RESEARCH: RADIOLOGICAL HEALTH. (Cr ar; prereq ‡) Barber

8-201.* RADIATION DOSIMETRY. (3 cr; prereq ‡) Barber
Radiant energy absorption in liquids, gases, and solids; absorption in biological systems.

8-202. RADIATION DOSIMETRY LABORATORY. (1 cr; prereq ¶8-201) Barber
Laboratory exercises involving principles discussed in 8-201.

8-208. FIELD PRACTICE IN RADIOLOGICAL HEALTH. (Cr ar; prereq ‡) Barber

8-210. RESEARCH: OCCUPATIONAL HEALTH. (Cr ar; prereq ‡) Michaelsen, Caplan

8-211. HEALTH SURVEY OF MANUFACTURING PROCESSES. (2 cr; prereq 5-211) Caplan
Survey of occupational disease problems and preventive measures in major industries and in operations common to many industries; field trips.

8-218. FIELD PROBLEMS IN OCCUPATIONAL HEALTH. (3 cr; prereq 5-211, 5-212 or or ¶5-213, ‡) Caplan
Guided evaluation of actual potential occupational health problems, recommendations, and design criteria for correction if indicated.

8-220. RESEARCH: FOOD SANITATION. (Cr ar; prereq ‡) Pflug

8-230. RESEARCH: INSTITUTIONAL ENVIRONMENTAL HEALTH. (Cr ar; prereq ‡) Michaelsen, Greene, Vesley

8-246. GROUNDWATER DEVELOPMENT. (Cr ar; prereq grad engr, ‡) Bond, Singer, staff, visiting lecturers
Groundwater exploration; well hydraulics, design, and construction; special references to public health problems.

8-247. FIELD WORK IN GROUNDWATER DEVELOPMENT. (Cr ar; prereq grad engr, 8-246) Bond, Singer, staff, visiting lecturers
Construction of wells, field tests, and public health problems.

8-248. WATER QUALITY INVESTIGATION AND RESEARCH TECHNIQUES. (6 cr; prereq ‡) Olson, Odlaug, Ruschmeyer
Field techniques and special research methods for establishing pollution base lines; recognition and appraisal of advancing eutrophication.

8-249. WATER QUALITY RESEARCH. (6 cr; prereq ‡) Olson, Odlaug, Ruschmeyer
Design and implementation of independent, short-term research activity. Literature review, statistical design and data processing.

Veterinary

5-300. COMPARATIVE MEDICINE AND PUBLIC HEALTH. (2 cr; prereq 5-002, ‡) Diesch
Comparative medicine in man's relationship to biologic environment, interrelationship between animal and human health, source of animal diseases, ecology of zoonoses; food production and hygiene; laboratory animal medicine.

5-303. MENTAL HEALTH — RELATIONSHIP OF ANIMALS AND MAN. (Cr ar; prereq ‡)
Study of principles of animal and human psychology in terms of animal behavior and the relationships with man; analysis and evaluation of potential influence of companion animals on the mental health of animal owners; potential role of appropriately qualified veterinarians as participants in the group of professionals serving community mental health programs.

5-306. ANIMAL MODELS OF HUMAN DISEASE. (3 cr; prereq 5-330 or ‡)
Selected animal models of human disease; principles involved in developing criteria for meaningful and appropriate use; methods for evaluation of experimental design and objectives of users; criteria for identification of additional models for comparative medical research.

5-315. PROBLEMS IN DISEASE CONTROL AND ERADICATION. (Cr ar; prereq 5-330 or ‡)
Analysis and evaluation of selected 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 U.S. or a foreign country for group evaluation and analysis.

5-317. PROBLEMS IN VETERINARY MEDICAL ADMINISTRATION AND SUPERVISION. (3 cr; prereq ‡)
Case studies of selected problems in administration and supervision with emphasis on application of knowledge to problem solving, developing and using appropriate skills, evaluation, decision making.

5-320. MEAT HYGIENE AS RELATED TO THE CONSUMER. (3 cr; prereq 5-375 or 5-070 or ‡)
The consumer's role in protecting the wholesomeness of meat from the time of purchase by consumer through transportation, storage, preparation, and serving for consumption. What the consumer should expect when purchasing meat in terms of industry and government responsibility for wholesomeness and freedom from adulteration. Examples of problems encountered and suggestions to aid consumers.

5-323. CHEMICAL DRUG ASPECTS OF MEAT HYGIENE. (3 cr; prereq VMic 5-220 or ‡)
Factors leading to drug residues in food producing animals; residue detection; criteria for determination of tolerance and action levels by government agencies; harmful effects of drug residues in relation to human health.

Epidemiology

5-330.* EPIDEMIOLOGY I. (3 cr; prereq 5-375 and 5-405, 5-407, or 5-450/5-451) Schuman, Stebbings
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.

5-331. FUNDAMENTALS OF BIOSTATISTICS. (3 cr) Visiting lecturers
Rates, probability methods, statistical inference, sampling distributions.

5-332. FUNDAMENTALS OF EPIDEMIOLOGY. (3 cr) Visiting lecturers
Basic epidemiologic concepts and methods of investigation of diseases.

5-335.* EPIDEMIOLOGY II. (3 cr; prereq 5-330) Schuman
Extension of epidemiologic principles to detailed study of selected infectious diseases.

5-336. INFECTIOUS DISEASE EPIDEMIOLOGY. (3 cr; prereq basic epidemiology and biostatistics) Visiting lecturers
Factors involved in epidemic occurrence; clinical response to infection; impact of zoonoses on man; immunologic responses; vaccine evaluation.

5-337. SEROLOGIC EPIDEMIOLOGY. (2 cr; prereq basic epidemiology and biostatistics) Visiting lecturers
Applications of immunologic and biochemical methods to epidemiologic problems of disease.

5-340. EPIDEMIOLOGIC SURVEY METHODS. (3 cr; prereq 5-330, 5-407 or equiv, ‡) Schuman, Stebbings
Practical aspects of survey design, execution, analysis, and interpretation.

5-341. HEALTH SURVEY METHODS. (2 cr; prereq basic epidemiology and biostatistics) Visiting lecturers
Problems of sampling, sample size determination, interview, questionnaire development and organization of community health research.

5-342. PUBLIC HEALTH BACTERIOLOGY. (Cr ar; prereq MicB 5-232, MicB 5-216, ‡) Bauer
Bacteriologic and serologic diagnosis, public health laboratory administration and methods.

5-345. EPIDEMIOLOGY OF CANCER. (3 cr; prereq basic epidemiology and biostatistics, 5-357 or ¶5-357) Schuman and visiting lecturers
Epidemiology of selected cancer sites. Emphasis on existing gaps in knowledge.

5-346. EPIDEMIOLOGY OF CARDIOVASCULAR DISEASES. (3 cr; prereq basic epidemiology and biostatistics, 5-357 or ¶5-357) Visiting lecturers
Epidemiologic aspects of various types of cardiovascular disease with emphasis on multivariate setting of etiologies.

5-347. EPIDEMIOLOGY OF MENTAL DISORDERS. (2 cr; prereq basic epidemiology and biostatistics) Visiting lecturers
Application of epidemiologic concepts and methods to psychiatric problems. Specific mental disorders.

5-348. EPIDEMIOLOGY OF NEUROLOGIC DISEASES. (2 cr; prereq basic epidemiology and biostatistics) Visiting lecturers
Epidemiologic approach to selected diseases of the nervous system including multiple sclerosis, Parkinsonism, cerebrovascular diseases and malignant disease and congenital deformities of the central nervous system.

5-349.* EPIDEMIOLOGY OF CHRONIC RESPIRATORY DISEASE. (Cr ar; prereq ‡) Stebbings
Critical review of current status of chronic respiratory disease epidemiology and methods. Design and analysis of longitudinal studies.

5-350. EPIDEMIOLOGIC BASIS FOR HEALTH SERVICES PLANNING AND EVALUATION. (2 cr; prereq 5-330, 5-332 or equiv, 5-407, 5-331 or equiv) Visiting lecturers
Epidemiologic approaches to planning and criteria of evaluation.

5-355. GENETICS AND EPIDEMIOLOGY. (3 cr; prereq basic epidemiology and biostatistics) Visiting lecturers
Genetic methods of evaluating families; topics in population genetics.

5-356. POPULATION DYNAMICS. (2 cr; prereq basic epidemiology and biostatistics) Visiting lecturers
Historical and current levels and changes in rates of population growth, mortality, natality, migration.

5-357. SELECTED STATISTICAL TOPICS IN EPIDEMIOLOGY. (3 cr; prereq basic epidemiology and biostatistics) Visiting lecturers
Rate adjustment, relative risk, measures of association, matched pair analyses, force of mortality, and estimation of survivorship.

5-358. RADIATION EPIDEMIOLOGY. (2 cr; prereq basic epidemiology and biostatistics and advanced statistics) Visiting lecturers
Critical review of the epidemiological studies of biological effects of radiation exposure in man with emphasis on the methodological problems encountered.

5-365. EXPERIMENTAL EPIDEMIOLOGY. (Cr ar; prereq 5-335 and 5-407 or 5-450 or equiv and ‡)
Infectious and non-infectious diseases in laboratory animal populations and simulated environmental conditions; effect of alterations in agent-host-environment on health and disease under varying controlled experimental conditions measured and evaluated. Results analyzed in terms of application to disease prevention and control programs.

5-370. APPLIED EPIDEMIOLOGY. (Cr ar; prereq 5-330 and 5-407 or 5-450 or equiv and ‡)
Application of epidemiologic principles and methods in field studies of outbreaks of disease in cooperation with veterinary medical practitioners, State Livestock Sanitary Board, U.S.D.A., State Health Department and H.E.W. Application of principles and methods to planning investigations, collection and analysis of data for proposed prospective and retrospective studies of acute and chronic diseases of animals; analysis and evaluation of field investigations and factors influencing their outcome.

5-375. BIOLOGICAL BASES OF HEALTH AND DISEASE. (3 cr; prereq course in microbiology or ‡) Schuman
Introduction to basic concepts and mechanisms of production of disease, infectious and non-infectious, and of maintenance of the healthy state. Illustrative diseases utilized as samples or models.

5-379.* TOPICS IN EPIDEMIOLOGY. (Cr ar; prereq ‡) Staff
Selected readings wth discussion based on these readings.

8-330. RESEARCH: EPIDEMIOLOGY. (Cr ar) Staff
Opportunities will be offered by the School of Public Health and by various cooperating organizations for qualified students to pursue research work.

8-340.* EPIDEMIOLOGY OF NONCOMMUNICABLE DISEASES. (3 cr; prereq 5-330) Schuman, Stebbings
Application of basic epidemiologic principles to noncommunicable diseases and to trauma; selected disease examples.

8-341. EPIDEMIOLOGY OF SELECTED CHRONIC DISEASES. (2 cr; prereq basic epidemiology and biostatistics) Visiting lecturers
Application of epidemiologic concepts and methods to the study of selected chronic diseases other than cardiovascular and cancer; e.g. diabetes, arthritis, chronic respiratory disease, etc.

8-379. SEMINAR: EPIDEMIOLOGY. (Cr ar; prereq ‡) Schuman, Stebbings
Discussion of selected current epidemiologic problems.

Physiological Hygiene

5-380.* APPLIED HUMAN NUTRITION. (3 cr; prereq ‡) J Anderson, Grande, Stief
Food composition, nutrient requirements, nutrition surveys, public health programs in nutrition.

5-386. PUBLIC HEALTH ASPECTS OF CARDIOVASCULAR DISEASE. (3 cr; prereq ‡) Grande, Keys, staff
Etiology, incidence, problems of control, and relationship to mode of life.

8-385. SEMINAR: PHYSIOLOGICAL HYGIENE. (1 cr) Staff
Nutrition, tests and measurements of human physical fitness; gerontology; adaptation in health and disease; body composition; circulatory dynamics and related topics.

8-386. READINGS IN PROBLEMS OF PHYSIOLOGICAL HYGIENE. (Cr ar; prereq ‡) Staff

8-387. RESEARCH: PHYSIOLOGICAL HYGIENE AND RELATED AREAS. (Cr ar) Staff

Biometry

5-403. COMPUTER APPLICATIONS IN HOSPITAL AND HEALTH CARE ADMINISTRATION. (3 cr; prereq hospital and health care administration students only, others ‡) Johnson
Introduction to digital computer and FORTRAN programming with applications in hospital and health care administration.

5-404. INTRODUCTION TO BIOSTATISTICS AND STATISTICAL DECISION. (4 cr; prereq ‡) 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.

5-405. BIOMETRIC METHODS IN ENVIRONMENTAL HEALTH I. (3 cr; prereq environmental health student, others ‡) Kjelsberg, Boen
Variation; frequency distribution; demographic techniques; probability; introduction to data analysis.

5-406. BIOMETRIC METHODS IN ENVIRONMENTAL HEALTH II. (3 cr; prereq 5-405) Bearman
Estimation; tests of significance; Poisson distribution; serial dilutions and most probable number; elements of bioassay; radiologic statistics.

5-407.* VITAL STATISTICS I. (3 cr) Bearman, Kjelsberg
Official sources; population changes; rates; trends; significant differences.

5-408. VITAL STATISTICS II. (3 cr; prereq 5-407 with grade of B) Bearman
Demographic techniques and statistical inference.

5-411. INTRODUCTION TO MATHEMATICAL DEMOGRAPHY. (3 cr, §Soc 5-561; ‡) DasGupta
For course description, see the main Biometry section.

5-412. SURVEY SAMPLING IN SOCIAL AND HEALTH SCIENCE RESEARCH. (3 cr, §Soc 5-970; ‡) DasGupta
For course description, see the main Biometry section.

5-430/5-431/5-432. BIOMEDICAL COMPUTING I, II, III. (3 cr per qtr; prereq Math 1-111) Johnson, staff
For course description, see the main Biometry section.

5-436. ANALYTICAL TECHNIQUES FOR HEALTH DELIVERY SYSTEMS. (3 cr; prereq calculus, 5-450, 5-451 or #) Johnson
For course description, see the main Biometry section.

5-450. BIOMETRY I. (3 cr; prereq familiarity with basic concepts of calculus desirable and ¶5-451) Bartsch, Jeffries
For course description, see the main Biometry section.

5-451. BIOMETRY LABORATORY I. (2 cr; prereq ¶5-450) Jeffries
For course description, see the main Biometry section.

5-452. BIOMETRY II. (3 cr; prereq 5-450, ¶5-453) Bartsch, Jeffries
For course description, see the main Biometry section.

5-453. BIOMETRY LABORATORY II. (2 cr; prereq ¶5-452) Jeffries
For course description, see the main Biometry section.

5-454. BIOMETRY III. (3 cr; prereq 5-452, ¶5-455) Bartsch, Jeffries
For course description, see the main Biometry section.

5-455. BIOMETRY LABORATORY III. (2 cr; prereq ¶5-454) Jeffries
For course description, see the main Biometry section.

5-460. DEMOGRAPHY AND HEALTH. (3 cr; prereq biometry major, others #) Kjelsberg
Needs, sources, collection, and interpretation of data in the areas of population, mortality, morbidity, natality, and health services.

Public Health Nursing

5-500. PUBLIC HEALTH-MENTAL HEALTH NURSING I. (4 cr; prereq #) Carver, Leonard
Critical analysis of selected theories of physical, psychosocial development; emphasis on developmental stages throughout the life span of an individual. Laboratory experiences in selected child care centers. Includes administration and interpretation of selected developmental and psychological screening tests.

5-501. PUBLIC HEALTH-MENTAL HEALTH NURSING II. (4 cr; prereq 5-500) Carver, Leonard
(Continuation of 5-500) Focus of the course is on the family. Provides opportunity for student to acquire and apply theory and integrate knowledge of human behavior for promotion of health and prevention of illness. Laboratory; interaction with an individual and family; application of nursing process principles.

5-502. CLINICAL SEMINAR: PUBLIC HEALTH-MENTAL HEALTH NURSING. (4 cr; prereq 5-501) Carver and staff
(Continuation of 5-501) Focus on family. Application of growth and developmental theories to family in stress or crises; utilization of nursing process. Supervised clinical experience in selected agencies.

5-508. DEVELOPMENT OF SELF: THE BASIS FOR HELPING RELATIONSHIPS. (Cr ar; prereq #) Downey
Consideration of conceptual framework for self understanding and personal growth; delineation of personal and professional goals within a rapidly changing societal and health scene; instrumental approach; identification and implementation of behavior facilitating achievement of goals.

5-510.* RESEARCH METHODOLOGY IN NURSING. (3 cr; prereq 5-407) Boen, Sparrow
Examination of selective research studies in nursing and of development of models and theory in nursing research; steps in formulating a research design.

5-517. SEMINAR: PATIENT CARE AND REHABILITATION IN THE COMMUNITY. (Cr ar; open to grad students in the health sciences; prereq #) E Anderson
Explanation of multidiscipline approach in developing community programs for patient care.

5-518. LONG-TERM PATIENT CARE AND REHABILITATION. (Cr ar; prereq #) E Anderson, associates
Problems associated with rehabilitation; selected experiences correlated with seminars.

5-519. ADULT AND GERIATRICS HEALTH MAINTENANCE, LONG-TERM CARE AND REHABILITATION. (Cr ar; prereq #) E Anderson
Independent study. Exploration of a comprehensive multidiscipline approach in the maintenance of wellness and in the continuity of care for long term patients.

5-520. FIELD EXPERIENCE: PHYSICAL AND OCCUPATIONAL THERAPY IN COMMUNITY AGENCIES. (Cr ar; prereq ‡) E Anderson
Advisory service and planning in-service programs for nursing staff; selected experiences in local, county and state health departments.

5-535. CONTEMPORARY SCHOOL NURSING. (Cr ar; prereq ‡) Fredlund
Exploration of changes occurring in school health programs with emphasis on the changing role of the public health nurse. Review of related research.

5-536. THE TEAM APPROACH IN SCHOOL NURSING. (3 cr; open to registered nurses employed in schools or to those interested in such employment) Fredlund
The school nurse's responsibility for the health of school children in relation to community health teams, to multidisciplinary pupil personnel teams and nursing teams. Consists of lecture-discussions, student projects, films and field trips.

5-538. CHILD CENTERED SCHOOL NURSING. (3 cr; open to RN's employed in school nursing or to those interested in such employment) Fredlund
Role of school nurse in providing health services and contributing to health education for school children. Some recent trends in school nursing discussed and the team approach in meeting children's health needs considered. Opportunity to focus on specific problem areas as designated by the class. Format will include lecture/discussions, student projects, and films.

5-560. FOUNDATION COURSE IN AMBULATORY CHILD HEALTH CARE. (Cr ar; open only to RN's enrolled in Pediatric Nurse Associate Program; prereq ‡) Leonard and Woodbury
Focus on preparation of the nurse to perform comprehensive health appraisals on children from birth through adolescence; review of anatomy and principles of examination; supervised clinical experience.

5-561. FOUNDATION COURSE IN AMBULATORY CHILD HEALTH CARE II. (Cr ar; open only to registered nurses enrolled in Pediatric Nurse Associate Program; prereq ‡) Leonard
The second course in a three-course series designed to provide foundational knowledge and clinical experience necessary to assess the health of children from birth through adolescence and to manage their health care within their family and community environments. Focuses on knowledge, normative criteria, and clinical skills essential for assessing the health of school age children and adolescents.

5-575. TOPICS IN PUBLIC HEALTH NURSING. (Cr ar; prereq ‡) Staff
Selected readings in public health nursing with discussion based on these readings.

8-503. CLINICAL SEMINAR: ADVANCED COMMUNITY NURSING. (3 cr; prereq 5-500, 5-501, 5-502) E Anderson, Fredlund, Sime
Focus on families with health problems (maternal and child health, chronic illness) utilizing behavioral and mental health concepts.

8-504. PUBLIC HEALTH NURSING OF THE MENTALLY ILL. (Cr ar; prereq ‡) Sparrow, Fredlund, associates
Selected experiences with mentally ill patients including a multidisciplinary approach to their total care; related theory.

8-505. PUBLIC HEALTH NURSING IN THE GROUP SETTING. (Cr ar; prereq ‡) Sparrow, Fredlund, associates
Opportunity for working with small groups in the community with emphasis on the group method of rendering public health nursing services.

8-510. DIRECTED RESEARCH. (Cr ar; prereq 5-510) Boen, staff
Guided study in research design.

8-511. DIRECTED RESEARCH. (6 cr; prereq 5-510, 8-510) Staff
Guided completion of a research study.

8-519. DIRECTED RESEARCH. (Cr ar)
Guided study in research related to physical therapy in community health programs.

8-520. SEMINAR: GERIATRICS, LONG-TERM PATIENT CARE AND REHABILITATION. (Cr ar; prereq 5-518 or 5-519 or ‡) E Anderson
Development of a project relative to multidisciplinary action affecting patient care; review of current research findings.

8-526. PRACTICUM IN TEACHING PUBLIC HEALTH NURSING. (4 cr per qtr [2 qtr course]; prereq ‡) Sloan
Identification of major health concepts; application of educational principles to teaching of public health nursing; selected experiences; supervised teaching in public health nursing; supervision of student in laboratory experience.

8-531. PROBLEMS AND PRACTICUM IN SUPERVISION AND ADMINISTRATION IN COMMUNITY NURSING. (4 cr per qtr [2 qtr course]; prereq #) E Anderson
Theory in collaboration with teaching students in public health. Analysis of and experience in selected aspects of the administrative and supervisory process.

8-535. SEMINAR: SCHOOL NURSING WITH RELATED FIELD PRACTICE. (Cr ar; prereq #) Fredlund
Exploration of nursing in the school setting.

Maternal and Child Health

5-600. FIELD WORK IN PUBLIC HEALTH NUTRITION. (Cr ar; prereq #) Stief and associates
Placement in an approved agency with opportunity for experience in nutritional aspects of public health programs.

5-601.* SEMINAR: PUBLIC HEALTH NUTRITION. (Cr ar; prereq #) Stief

5-609. TOPICS: PUBLIC HEALTH NUTRITION. (Cr ar; prereq #) Staff
Selected readings and problems.

5-610. MATERNAL AND CHILD HEALTH. (3 cr; prereq #)
Community health needs and services for mothers and children.

5-611. MATERNAL AND CHILD HEALTH PROGRAMS. (1 cr, §5-610; prereq hospital administration student, #)
Community programs for major maternal and child health problems.

5-612. HUMAN GENETICS AND PUBLIC HEALTH. (3 cr; prereq #) Schacht
Evaluation of current studies in human genetics and applications to community health.

5-613. HANDICAPPED CHILDREN. (Cr ar; prereq 5-610, #)
Prevention and rehabilitation of handicapping conditions affecting children; community activities related to emotional, physical, and intellectual handicaps.

5-649. TOPICS: MATERNAL AND CHILD HEALTH. (Cr ar; prereq #) Staff
Selected readings and problems.

8-610. HEALTH OF THE SCHOOL AGE CHILD. (2 cr; prereq 5-610 or #)
Review of major health problems among children of school age; methods of providing and evaluating school health services.

8-611. MATERNAL AND CHILD HEALTH PROBLEMS. (3 cr; prereq 5-610) Martens
Problems in administration of health programs for infants, preschool and school age children, handicapped children, and women of childbearing age.

Dental

5-650. DENTAL HEALTH. (1 cr; prereq #) Staff
Conditions resulting in tooth decay and loss; preventive and corrective measures; mouth hygiene; community programs for dental health.

5-651. PHILOSOPHY AND CONCEPTS OF PREVENTIVE DENTISTRY. (3 cr; prereq #) Meskin, Martens
Basic principles of preventive dentistry; relationship between oral and general disease processes; epidemiology of oral diseases; preventive procedures; organizing and evaluating community dental health programs.

5-652. SEMINAR: DENTAL HEALTH LITERATURE. (Cr ar; prereq #) Meskin, staff
Current review of literature pertinent to dental public health, critical examination for design, content, and validity of conclusions.

5-653. DENTAL HEALTH PROGRAMS. (Cr ar; prereq #) Meskin, Martens
Dental health activities and problems in a community situation; observation visits and participation in public and voluntary facilities; preventive, curative, rehabilitative, and research activities of local, state, and federal agencies; problems of dental manpower.

5-654. TOPICS IN DENTAL PUBLIC HEALTH. (Cr ar; prereq #) Staff
Selected readings with discussion based on these readings.

Public Health Administration

5-700.* PUBLIC HEALTH ADMINISTRATION. (3 cr; prereq #)
Structure, basic functions, and activities of public health agencies.

5-701. PUBLIC HEALTH ADMINISTRATION PROBLEMS. (3 cr; prereq 5-700)
Budgeting, program planning, and appraisal of public health procedures.

5-749.* TOPICS: PUBLIC HEALTH ADMINISTRATION. (Cr ar; prereq #) Staff

Hospital and Health Care Administration

5-751. PRINCIPLES OF ORGANIZATION AND MANAGEMENT IN HEALTH SERVICES ORGANIZATIONS. (3 cr; prereq ‡) Dornblaser and staff
Lectures and case studies on the role of health care services administrators, principles of management and the administrative process.

5-760. ORIENTATION TO MEDICAL SCIENCES. (3 cr; prereq ‡) Phin
Presentation of method of medical terminology by body system; applied physiology and anatomy; examination of elements of medical practice.

5-763. HEALTH ORGANIZATIONS, STANDARDS AND EVALUATION. (3 cr; prereq ‡) Phin and staff
Examination of characteristics of health organizations and current standards in the health care field; implications to hospital and health care management; relationship of standards to health care evaluation.

5-764. PRINCIPLES OF PERSONNEL AND FINANCIAL MANAGEMENT AND LEGAL ISSUES IN HEALTH SERVICES ORGANIZATIONS. (6 cr; prereq ‡) Brodahl, Stephan, Bieter and staff
Examination of principles of personnel management and labor relations; financial management including budgeting; law and legal liability and insurance associated with hospitals and other health care organizations.

5-765. HOSPITAL DEPARTMENTAL OPERATIONS. (4 cr; prereq ‡) Brodahl and staff
Examination of selected hospital departments and functions; alternative ways of providing services.

5-790. SOCIAL, ECONOMIC, AND POLITICAL ASPECTS OF MEDICAL CARE. (3 cr; prereq ‡) Litman, staff
Social, economic, and political forces shaping health care systems; possible future impact of these forces.

8-750/8-751†. SEMINAR: ALTERNATIVE PATTERNS OF HEALTH CARE. (3 cr per qtr; prereq ‡; offered 1972-73 and alt yrs)
Critical examination of alternative approaches to meeting the health care problems of ambulatory care, aging and chronic disease, physical rehabilitation, maternal and child care, mental health, and poverty.

8-752. SEMINAR: COMPARATIVE HEALTH CARE SYSTEMS. (3 cr; prereq ‡; offered fall 1973 and alt yrs) Litman
Extensive examination and comparison of the 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.

8-760. TOPICS: HOSPITAL AND HEALTH CARE ADMINISTRATION. (Cr ar; prereq ‡) Dornblaser, Weckwerth
Independent study and tutorial guidance on selected problems and current issues in the field of health and health care.

8-761. READINGS IN THEORY AND PRINCIPLES OF HOSPITAL AND HEALTH CARE ADMINISTRATION. (Cr ar; prereq ‡) Dornblaser, Weckwerth

8-762. CONTEMPORARY PROBLEMS OF HOSPITAL AND RELATED HEALTH SERVICES. (Cr ar; prereq ‡) Weckwerth
Current concepts, problems, principles, and future developments in the field of health and health care.

8-770. HEALTH AND HUMAN BEHAVIOR. (3 cr; prereq Soc 5-855, offered spring 1973-74 and alt yrs) Litman
Examination of the sociology of health and health care; social and personal components of health and illness behavior; community health; and the relationship of social and cultural factors in the organization and delivery of health care services.

8-780. ADVANCED STATISTICAL METHODS IN HEALTH CARE RESEARCH. (3 cr; prereq 5-450 or ‡) Weckwerth
Survey and analysis of the application of nonparametric statistics to health care research.

8-781. SEMINAR: RESEARCH STUDIES IN HEALTH CARE. (3 cr; prereq ‡; offered spring 1972-73 and alt yrs) Litman, Weckwerth, staff

8-782. RESEARCH PRACTICUM. (6 cr; prereq ‡) Litman, Weckwerth and staff
Summer field experience in health care research. Supervised independent and team research on selected topics and problems in the field of health care.

8-790. POLITICAL ASPECTS OF HEALTH SERVICES. (3 cr; prereq ‡; offered winter 1972-73 and alt yrs) Litman
Analysis of interrelationships between government, politics, and health care; the political and social basis of health legislation and community decision making in provision and modifications of health services.

8-795. ECONOMIC ASPECTS OF HEALTH CARE. (3 cr; prereq ‡) Bognanno
Economic analysis of America's health care sector, emphasizing its problems of pricing, production, and distribution. Evaluating health care services as one factor input contributing to the nation's health.

8-796. TOPICS IN HEALTH ECONOMICS. (3 cr; prereq at least 1 economics course and ‡) Dahl
General principles of health economics applied to current issues in health such as insurance, licensure, family practice, malpractice and hospital costs. Models of hospital functioning, area planning, and disease intervention are presented within the framework of economic analysis and used to explain and predict health behavior. Concepts of cost benefit and cost effectiveness analysis are discussed and applied to problems in health care delivery.

RADIOLOGY (Rad)

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

RHETORIC (Rhet)

Courses Which Carry Graduate Credit When Program Related

5-147. ADULT READING PROGRAMS. (2 cr; prereq Elem 5-331 or SeEd 5-344 or ‡) J. Brown
Problems, methods, and research in this field. Survey and evaluation of program designs, including those suitable for TV.

5-169. COMMUNICATION PROBLEMS AND PROCESSES. (3 cr; prereq grad status or ‡) Ar
Contemporary communication theories and research. Problems of language, perception, and status in the application of communication theory to professional activity and growth.

5-170. MANAGERIAL COMMUNICATIONS. (4 cr) Ar
Systematic analysis of communication techniques and procedures for the manager. Emphasis on manager's ability to achieve vertical and horizontal understanding and acceptance. Readings, guest speakers, term project.

5-175. PRINCIPLES OF LANGUAGE DEVELOPMENT. (4 cr) Pearsall
Analysis through history and semantics of principles of the English language. Attempt to understand how English has evolved to generate a more enlightened attitude in its use.

5-180. INTERNSHIP IN TECHNICAL WRITING. (Cr ar) Pearsall
Gives technical communication majors practical on-the-job experience with communication problems. Students intern as writers or editors either at the University or in industry.

5-301. HUMANITIES SEMINAR: THE INDIVIDUAL AND SOCIETY. (3 cr; prereq 1-301, 1-302, 1-303, or ‡) Drake
Contemporary ethical and cultural values as manifested in such conflicts as: liberty and authority; freedom and organization; art and technology; science and religion.

5-551. REPORT AND THESIS WRITING. (3 cr; prereq 3-551 or ‡) Pearsall
Organization of reports and thesis; library investigation; presentation of data; methods of documentation. Revision of manuscripts and improvement in writing style.

5-561. WRITING FOR PUBLICATION. (4 cr; prereq 3-551 or 3-562) Wright
The professional as communicator; analysis of markets; professional, trade, and general; information sources and topic selection; adaptation to specialized and general reader; writing and preparing manuscripts for publications; marketing techniques.

8-251. SEMINAR: LISTENING COMPREHENSION. (1-3 cr; prereq undergrad speech major, ‡) Ar
Research problems and methods. Evaluation of published research.

RHINOLOGY

For information on staff, program and courses, see the otolaryngology and rhinology section of the bulletin, *Graduate Programs in the Health Sciences.*

SCANDINAVIAN (Scan)

Professor
Nils Hasselmo, *chairman*
Marion Nelson
Cecil Wood

Associate Professor
Meri Lehtinen
J. Allen Simpson

Assistant Professor
Luther Askeland
William Mishler

Instructor
Kaaren Grimstad
Mariann Tiblin

Prerequisites—For major work in Scandinavian languages and literature, 27 credits, 18 of which must be in Scandinavian, and reading knowledge of any one of the Scandinavian languages. Candidates lacking some or even all of these prerequisites may be admitted on the basis of work in related fields.

Language Requirement—Candidates for the Master's degree in Scandinavian languages and literatures must have reading knowledge of one modern language other than the language of their major field. French or German would be acceptable.

Requirements for the Degree of Master of Arts

General Requirements—In addition to the specific requirements listed below, the candidate for a Master's degree in Scandinavian is expected to have (1) a reading and speaking knowledge of one modern Scandinavian language, and a reading knowledge of the other two; (2) a general acquaintance with all periods of Scandinavian literature; and (3) a general acquaintance with the history of the Scandinavian languages.

Required Courses—(1) Proseminar in Scandinavian Languages and Literature (2-4 credits) and (2) Bibliography and Methods (2-4 credits). These seminars should be taken in the first fall and winter quarter a graduate student is registered.

The M.A. Program—There are no specific course requirements other than those specified above. It is recommended that the student select courses representing different subfields (the drama, the novel, medieval literature, Old Norse, linguistics, etc.) rather than concentrate all or most courses within a single subfield. The selection of courses should be made in consultation with the director of graduate study.

Under Plan A, a student must have a B.A. degree in Scandinavian or equivalent training, and must complete a minimum of 27 graduate credits, including at least 18 credits in the major and 9 credits in the minor.

Under Plan B, the student with a B.A. degree in Scandinavian from the University of Minnesota (or with equivalent training) must complete a minimum of 45 credits, including at least 21 credits in the major and 18 credits in at least two related fields with a minimum of 6 credits in each. Students without an undergraduate major in Scandinavian or equivalent knowledge are expected to complete the work for *one* of the undergraduate sequences entitled Introduction to Danish/Norwegian/Swedish Literature. If these courses are taken for credit, the credits do not count towards a graduate degree.

Requirements for the Degree of Doctor of Philosophy

Filing Programs—The departmental *provisional* program and a comprehensive reading list must be filed with the student's adviser not later than the second quarter after the student has been admitted as a Ph.D. student. The *official* program, together with an *official* transcript must be filed with the Graduate School office five months before the preliminary oral examination is to be taken. The program must be signed by the student's adviser and the director of graduate study in the minor field.

Language Requirement—The following must be completed before the preliminary examinations: (a) two languages outside the major area, one of which must be German or French (usually passed for the M.A.); Modern Icelandic or Finnish may be used as the second language; (b) a thorough reading and speaking knowledge of Danish, Norwegian, or Swedish and a thorough reading knowledge of the two languages not chosen as the main language; (c) a reading knowledge of Old Norse.

Courses—There are no required courses for the Ph.D. Students who intend to submit a Ph.D. program without or with a minimum of courses (less than 75-80 credits) should consult the director of graduate study concerning a statement to be submitted with their Ph.D. program. This statement should outline the work the student wants to have considered in place of course work.

Credits—Depending on the previous training and the strength of the candidate, from 75-100 credits are required beyond the B.A., of which 21 must be in the minor field (in the traditional minor the minimum is 18 credits, providing these are supplemented by 3 credits in a related field). For the "no course" option, see above.

Comparative Literature—For information on this program, see the Comparative Literature section of this bulletin.

Courses identified by the §§ symbol require no knowledge of the Scandinavian languages except for majors in Scandinavian.

5-201. SCANDINAVIAN LITERATURE FROM THE LATE MIDDLE AGES TO THE ENLIGHTENMENT. (4 cr; prereq 8 cr in literature and a reading knowledge of a Scandinavian language; offered alt yrs)
Representative literary works from the 14th century to Bellman and Holberg.

5-202. FROM ROMANTICISM TO THE MODERN BREAKTHROUGH. (4 cr; prereq 8 cr in literature and a reading knowledge of a Scandinavian language; offered alt yrs)
Works of Romantic and early realistic authors.

5-404. HISTORY OF FINNISH. (4 cr)
Internal history of Finnish; special emphasis on its relationship to other Finno-Ugric languages.

5-411. STRUCTURE OF FINNISH. (4 cr)
Analysis of phonology, morphology, and syntax of modern Finnish.

5-421§§. FINNISH FOLKLORE: THE KALEVALA. (4 cr; offered alt yrs)
Finnish national epic from a folkloristic point of view. All readings in translation.

5-501§§. SCANDINAVIAN MYTHOLOGY. (4 cr) Grimstad
Study of Scandinavian myths based on the Poetic Edda and the Prose Edda. All readings in translation.

5-502§§. THE ICELANDIC SAGA. (4 cr) Grimstad
Literary study of the Saga literature, its origins and development. All readings in translation.

5-503§§. SCANDINAVIAN FOLKLORE. (4 cr)
Literary and folkloristic investigation of the Scandinavian ballad and folk tale. All readings in translation.

5-511. SKALDIC POETRY, ITS METHOD. (4 cr; prereq a reading knowledge of Old Icelandic: offered alt yrs)
Detailed analysis of a representative selection of Skaldic poetry and its forms and method.

5-601§§. INGMAR BERGMAN IN THE CONTEXT OF MODERN SCANDINAVIAN LITERATURE. (4 cr) Mishler
Presentation of the literary and cultural environment in which Bergman has developed. Readings in Strindberg, Lagerkvist, expressionism, Bergman's own plays and film scripts. All readings in translation.

5-613§§. CONTEMPORARY SCANDINAVIAN LITERATURE. (4 cr) Mishler
Works of authors representing major trends after 1945. All readings in translation.

5-615§§. IBSEN AND THE BEGINNINGS OF THE MODERN DRAMA. (4 cr) Askeland
Intensive examination of the plays of Ibsen and his role as "founder" of modern European drama.

5-616§§. STRINDBERG AND THE DRAMA IN REVOLT AND TRANSITION. (4 cr)
Strindberg as master of the naturalistic drama and as "the father of modernity" in European and American theatre. All readings in translation.

5-617§§. THE CONTEMPORARY SCANDINAVIAN THEATER. (4 cr)
Emphasis on its "experimental" trends both in dramatic composition and staging. All readings in translation.

5-619. SCANDINAVIAN POETRY SINCE 1890. (4 cr; offered alt yrs) Simpson
Analysis of the work of representative poets since 1890.

5-631§§. THE SCANDINAVIAN NOVEL, 1800-1890. (4 cr) Simpson
The "Modern Breakthrough" of the 1870's and the 1880's, but includes representative works from the preceding periods. All readings in translation.

5-632§§. THE SCANDINAVIAN NOVEL, 1890-WORLD WAR I. (4 cr) Simpson
Representative novels chosen from the authorship of Hamsun, Strindberg, Soderberg, Jensen, others. All readings in translation.

5-633§§. THE SCANDINAVIAN NOVEL FROM WORLD WAR I TO 1950. (4 cr) Simpson
Trends in the Scandinavian novel since World War I. All readings in translation.

5-670§§. TOPICS IN SCANDINAVIAN LITERATURE. (4 cr)
Topic to be selected by instructor and announced in advance of first class period. Open to majors and non-majors. All readings in translation.

5-701, 5-702. OLD NORSE LANGUAGE AND LITERATURE. (4 cr per qtr)
Acquisition of a reading knowledge of Old Icelandic: introduction to the linguistic, philological, and literary study of Old Norse language and literature.

5-704. HISTORY OF THE SCANDINAVIAN LANGUAGES. (4 cr) Hasselmo
Development of the Scandinavian languages from the early Middle Ages to the present with emphasis on cultural history.

5-711. STRUCTURE OF THE SCANDINAVIAN LANGUAGES. (4 cr; prereq introductory course in linguistics or ‡; offered alt yrs) Hasselmo

5-712. SCANDINAVIAN HISTORICAL LINGUISTICS. (4 cr; prereq introductory course in linguistics or ‡; offered alt yrs) Hasselmo
Internal history of Danish, Norwegian, and Swedish.

5-721, 5-722. MODERN ICELANDIC. (1 cr per qtr; prereq knowledge of Old Icelandic or ¶5-701, 5-702)
Modern Icelandic phonology and grammar; reading of texts.

5-970. DIRECTED STUDIES. (1-15 cr)
Study of topics not covered by regular courses; readings in Scandinavian literature in the original.

8-201. PROSEMINAR IN SCANDINAVIAN LANGUAGES AND LITERATURE. (2-4 cr; required of all graduate majors)
Discussion of problems and approaches by staff members representing different specialties.

8-202. BIBLIOGRAPHY AND METHODS. (2-4 cr; required of all graduate majors) Tiblin

8-501, 8-502. SEMINAR: MEDIEVAL SCANDINAVIAN LANGUAGES AND LITERATURE. (2-4 cr per qtr; offered when feasible)

8-511, 8-512. SEMINAR: SCANDINAVIAN LINGUISTICS. (2-4 cr per qtr; offered when feasible)

8-601, 8-602. SEMINAR: SCANDINAVIAN NOVEL. (2-4 cr per qtr; offered when feasible)

8-611, 8-612. SEMINAR: SCANDINAVIAN DRAMA. (2-4 cr ptr qtr; offered when feasible)

8-621, 8-622. SEMINAR: SCANDINAVIAN POETRY. (2-4 cr per qtr; offered when feasible)

8-631, 8-632. SEMINAR: SCANDINAVIAN CRITICISM. (2-4 cr per qtr; offered when feasible)

8-970. RESEARCH IN SCANDINAVIAN LANGUAGES AND LITERATURE. (1-6 cr [may be repeated])
Guided research for advanced graduate students.

SLAVIC AND EAST EUROPEAN LANGUAGES

Associate Professor
Wassilij Alexeev

Assistant Professor
Adele K. Donchenko, *chairman*
Keith Armes
Eugene M. Kleiner
Catherine Kulesov
Marilyn J. Sjoberg

Instructor
Arthur G. Hudgins, *director of graduate study*

No graduate degrees are offered at present. Graduate students with a minimum of 2 years' college study of Russian language or the equivalent may offer a minor program from the following courses, with the approval of the adviser in the Department of Slavic and East European Languages.

Russian (Russ)

5-021. SOVIET UNION STUDY TOUR. (6-18 cr; prereq △ based on oral, written exams)
Intensive language study program at the University of Leningrad. Six weeks summer program for students with minimum 2 years college Russian, 14 weeks semester program for students with minimum 3 years Russian.

5-201/5-202/5-203. SOVIET RUSSIAN LITERATURE IN TRANSLATION. (4 cr per qtr) Armes
Course conducted in English.

5-204. 19TH-CENTURY RUSSIAN CRITICISM. (4 cr) Alexeev
Analysis and discussion of works of major Russian literary critics of the period, in their literary, political, and social implications.

5-301. RUSSIAN POETRY: 19TH CENTURY. (4 cr)

5-401. DOSTOEVSKY. (4 cr) Hudgins
Analytic approach to novels of Dostoevsky.

5-403. GOGOL. (4 cr)
Study of earlier and major works of N. V. Gogol.

5-404. TOLSTOY. (4 cr) Hudgins
Tolstoy's novels, stories, and dramas.

5-406. PUSHKIN. (4 cr) Hudgins

5-407. THE PLAYS OF ANTON CHEKHOV. (4 cr)
Early short works and major plays of Anton Chekhov.

5-409. THE 19TH-CENTURY RUSSIAN NOVEL. (4 cr)
The Russian realistic novel from its origin to its decline, together with social, political and intellectual circumstances which led to its emergence as the dominant genre of the "Age of Realism" in Russia.

5-501. INTELLECTUAL TRENDS IN 19TH-CENTURY RUSSIA. (4 cr) Alexeev
Intellectual and social movements in the 19th century in their relation to literary developments of that period.

5-701/5-702. STRUCTURE OF MODERN RUSSIAN. (4 cr per qtr; prereq 1-106 or ♯) Kleiner

5-704/5-705. HISTORY OF RUSSIAN LANGUAGE. (4 cr per qtr; prereq 1-106 or equiv)
Linguistic analysis of historical development of Russian language.

5-970. DIRECTED READINGS. (1-3 cr per qtr; prereq ♯)

Slav 5-701/5-702. OLD CHURCH SLAVIC. (4 cr per qtr; prereq Ling 3-005 or ♯) Kleiner
Introduction to Slavic linguistics.

Serb 5-970. DIRECTED READINGS. (1-4 cr per qtr; prereq ♯)

Plsh 5-301. CONTEMPORARY POLISH DRAMA. (4 cr)

Plsh 5-970. DIRECTED READINGS. (1-4 cr per qtr; prereq ♯)

SOCIAL WORK (SW)

Professor

Alan Wade, *director*
John C. Kidneigh, *director of graduate study*
Chester Bower
Beulah E. Compton
William Hoffmann
Gisela Konopka
Mayo K. Newhouse
Richard Sterne
Dorothy A. Whitmore
Helen C. Yesner

Associate Professor

Peter W. Chommie
Miriam R. Cohn

Assistant Professor

James L. Brusseau
Susan Goldman
Annalee Stewart

Lecturer

Ruth B. Teeter

Instructor

Gertrude Friedman
Burton Galaway
James Wiebler

Prerequisites—An applicant of satisfactory scholastic record, character, and professional qualifications whose Bachelor's degree was granted by a recognized college or university may be admitted by the dean of the Graduate School upon recommendation of the Admissions Committee of the School of Social Work.

A candidate for admission to the School of Social Work must present 39 quarter credits in social sciences, i.e., in sociology, political science, economics, psychology, history, or anthropology, including one or more courses in at least three of these social sciences.

Application blanks and instructions regarding admission may be secured from the School of Social Work, 909 Social Sciences Building, University of Minnesota, Minneapolis, Minnesota 55455.

Applications and transcripts in duplicate must be filed at least 6 months prior to the opening of the quarter in which the student expects to register. Beginning graduate students are admitted only fall quarter. Persons with previous training and experience may be admitted at the quarter which makes progression from their previous training feasible.

An application for admission is considered first by the graduate faculty of the School of Social Work, then recommended to the dean of the Graduate School for approval and admission. Acceptance of candidates is based upon evidence of ability to meet standards of graduate work as indicated by high grades, including psychological tests, and evidence of stability of personality and aptitude in interpersonal relationships.

Advanced standing may be granted for work done in other approved schools of social work, limited by the rules stated herein.

Language Requirement—None.

Master's Degree—The degree of master of social work requires 2 years of graduate study and will be awarded to students who fulfill the following requirements:

1. Present 90 credits, not less than 60 of which must be exclusive of field work credits, with an average grade of B or better.
2. Complete not less than 35 credits in a concentration approved by the adviser after completing the basic seminars and courses involving knowledge and values, administration and research offered in the first graduate year.
3. Complete research requirements involving knowledge of theory, method (including statistics), design, and production of an acceptable paper.
4. Earn not less than 18 practicum credit hours at the University of Minnesota to be satisfied by field work and/or research practicum.

5. Earn not less than 45 credit hours in residence at the University of Minnesota with an average grade of B or better.
6. Not more than 45 credit hours will be accepted by transfer and then only if earned in an accredited school of social work. Credits accepted for transfer shall show an average of B or better.
7. Credits earned in extension courses will not be applicable on degree requirements unless the student is admitted to the Graduate School before taking the course. Not more than 9 credit hours earned in extension will be accepted in any case.
8. All credits offered for the degree must have been earned within 7 years preceding the quarter in which the degree is conferred.
9. Following completion of 40 graduate credits, not less than 15 of which must have been earned at the University of Minnesota, and not later than the opening of the quarter preceding the quarter in which the degree is to be conferred, the student shall submit, through the major adviser, a program of all credits presented for the degree upon the appropriate degree program form.

Doctor's Degree—Students who have the Master's degree in social work from this school, or the comparable Master's degree from a school of social work accredited by the Council on Social Work Education, may, if their records are distinctly superior, become candidates for the Ph.D. degree in social work (requiring at least 2 years of post-Master's graduate work).

A. Special Topics and Reading Courses

5-010. SPECIAL TOPICS IN SOCIAL WORK. (Cr ar; prereq #)

8-970. READINGS IN SOCIAL WORK. (Cr ar)
Independent study under tutorial guidance.

B. Field Work

8-010. FIELD INSTRUCTION IN SOCIAL WORK I. (Cr ar; prereq 8-402 or 8-412 or equiv) Yesner and staff

8-020. FIELD INSTRUCTION IN SOCIAL WORK II. (Cr ar; prereq 8-010) Yesner and clinical field staff
Field practice in social work process under direct supervision.

8-030. FIELD INSTRUCTION IN SOCIAL WORK III. (Cr ar; prereq M.S.W. degree)
Field experience in social work process under direct supervision.

8-090. SEMINAR FOR CLINICAL FIELD INSTRUCTORS. (Cr ar; limited to persons engaged in supervising students in field work) Yesner

C. The Social Services

8-100x. GENERAL SEMINAR: SOCIAL SERVICES. (Cr ar; prereq grad social work students) Newhouse and staff

8-101/8-102/8-103. SOCIAL POLICY AND PROGRAMS. (Cr ar; offered 1973-74 and when feasible) Newhouse
Social policy and social work programs, public and private, in economic security, housing, health, rehabilitation, interpersonal and intergroup relations, education, recreation, corrections and protective functions, and occupational and vocational functions indicating the role of the social work profession.

8-104. SOCIAL POLICY AND PROGRAMS IV-V. (Cr ar; prereq 8-103; offered 1973-74 and when feasible) Newhouse
Continuation of 8-103.

8-111. INTERNATIONAL SOCIAL WELFARE. (Cr ar; prereq #)

8-120. SEMINAR: SOCIAL WORK AS A PROFESSION. (Cr ar; prereq ‡) Kidneigh

8-130. SEMINAR: THE HISTORY OF SOCIAL WORK. (Cr ar; primarily for doctoral students) Konopka
Historical backgrounds of modern social work movement; evolution of theory underlying it.

8-140. SEMINAR: SOCIAL WORK EDUCATION. (Cr ar; prereq M.S.W. degree)

D. Human Growth and Behavior

8-200x. GENERAL SEMINAR: CONCEPTS OF HUMAN BEHAVIOR IN SOCIAL WORK PRACTICE. (Cr ar; prereq grad social work students) Teeter

8-201/8-202. CONCEPTS OF HUMAN GROWTH AND BEHAVIOR IN SOCIAL WORK PRACTICE I. (Cr ar; prereq ¶8-010 or ‡) Teeter, Chommie
Sociopsychobiological factors associated with individual and group development as applied to social work practice.

8-203/8-204. CONCEPTS OF HUMAN GROWTH AND BEHAVIOR IN SOCIAL WORK PRACTICE II. (Cr ar; prereq ¶8-010 or ‡) Teeter
Continuation of 8-201/8-202.

8-205. CONCEPTS OF HUMAN GROWTH AND BEHAVIOR IN SOCIAL WORK PRACTICE III. (Cr ar; prereq ‡)
Psychological factors associated with individual and group development as applied to social work practice.

8-206/8-207. CONCEPTS OF HUMAN GROWTH AND BEHAVIOR IN SOCIAL WORK PRACTICE IV-V. (Cr ar; prereq 8-205, ¶8-020) Teeter, Sterne
Clinical cases of psychosomatic and psychiatric illness; implications for social work practice.

8-208. CONCEPTS OF HUMAN GROWTH AND BEHAVIOR IN SOCIAL WORK PRACTICE VI. (Cr ar; prereq 8-205, ¶8-020) Staff
Use of psychiatric concepts in social work practice.

E. Social Work Practice

8-301. PRINCIPLES OF ADMINISTRATION IN SOCIAL WORK. (Cr ar) Kidneigh
Technical study of process of transforming social policy into social services.

8-305. COMMUNITY ORGANIZATION. (Cr ar) Bower
Process by which groups and individuals within a community work together to equate social services to community need and establish social policy for planning and coordination of social services.

8-306. SOCIAL WORK METHODS FOR WORKING WITH UNIFUNCTIONAL AND LOCAL ORGANIZATIONS. (Cr ar; prereq 8-301, 8-407, ¶8-020) Bower
Principles by which practice can be guided in working toward establishing or implementing social purposes through unifunctional and local organizations.

8-307. METHODS FOR WORKING WITH MULTIFUNCTIONAL AND COMPLEX SOCIAL STRUCTURES. (Cr ar; prereq 8-306, ¶8-020) Bower
Principles to guide professional worker in policy-making processes, planning, and implementation of purposes in a complex society.

8-310. SEMINAR: SOCIAL WORK ADMINISTRATION. (Cr ar; prereq 8-102, 8-301, or ‡) Kidneigh

8-320. SEMINAR: COMMUNITY ORGANIZATION. (Cr ar; prereq 8-305) Bower

8-321. SUPERVISION IN SOCIAL CASEWORK. (Cr ar; prereq 8-301, ‡) Compton
Principles applied to supervisory process in agencies offering casework services.

8-322. SUPERVISION IN SOCIAL GROUP WORK. (Cr ar; prereq 8-301, 8-414) Cohn
Principles applied to supervision of volunteers and others working in agencies offering group work services.

8-332. ADMINISTRATION IN SOCIAL GROUP WORK. (Cr ar; prereq 8-301, 8-415) Cohn
Principles applied to subexecutive positions in agencies offering group work services.

8-400x. GENERAL SEMINAR: SOCIAL WORK METHODS. (Cr ar; prereq ‡) Compton, Bower, Cohn, Whitmore

8-402. SOCIAL CASEWORK I. (Cr ar; prereq ¶8-010; offered 1973-74 and when feasible) Whitmore
Philosophy and processes, methods and skills of social casework.

8-403, 8-404. SOCIAL CASEWORK II-III. (Cr ar; prereq 8-402, ¶8-010; offered 1973-74 and when feasible) Whitmore
(Continuation of 8-402) Critical analysis of casework process and development of skill.

8-405, 8-406, 8-407. SOCIAL CASEWORK IV-V-VI. (Cr ar; prereq 8-404, ¶8-020) Whitmore, Compton
Advanced casework method focused primarily on treatment methods.

8-412. SOCIAL GROUP WORK I. (Cr ar; fall qtr open to social work students only, spring qtr open to other grad students, offered 1973-74 and when feasible) Konopka, Cohn

8-413. SOCIAL GROUP WORK II. (Cr ar; prereq 8-412, 8-010) Cohn
(Continuation of 8-412) Role of worker in group process, group formation, and social forces, focused on development of skill. Introduction to rationale of program as tool.

8-414. SOCIAL GROUP WORK III. (Cr ar; prereq 8-413, ¶8-010; offered 1973-74 and when feasible) Cohn
Intensified understanding of individualization process in working with groups. Skill and planning in executing program activities.

8-415. SOCIAL GROUP WORK IV. (Cr ar; prereq 8-414, ¶8-020; offered 1973-74 and when feasible) Konopka
Advanced group work method.

8-416, 8-417. SOCIAL GROUP WORK V-VI. (Cr ar; prereq 8-415 or ‡) Konopka
Group work with individuals in groups for treatment purposes, group therapy.

8-901/8-902. RESEARCH. (Cr ar) Chommie, Sterne
Research design and analysis.

8-980. SEMINAR: RECENT RESEARCH IN SOCIAL WORK. (Cr ar; primarily for doctoral students) Staff

8-990. SPECIAL STUDIES IN SOCIAL WORK. (Cr ar; fulfills 9-cr degree project) Chommie, Sterne

8-991/8-992/8-993. GENERAL SEMINAR: SOCIAL WORK. (Cr ar; prereq M.S.W. degree and admission to doctoral program) Kidneigh

SOCIOLOGY (Soc)

Professor

Theodore R. Anderson, *director of graduate study*
Roy E. Carter, Jr.
John P. Clark
David Cooperman
George A. Donohue
Bert L. Ellenbogen
Robert Fulton
Richard H. Hall
Reuben Hill
Arthur L. Johnson
Theodor J. Litman
Don Martindale
Charles E. Ramsey
Ira L. Reiss
Caroline B. Rose
Gregory P. Stone
David A. Ward

Associate Professor

George W. Bohrnstedt, *chairman*
Joan Aldous
Shirley M. Clark
Harold Finestone
Donald G. McTavish
Joel I. Nelson
Stephan P. Spitzer
Irving Tallman

Assistant Professor

Brian C. Aldrich
Ronald E. Anderson
Robert E. Kennedy, Jr.
Neil J. MacKinnon
Dario Menanteau
Paul D. Reynolds
Roberta G. Simmons
Richard E. Sykes

For specific information about graduate study in sociology, financial aid, and admission procedures, applicants should write to the director of graduate study in the Department of Sociology. All application material for admission should reach the Graduate School and financial aid requests should reach the department no later than January 15 for fall quarter entry. While applications will be considered at other times, chances for admission are greatly reduced.

Admission Requirements—Acceptance by the department's Admissions and Awards Committee is based on general ability, knowledge of basic tools and skills (e.g., GRE math and verbal scores, statistics, research methods, English, computer usage, and math), knowledge of basic sociology (usually 18 quarter credits in undergraduate work or M.A. in sociology or closely related field), creativity and interest and ability to join in a vigorous milieu of inquiry. A sample of previous writing is requested (course term paper, etc.). Admission is competitive among those applying for a given cohort. Special consideration is given to minorities. More detailed information is available from the department.

Master's Degree—The emphasis of graduate study in the Department of Sociology is upon the Ph.D. program. The Master's degree is offered under Plan A and Plan B or, if the student desires, in the normal progression toward the Ph.D.

Doctor's Degree—The Ph.D. program of study is detailed in the department's *Guide to Graduate Study*. In outline, the program consists of a period of concentrated course work (or its equivalent), extensive preparation in the student's area of specialization, a significant research experience, preparation in a special research technique and a doctoral dissertation.

Criminology and Deviance

5-105. CONTEMPORARY PENOLOGY. (4 cr; prereq 3-101, or ‡) Ward
Prisons as social organizations; description and evaluation of current treatment programs for adult offenders.

5-111. SOCIOLOGY OF DEVIANT BEHAVIOR. (4 cr; prereq 3-101, or ‡) Finestone
Various sociological conceptions of the nature of deviant behavior, the social processes associated with the careers of deviants, and the relationship of deviancy to the problems of social control.

5-115. ADULT PAROLE AND PROBATION. (4 cr; prereq 3-101, or ‡) Finestone
Critical examination of problems and practices in supervision of adult criminals.

5-121. LAW AND LEGAL SYSTEM FOR CORRECTIONAL AND SOCIAL WORKERS. (4 cr)
Law and judicial process for social workers, particularly those engaged in correctional field.

5-125. POLICE PROBLEMS AND PRACTICES IN THE UNITED STATES. (4 cr; prereq 3-101, or ‡) Clark
Personnel, organization, and public relations of police forces, with special attention to successful techniques of integrating police work with other community agencies.

5-131. INSTITUTIONAL TREATMENT OF JUVENILE DELINQUENTS: PROBLEMS AND PRACTICES. (4 cr)
Current problems of institutional treatment of juvenile offenders and contributions of different professions to treatment.

5-135. WHITE COLLAR CRIME. (4 cr)
Analysis of various types of white-collar crime, broadly construed; roots in American society; responses by theoreticians, amateur and professional politicians.

5-138. ISSUES IN THE ADMINISTRATION OF CRIMINAL JUSTICE. (4 cr; prereq 3-101) Ward
By analyzing a number of issues facing police, prosecutors, defense attorneys, courts, and correctional agencies, course will focus attention upon the process of the administration of criminal justice.

5-141. DELINQUENT BEHAVIOR. (4 cr; prereq 3-101) Clark
Critical analysis of nature of delinquent behavior and its "causes"; consideration of help that understanding of causes can give to its modification and its prevention.

5-145. MODERN AGENCIES FOR CONTROL OF JUVENILE DELINQUENCY. (4 cr; prereq 3-101, 5-141) Clark
Functions of school, of welfare, casework, and group work agencies, of juvenile bureau in police departments, juvenile court, detention home, probation services, clinics, and integrated state agencies like Minnesota Youth Conservation Commission in prevention and modification of delinquent behavior.

8-101, 8-102, 8-103. SEMINAR: RESEARCH IN SOCIAL DEVIANCE. (3 cr per qtr) Clark, Finestone, Spitzer, Ward

8-111, 8-112, 8-113. SEMINAR: RESEARCH PROBLEMS IN JUVENILE DELINQUENCY. (3 cr per qtr; offered when feasible)

Sociology of Religion

5-151. RELIGION AS A SOCIAL INSTITUTION. (4 cr; prereq 1-001 or 1-005 and 1-006 or ‡) Johnson
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.

8-151, 8-152, 8-153. SEMINAR: SOCIOLOGY OF RELIGION. (3 cr; prereq 5-151 or ‡) Johnson
Intensive study of a major social institution; methodological techniques, problems, theoretical models, and specialized areas in sociological study of religion.

Social Psychology

5-201. INTRODUCTION TO SOCIAL PSYCHOLOGY. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡)
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.

5-201H. HONORS COURSE: INTRODUCTION TO SOCIAL PSYCHOLOGY. (4 cr; prereq ‡) Stone

5-205. SYMBOLIC INTERACTION. (4 cr; prereq 5-201 or ‡) Stone, Spitzer
Methods of acquiring knowledge in social psychology; analysis of outstanding pieces of research. Social psychology of small groups, mass behavior, and making of political and economic choices. A major aim is to familiarize student with current thinking and research in this field in light of concepts and theories presented in introductory course in social psychology.

5-211. SOCIAL PROCESSES IN SMALL GROUP SETTINGS. (4 cr; prereq 5-201 or ‡)
Introduction small group research and theory focusing on both laboratory and nonlaboratory investigation of areas such as interpersonal exchange, communication structures, status and power relations, coalition formation, reference groups, role differentiation, group uniformity, social influence, and problem-solving behavior. Laboratory to be arranged.

8-201, 8-202, 8-203. SEMINAR: ATTITUDES AND COGNITIVE PROCESSES. (3 cr per qtr; offered when feasible) Spitzer, Stone

8-208. SOCIAL LINGUISTICS. (3 cr; prereq ‡)
Social communication in groups, organizations, and institutions.

8-211, 8-212, 8-213. SEMINAR: RESEARCH IN SMALL GROUPS. (3 cr per qtr) Tallman

8-215. THEORIES OF SOCIAL PSYCHOLOGY. (3 cr)
For first year graduate students. 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

5-301. SOCIAL MOVEMENTS IN A CHANGING SOCIETY. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡)
Factors underlying social change in modern mass society. Consideration of recent researches on social movements, reform and revolution, culture contact, impact of rapid technological change. Individual and social structure under conditions of rapid social change.

5-305. SOCIAL LIFE AND CULTURAL CHANGE. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡) Martindale
Theories of social change; particular attention to their methodological problems. Materials drawn from comparative social thought and structure of antiquity utilized as basic data for analysis.

5-311. SOCIOLOGY OF CONFLICT. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡) Cooperman
Manifest forms of antagonism among groups of persons; causes of conflict; methods of resolving through accommodations; role of conflict and social change.

5-315. LATIN-AMERICAN SOCIETIES IN TRANSITION. (4 cr; prereq 10 cr in sociology, economics, or political science, or ‡) Ellenbogen, Menanteau
Relationship of population, technology, and organizational structure to levels of modernization among Latin-American nation states. Attention given to differentiation, diffusion, innovation, and social conflict as precipitants of social change.

8-305. SEMINAR: PERSPECTIVES OF SOCIAL AND ECONOMIC DEVELOPMENT—LATIN AMERICA. (3 cr; prereq ‡) Ellenbogen
Evolution of an "orientation" toward development in Latin America will be analyzed. Strategies and tactics of planned change at national, regional, and community levels. Selected methodological and conceptual issues related to development will be examined.

Popular Culture and Public Opinion

5-351. SOCIOLOGY OF POPULAR CULTURE. (4 cr; prereq 15 cr in sociology)
Social preconditions and social effects of popular culture, with an analysis of selected popular arts.

5-355. OPINION AND COMMUNICATION: SOCIAL FACTORS. (4 cr; prereq sr, 1-001 or 1-005, 1-006 or 5-201 or Psy 5-201 or ‡) Carter
Processes of opinion formation and change in relation to personality and social structure will lay groundwork for analysis of flow of public communications through society and impact of selected types of mass communication on particular audiences.

8-351, 8-352, 8-353. SEMINAR: RESEARCH PROBLEMS OF MODERN MASS SOCIETY. (3 cr per qtr; offered when feasible)

Social Organization and Social Structure

5-401. SOCIAL ORGANIZATION. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡) Aldrich, Sykes
Organization and structure of social groups; basic culture patterns of economic, political, and social institutions. Integration and disintegration of social groups and institutions. Essentials of social dynamics.

5-401H. HONORS COURSE: SOCIAL ORGANIZATION. (4 cr; prereq ‡) Hall

5-405. SOCIAL STRATIFICATION AND MOBILITY. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡) Fulton, Nelson
Analysis of form and content of hierarchical arrangements. Relationship of hierarchical arrangements to problems of social order and individual behavior.

5-405H. HONORS COURSE: SOCIAL STRATIFICATION AND MOBILITY. (4 cr; prereq ‡)

5-411. FORMAL ORGANIZATIONS. (4 cr; prereq 1-001 or 1-005, 1-006, 15 cr in sociology, psychology, political science, or economics) Hall, Aldrich, Reynolds
Sources, types, and consequences of variations in organizational structures and functions. Varying organizational arrangements as they affect and are affected by changes in input and output. Bureaucracy and its impact from a comparative perspective.

5-411H. HONORS COURSE: FORMAL ORGANIZATIONS. (4 cr; prereq ‡) Hall

5-415. COMPARATIVE SOCIAL ORGANIZATIONS. (4 cr; prereq 20 cr in sociology, economics, or political science, or ‡)
Demographic and ecological characteristics, stratification system, institutional organization, and forms of association in several modern nations other than the United States.

5-421. OCCUPATIONAL SOCIOLOGY. (4 cr; prereq 6 cr in sociology or ‡) Hall
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.

8-401, 8-402, 8-403. SEMINAR: RESEARCH IN LARGE-SCALE ORGANIZATION. (3 cr per qtr; perereq 5-411) Hall

8-411. SEMINAR: RESEARCH PROBLEMS IN SOCIAL STRATIFICATION. (3 cr; prereq 5-405 or ‡) Nelson
Problems of research in social stratification with particular attention to theory and methodology for understanding stratification as a structural or organizational variable.

8-415. THEORIES OF SOCIAL ORGANIZATION. (3 cr)
For first-year sociology graduate students. Survey of social organization; presentation and critical analysis. Examination of major social organizational concepts, theoretical perspectives, and current theoretically relevant literature.

Family Sociology

5-501. THE FAMILY. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡) Johnson, Reiss
Evolution of family, development of unity or disunity, roles of the several members of family, methods of investigation of family.

5-501H. HONORS COURSE: THE FAMILY. (4 cr; prereq ‡)

5-505. FAMILY DEVELOPMENT. (4 cr; prereq 1-001 or 1-005, 1-006, 5-201, CPsy 3-301 or ‡) Aldous, Hill
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.

5-506. NEW FORMS OF THE FAMILY. (4 cr; prereq 1-001 or 1-005, 1-006) Reiss
Evolving courtship, marital, and family forms. New concepts of sexuality, masculinity-femininity, familial roles, legitimacy, communal living, examined with the goal of affording perspective on the developing family system.

5-511. COMPARATIVE FAMILY ORGANIZATION. (4 cr; prereq 1-001 or 1-005, 1-006, Psy 1-001) Aldous, Reiss
Comparison of family organization and modes of functioning in selected major world civilizations. Emphasis on interrelations of family with economic system and urbanization, and family influences on personality formation.

5-515. SOCIOLOGY OF FAMILY FORMATION. (4 cr; prereq 1-001 or 1-005, 1-006) Reiss
Analysis of courtship structure in American society by class, ethnicity, religion, and history. Courtship and other institutions.

8-501, 8-502. SEMINAR: CONTEMPORARY RESEARCH ON MARRIAGE AND THE FAMILY. (3 cr per qtr; offered when feasible) Hill

8-505. SEMINAR: THEORY DEVELOPMENT AND THE FAMILY. (3 cr; prereq ‡) Aldous, Hill
Consideration of theory and strategies for developing theory with particular reference to family areas.

8-511. SEMINAR: DEVIANT BEHAVIOR AND THE FAMILY. (3 cr) Reiss
Various explanations of deviance utilizing deviant behavior related to the family such as illegitimacy and homosexuality.

8-514, 8-515, 8-516. SEMINAR: RESEARCH PROBLEMS IN THE FAMILY. (3 cr per qtr; offered when feasible) Hill, Johnson

8-521, 8-522, 8-523. SEMINAR: SOCIAL PSYCHOLOGY OF MARRIAGE. (3 cr per qtr; prereq ‡) Neubeck, Hey
Same as Psy 8-214, 8-215, 8-216.

Demography

5-551. WORLD POPULATION PROBLEMS. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡) Kennedy
Population policy, both historical and present day, in Europe, Asia, and other selected areas but with special emphasis on United States. Some discussion given to field of population and power politics.

5-555. POPULATION THEORY. (4 cr; prereq 5-551 or ‡) Kennedy
Emphasizes cultural and social phases of population change; particular reference to birth rates, death rates, and migration. Implications of population change.

5-555H. HONORS COURSE: POPULATION THEORY. (4 cr; prereq ‡) Kennedy

5-561. INTRODUCTION TO MATHEMATICAL DEMOGRAPHY. (4 cr, §PubH 5-411; prereq 5-551 or ‡)
Basic demographic measures and concepts of fertility, mortality, and migration. Introduction to stable population methods and demographic estimates from incomplete data.

8-551, 8-552, 8-553. SEMINAR: PROBLEMS IN POPULATION RESEARCH. (3 cr per qtr) Kennedy

Urban Sociology

5-601. URBAN SOCIOLOGY. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡) Stone, T Anderson
Introduction to the study of cities; urban ecology; urban institutions and urban way of life.

5-605. URBANIZATION AND SOCIAL POLICY. (4 cr; prereq 5-601 or ‡) Cooperman
Contemporary changes in urban processes that are considered problematic and the responses and policies of public groups. Analysis of interrelationships of social, cultural, economic, political factors in development of urban problems. Study of models of urban systems and social policy formation. Methods of social cost analysis and formation of policy alternatives.

5-611. PLANNING. (4 cr, §Arch 5-132; prereq sr) Stone
Social, economic, political, geographic, and technical phases of modern city planning.

8-601, 8-602. SEMINAR: RESEARCH IN URBAN SOCIOLOGY. (3 cr per qtr) Stone

Rural Sociology

5-651. RURAL SOCIAL INSTITUTIONS. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡) Donohue
Factors in the rural environment which condition the functioning of rural social institutions, including family, school, church, local government, health, and welfare.

5-661. RURAL COMMUNITY ANALYSIS. (4 cr; especially for all persons interested in rural community organization, rural teaching, extension work, and related fields; prereq 1-001 or 1-005, 1-006, sr or ‡) Donohue
Emphasis on tools, techniques, and methods of making community field studies.

5-671. COMPARATIVE RURAL SOCIETIES: LATIN AMERICA. (4 cr; prereq 10 cr in sociology, economics, or political science or ‡) Ellenbogen, Menanteau
Analysis of social and cultural change in Latin America. Consideration given to demographic and ecological characteristics, institutional structure and its accompanying associations, linkages with "outside" and "worldview."

5-675. WORLD FOOD SUPPLY PROBLEMS. (4 cr, §AgEc 5-790, §HE 5-381, §PlPa 5-220, §VM 5-790; prereq major in agriculture, veterinary medicine, nutritional sciences, social science field or ‡...grad students by △ only) Ellenbogen
Multidisciplinary approach in examining social, economic, and technical problems of feeding the world's growing population. Principles sought from the social and economic sciences, the animal sciences, and the nutritional sciences for their application to food problems.

8-651, 8-652, 8-653. SEMINAR: RURAL SOCIOLOGY. (3 cr per qtr; offered when feasible)

8-661. SEMINAR: RESEARCH METHODS IN RURAL SOCIOLOGY. (3 cr; offered when feasible)

Social Theory

5-701. ANALYTICAL SOCIAL THEORY. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡) Martindale
Major problems of sociological theory; main types of sociological theory (positivistic, rationalistic, idealistic); major theoretical concepts.

5-705. BACKGROUNDS OF MODERN SOCIAL THOUGHT. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡) Martindale
Survey of major trends of social thought from Renaissance to 19th century; special attention to factors contributing to origin of sociology.

5-711. ELEMENTS OF SOCIOLOGICAL ANALYSIS. (4 cr; prereq 9 cr in sociology)
Examination and analysis of premises upon which social theories are developed. Examination and analysis of construction of social theories.

8-701, 8-702, 8-703. SEMINAR: SOCIAL THEORY. (3 cr per qtr) Martindale

8-711, 8-712†. SEMINAR: PRINCIPLES OF SOCIOLOGY. (3 cr per qtr) Stone

8-714, 8-715, 8-716. SEMINAR: SELECTED PROBLEMS IN COMPARATIVE SOCIOLOGY. (3 cr per qtr; offered when feasible)

8-721. SEMINAR: SOCIOLOGY OF KNOWLEDGE. (3 cr) Cooperman
Systematic study of social factors concerning acquisition, production, growth, and diffusion of knowledge (ideas, belief systems, ideologies, artistic and scientific productions).

8-724. SEMINAR: SOCIOLOGY OF SCIENCE. (3 cr; offered when feasible)

8-725. SEMINAR: EVALUATION OF THEORY. (4 cr)
Fundamental issues in philosophy of science (concept formations, scientific statements, forms of theory, evaluation of theory, strategies for developing science); experience in evaluating theory.

Sociology of Political and Legal Institutions

5-755. SOCIAL STRUCTURE AND POLITICAL BEHAVIOR. (4 cr; prereq 1-001 or 1-005, 1-006) Tallman, Cooperman
Analysis of 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.

8-751, 8-752, 8-753. SEMINAR: METHODS FOR THE EVALUATION OF SOCIAL ACTION PROGRAMS. (3 cr per qtr) Finestone

8-761. SEMINAR: SOCIOLOGY OF LAW. (3 cr) Cooperman
History of sociological jurisprudence and the sociology of law. Research studies in family law, crime and punishment, functioning of juries, the legal profession. The social scientist as an expert witness. Sociology and social psychology in civil rights decisions. Social factors affecting decisions of police, prosecutors, and judges.

Methodology

5-801. COMPUTER USAGE IN SOCIAL RESEARCH. (4 cr; prereq 3-801, 3-802, 3-803, or equiv recommended; 3 hrs lect, 2 lab hrs per wk) 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.

8-801, 8-802, 8-803. SEMINAR: RECENT DEVELOPMENTS IN SOCIOLOGICAL RESEARCH TECHNIQUES. (3 cr per qtr; offered when feasible) McTavish

8-811. METHODS OF SOCIAL RESEARCH. (4 cr; prereq 3-802, 3-803 or ‡) T Anderson, Bohrnstedt, McTavish, Ramsey
Survey of methods; advantages and limitations of major methods when applied to specific types of problems.

8-812. INTERMEDIATE STATISTICS FOR SOCIOLOGISTS. (4 cr; prereq 3-801, 3-802, 3-803, or ‡) T Anderson, Bohrnstedt, McTavish
Intermediate level bivariate and multivariate correlation and regression, analysis of variance, analysis of covariance and dummy variable techniques.

8-813. DATA ANALYSIS. (4 cr; prereq 8-812 or ‡) T Anderson, Bohrnstedt, McTavish
Application of multivariate techniques using the computer. Factor analysis, methods of casual analysis elementary stochastic models and problems in measurement.

8-814, 8-815, 8-816. SEMINAR: DESIGN OF SOCIOLOGICAL RESEARCH. (3 cr per qtr)

8-817/8-818. FIELD WORK AND LABORATORY TRAINING IN SOCIAL RESEARCH. (5 cr per qtr)
Direct experience with a variety of research techniques.

8-831, 8-832, 8-833. MEASUREMENT. (3 cr per qtr; prereq 3-803 or equiv) R Anderson, Tallman
Nature of measurement and its role in theory and research measurement models and techniques of scaling, special problems in measurement analysis.

Sociology of Health and Health Care

5-855. SOCIOLOGY OF MEDICINE AND MEDICAL INSTITUTIONS. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡) Litman
Social factors associated with incidence of physical and mental illness and its treatment. Social organization of medical institutions. Public needs and medical services. Sociology of aging, and social problems of aged.

8-855. SEMINAR: HEALTH AND HUMAN BEHAVIOR. (3 cr; prereq 5-855 or ‡; offered when feasible)
(Same as PubH 267) Social ecology of health; social and personal components of illness; health and the community; social cultural aspects of health care services.

8-861. SEMINAR: SOCIOLOGY OF MENTAL HEALTH AND MENTAL DISORDERS. (3 cr) Spitzer
Social factors on 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 Courses

5-951. MINORITY GROUP RELATIONS. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡) Finestone, Rose
Analysis of ethnic stratification with special focus upon race relations in American society.

5-952. YOUTH IN MODERN SOCIETY. (4 cr; prereq 1-001 or 1-005, 1-006 or ‡) J Clark
Analysis of the role of youth in advanced societies; youth as a social entity; functions of youth in industrialized societies generally with emphasis on their roles in family, education, politics and government, economy and work world, welfare and religion; youth organizations, social movements, and subcultures; emphasis on empirical research and cross-cultural perspective.

5-953. SOCIOLOGY OF EDUCATION. (3 cr, §HEd 5-190; prereq 1-001 or 1-005, 1-006 or ‡) S Clark, Harkins
Advanced studies in social aspects of education including school as socialization process, social structure of education, role of school in social change, and others. Emphasis on theory and empirical research.

5-954. WOMEN AND MEN IN THE UNITED STATES TODAY. (4 cr; prereq 1-001 or 1-005, 1-006 or equiv)
Sociological analysis of position of women *vis à vis* men in United States today; emphasis on changes that result in present situation, how other portions of society are changing and can be changed to adjust to sex role change.

5-956. SOCIOLOGY OF DEATH. (4 cr; prereq jr, or sr, 6 cr sociology, or ‡)
Issues and problems that mortality presents contemporary society.

5-960. TOPICS IN SOCIOLOGY. (4 cr; prereq △)
Specific title will be listed in appropriate class schedule for each section offered in a quarter.

5-970. DIRECTED STUDY. (1-15 cr; prereq ‡)

8-090. TOPICS. (Cr ar; prereq ‡)
Specific titles for each section will be listed in *Class Schedule*. May also be taken as Directed Study (General Seminar) only, by arrangement with an instructor in the department.

8-951. 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.

8-955. SEMINAR: TEACHING SOCIOLOGY ON THE COLLEGE LEVEL. (3 cr; prereq 2nd or 3rd yr sociology grad student or ‡)
Purposes; new developments. Examination of relevant learning theories; opportunity to develop a plan for teaching a course either individually or as part of a team.

8-956. SOCIOLOGY OF DEATH. (3 cr; prereq ‡)
Issues and problems that mortality presents contemporary society.

SOIL SCIENCE (Soil)

Professor

William P. Martin, *chairman, director of graduate study*
Russell S. Adams
Harold F. Arneman
Donald G. Baker
George R. Blake
Alfred C. Caldwell
Rouse S. Farnham
David A. Farrell
Robert G. Gast
Janis Grava
Lowell D. Hanson
Robert F. Holt
William E. Larson
John M. MacGregor
Richard H. Rust
Edwin L. Schmidt
Charles A. Simkins
Cornelius A. Van Doren

Associate Professor

Charles E. Clapp
William E. Fenster
George E. Ham
James B. Swan

Assistant Professor

David F. Grigal

Research Associate

Harvey L. Meredith

Prerequisites—For major work, a good background in chemistry, including quantitative analysis, and college physics is desired. All students should have mathematics through analytic geometry or its equivalent, and instruction in calculus is advisable.

For a minor in soil science, students must satisfy the graduate faculty that their preparation is adequate.

Major and Minor—A graduate student in soil science may concentrate in such areas as genesis and classification, chemistry and fertility, microbiology, microclimatology, or physics. The course of study will vary with the requirements of the area and the interests of the student under supervision of the major adviser. A minor or supporting field will be selected usually in some allied field such as agronomy, botany, chemistry, microbiology, biochemistry, physics, geology, economics, forestry, agricultural engineering and others.

A student minoring in soil science will take the courses acceptable to the minor adviser.

Language or Collateral Field Requirement—For the Master's degree, none. For the Ph.D. degree, either (a) 15 credits in collateral field courses or (b) higher level of proficiency in a single foreign language.

The collateral field may be comprised of a program formulated about *one* of the following suboptions: (a) 15 credits in courses related to, but clearly outside of, the major or minor/supporting programs, (b) 15 credits unrelated to the major or minor/supporting programs, or (c) combinations of a and b in the ratios of 9:6 credits or 6:9 credits.

Higher proficiency in a single foreign language is meant to embody a level of both reading and conversational skill adequate to the use of the language as a professional tool. A foreign student whose native language is other than English may not use it to satisfy this option.

Master's Degree—Offered under Plan A and Plan B. Students contemplating graduate work beyond the Master's degree will take Plan A.

Doctor's Degree—Work for the Ph.D. degree is offered under the general requirements of the Graduate School.

5-114. SPECIAL PROBLEMS IN SOILS. (1-5 cr per qtr [10 cr max]; prereq 1-122 or ‡)
Research, readings, instruction.

5-220. SOIL AND WATER MANAGEMENT AND CONSERVATION. (2 cr; prereq 1-122)
See Soil 3-220.

5-232. SOIL PHYSICS. (4 cr; prereq 1-112, Math 1-111 and 1 yr physics)
Soil structure, compaction, tilth, tillage; water infiltration, retention, availability, movement, and evaporation; heat capacity, flow, air porosity, diffusion, deficiency effects on plants, drainage requirement. Lectures and laboratory.

5-240. MICROCLIMATOLOGY (SOILS). (3 cr; prereq Math 1-111, 10 cr in physics)
Meteorology and climatology in relation to the soil-atmosphere interface with particular emphasis on the microclimate; physical processes taking place within the microclimate; modification of the microclimate by agricultural practices; weather instruments and use of climatic data.

5-310. SOIL CHEMISTRY AND MINERALOGY. (4 cr; prereq 1-122 or ‡; offered 1973-74 and alt yrs)
Basic structure of clay minerals in soils. Chemical composition of mineral and organic matter, ionic exchange and factors affecting ionic movement. Acid, alkaline, calcareous, and alkali soils.

5-333. SOIL ANALYTICAL CHEMISTRY TECHNIQUES. (3 cr; limited to 10 students; prereq 1-122 or 5 cr in physics, one course in analytical chemistry; not offered 1972-73)
Instrumental methods of inorganic and organic chemical analyses in soils. Lectures and laboratory.

5-340. ORGANIC AND PESTICIDAL RESIDUES. (5 cr; prereq 1-122 and 9 cr in biochemistry and/or organic chemistry; not offered 1972-73)
Fate of natural and synthetic organic materials in soil, with emphasis upon the chemical, physical, and biological factors of the soil which influence composition or persistence.

5-412. SOIL FERTILITY EVALUATION. (4 cr; prereq 1-122)
Methods of soil fertility evaluation; soil tests and tissue tests and their use in fertilizer and lime recommendations; fertility demonstration techniques. Lectures, laboratory.

5-420. FERTILIZERS. (3 cr; prereq 1-122 or ‡)
History of the fertilizer industry; manufacture, characteristics, and use of important fertilizer nutrients.

5-430. SOIL FERTILITY. (3 cr; prereq 1-122)
Plant root-soil relationships, chemistry of essential elements in the soil and plant; diagnosing soil deficiencies.

5-512. SOIL GEOGRAPHY. (4 cr; prereq 1-122)
Introduction to soil morphology and classification as essential to understanding distribution patterns of soils. Primary emphasis on soil geography of the state, region, United States and the world; interpretation of this geography with the use of soil maps and aerial photographs in various types of resource development. Lecture, laboratory, field trips.

5-520. SOIL DEVELOPMENT AND CLASSIFICATION. (3 cr; prereq 5-512 or ‡)
Soil profile characteristics; influence of parent material, climate, topography, vegetation, and time on soil development; system of soil classification; world distribution of major soil groups.

5-532. SOILS AND THE ECOSYSTEM. (5 cr; limited to 20 students; prereq course in ecology; offered at Itasca)
Formation and distribution of soils in relationship to vegetation, climate, and other soil-forming factors. Interrelationships of soils in the ecosystem.

5-540. SOIL RESOURCES AND ENVIRONMENTAL RELATIONSHIPS. (4 cr; prereq 1-122 or ‡)
Current types of soil resource concepts, land use as related to soils, and the interactions of technology on the soil environment. Possible short- and long-term effects of fertilizers, soil amendments, and other substances on the soil-water ecosystem.

5-550. ORGANIC SOILS. (3 cr; prereq 1-122)
Formation, classification, and properties of organic soils; their use and management. Lectures and laboratory.

5-612. ECOLOGY OF SOIL MICROORGANISMS. (4 cr; prereq MicB 3-103 or 3-013; offered 1972-73 and alt yrs)
(Same as MicB 5-612) Soil as a microhabitat; the nature of the microbial population of soil; interactions among microorganisms in the soil ecosystem; significant activities of soil microorganisms. Lectures and laboratory.

8-122. ADVANCED SOIL SCIENCE. (3 cr; prereq ‡) Staff
Recent advances in soil classification, chemistry, physics, microbiology.

8-124.* RESEARCH PROBLEMS IN SOILS. (2-5 cr; hrs ar) Staff
Individual laboratory or field work in special problems in a phase of soils other than student's major thesis. Arrangements must be made in advance.

8-128.* SEMINAR: SOILS. (1 cr) Staff
Assigned reading, reports, and discussion on soil topics.

8-250. FLUID FLOW IN SOILS. (2 cr; prereq 5-232, differential equations or ‡; offered 1972-73 and alt yrs) Blake
Flow and behavior of water and air in unsaturated soils. Characteristics of the soil matrix, properties of absorbed water, diffusion of water vapor.

8-322. SELECTED METHODS OF CLAY MINERAL ANALYSES. (3 cr; prereq 5-310 or ‡; offered 1973-74 and alt yrs) Rust
Identification and characterization of clay mineral and clay-size components of pedological importance using methods of analytic chemistry and mineralogy.

8-330. SOIL PHYSICAL CHEMISTRY. (3 cr; prereq physical chemistry, 8-322 or ‡; offered 1973-74 and alt yrs) Gast
Selected topics. Charge characteristics of clays, electric double layer theory, thermodynamics of the soil solution, for exchange and molecular adsorption.

8-620. SOIL ORGANIC MATTER AND MICROBIAL TRANSFORMATIONS. (4 cr; prereq major or minor in soil science or ‡; offered 1973-74 and alt yrs) Adams, Clapp, Ham, Schmidt
Origin, nature, and biochemistry of soil organic matter; microbiological bases of nutrient transformations in soil. Lectures, directed readings, and assigned topics.

SOUTH ASIAN STUDIES

Assistant Professor
Usharbudh Arya
Indira Junghare
Pramod Kale
Brian Silver
Paul Staneslow

Instructor
Supriya Bari
Ram Dayal Munda

The department offers graduate programs leading to the M.A. and Ph.D. in South Asian languages and literatures with special concentration in Bengali, Hindi, Sanskrit, Marathi, and Urdu. For specific information about graduate study in South Asian languages, financial aid, and admission procedures, applicants should write to the director of graduate study in the Department of South Asian Studies. Also, see courses in anthropology, art history, geography, history, international relations and political science.

Bengali (Ben)

5-101/5-102/5-103. BEGINNING BENGALI. (5 cr per qtr)

5-131/5-132/5-133. INTERMEDIATE BENGALI. (5 cr per qtr; prereq 1-103 or 5-103 or ‡)

5-161/5-162/5-163. ADVANCED BENGALI. (4 cr per qtr; prereq 3-033 or 5-133 or ‡)
Reading and discussion of short stories and other literature in class.

5-201/5-202/5-203. READING AND ANALYSIS OF BENGALI LITERARY TEXTS. (4 cr per qtr; prereq 5-163.)
Critical reading of selected works of major Bengali poets and novelists.

5-970. DIRECTED STUDIES. (Cr ar; prereq ‡)
Designed to direct readings of individual students in specialized areas preparatory to research.

5-990. RESEARCH. (Cr ar; prereq ‡)
Advanced course for students seeking guidance in the reading or analysis of specialized material.

Hindi (Hndi)

5-101/5-102/5-103. BEGINNING HINDI. (5 cr per qtr)

5-131/5-132/5-133. INTERMEDIATE HINDI. (5 cr per qtr; prereq 1-103 or 5-103 or ‡)

5-161/5-162/5-163. ADVANCED HINDI. (4 cr per qtr; prereq 3-033 or 5-133 or ‡)
Reading and discussion of short stories and other literature in class.

5-201/5-202/5-203. READING AND ANALYSIS OF HINDI LITERARY TEXTS. (4 cr per qtr; prereq 5-163)
Critical reading of selected works of major Hindi writers.

5-701/5-702. STRUCTURE OF HINDI. (4 cr per qtr; prereq 3-031 or 5-131 or ‡)
Intensive examination of the history and structure of the Hindi language with special attention to syntactic and semantic structure.

5-970. DIRECTED STUDY. (Cr ar; prereq ‡)

5-990. RESEARCH. (Cr ar; prereq ‡)
For students seeking guidance in reading of specialized material. Could include Lok Sabha reports, etc.

Indic (Indc)

5-001. INTRODUCTION TO SOUTH ASIAN LANGUAGES. (4 cr; prereq ‡; offered alt yrs)

5-201/5-202/5-203. SURVEY OF INDIAN LITERATURE. (4 cr per qtr)

5-301. ART OF THE FILM—INDIA. (4 cr; prereq ‡)
History of Indian films; a mass art form and its relation to cultural factors.

5-302. THEATRE AND DRAMA IN ANCIENT INDIA. (4 cr; prereq 5-201 or ‡)

5-401. THE NATYASASTRA. (4 cr; prereq ‡)
Intensive study of theory and practice of ancient Hindi theatre.

5-511/5-512. THE RELIGIONS OF INDIA. (4 cr per qtr; prereq 1-504 or ‡)
Thorough examination of the major religious traditions of India. Historical development of schools and sects. Emphasis on contemporary situations.

5-520. STUDIES IN THE RELIGIONS OF INDIA. (Cr ar; prereq 5-512 or ‡)
Selected topics in India's religious history. Topic 1972-73: the Bhagavad Gita.

5-531/5-532. CULTURAL HISTORY OF NORTH INDIA, 1000-1707. (4 cr per qtr; prereq 1-502 or ‡)
India in the Muslim period. Special consideration to developments in Indian Islam. Analysis of such syncretic movements as Sikhism.

5-533. HISTORY OF HINDUSTANI CULTURE. (4 cr)

5-710. SEMINAR: SOUTH ASIAN LANGUAGES AND LITERATURES. (Cr ar; prereq ‡)
Detailed examination of selected problems.

5-801. INTRODUCTION TO SANSKRIT POETICS. (4 cr; prereq 5-202 or ‡)

5-802. WESTERN APPROACHES TO EASTERN THEATRE. (4 cr; prereq ‡; offered alt yrs)
Study of historical and critical approaches of major Western dramatists and theorists to theatre of the East: Artaud, Brecht, Langer, Strindberg, Yeats, etc.

5-970. DIRECTED STUDY. (Cr ar; prereq ‡)

5-990. RESEARCH. (Cr ar; prereq ‡)

Marathi (Mar)

5-101/5-102/5-103. BEGINNING MARATHI. (5 cr per qtr)

5-131/5-132/5-133. INTERMEDIATE MARATHI. (5 cr per qtr; prereq 1-103 or 5-103 or ‡)

5-161/5-162/5-163. ADVANCED MARATHI. (4 cr per qtr; prereq 3-033 or 5-133 or ‡)

5-201/5-202/5-203. MARATHI LITERARY TEXTS. (4 cr per qtr; prereq 5-163)
Critical reading of selected works of major Marathi writers.

5-970. DIRECTED STUDY. (Cr ar; prereq ‡)

5-990. RESEARCH. (Cr ar; prereq ‡)

Sanskrit (Skt)

5-011. SANSKRIT SYNTAX. (4 cr; prereq ‡)

5-201/5-202/5-203. BEGINNING SANSKRIT. (5 cr per qtr)

5-204/5-205/5-206. INTERMEDIATE SANSKRIT. (5 cr; prereq 1-203 or 5-203)

5-401/5-402/5-403. ADVANCED READINGS IN SANSKRIT. (4 cr; prereq 5-206)

5-490. STUDIES IN SANSKRIT LITERATURE. (4 cr; prereq 5-403 or ‡)

5-701. INTRODUCTION TO VEDIC GRAMMAR. (4 cr; prereq 5-206 or ‡)

5-970. DIRECTED STUDY. (Cr ar; prereq ‡)

5-990. RESEARCH. (Cr ar; prereq ‡)

Urdu

5-131/5-132/5-133. INTERMEDIATE URDU. (5 cr per qtr; prereq Hndi 1-103, 5-103 or ‡)

5-161/5-162/5-163. ADVANCED URDU. (4 cr per qtr; prereq 3-033 or 5-133 or ‡)

5-970. DIRECTED STUDY. (Cr ar; prereq 3-033 or ‡)
Advanced study of Urdu language and literature tailored to individual student requirements.

SPANISH AND PORTUGUESE

Professor
Rodolfo O. Floripe, *acting chairman*
Russell G. Hamilton, Jr., *director of graduate study*
Ricardo A. Narváez

Associate Professor
Ruth E. Jones
Lawrence C. Mantini

Assistant Professor
Nicholas Spadaccini
Constance A. Sullivan

Prerequisites—For major work, 27 Upper Division credits or equivalent in the major field of which at least 20 credits must be in literature courses. For minor work, 18 upper division credits or equivalent in the major field. Candidates will ordinarily find it necessary to supplement their undergraduate work by a considerable amount of independent reading. Lists of required and recommended readings are available from the departmental secretary.

Language Requirement—Candidates for the Master's degree must have a reading knowledge of at least one modern language other than the language of their major field. Candidates for the Doctor's degree must have a knowledge of Latin equivalent to at least 2 years of high school Latin; 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, German.

Master's Degree—Offered under both Plan A and Plan B in Spanish.

Doctor's Degree—Offered in Spanish.

Before registering for their first quarter of graduate work, students should consult the director of graduate study in their major. They are to familiarize themselves with the special requirements of the department, which includes submitting a provisional (departmental) program for the M.A. during the second quarter of residence; Ph.D. candidates must file a provisional program within 1 quarter after obtaining an M.A. degree at this University, or during the first quarter of residence if accepted to work directly toward a doctorate. Detailed information, mimeographed, is available from the departmental secretary and is also posted on the graduate bulletin board of the department.

Comparative Literature—For information on this program see the Comparative Literature section of this bulletin.

Portuguese (Port)

5-112, 5-113, 5-114. TOPICS IN PORTUGUESE LITERATURE. (4 cr per qtr; prereq 3-213; offered 1973-74 and alt yrs) Hamilton

5-212, 5-213, 5-214. TOPICS IN BRAZILIAN LITERATURE. (4 cr per qtr; prereq 3-213; offered 1972-73 and alt yrs) Hamilton

5-225. PROSEMINAR: CONTEMPORARY BRAZILIAN LITERATURE. (4 cr; prereq 3-211 or 3-212 or 3-213 or ¶3-211 or ¶3-212 or ¶3-213)

5-721. INTRODUCTION TO ROMANCE PHILOLOGY. (3 cr; prereq Span 3-721 or Port 3-721 or ‡) Mantini

8-101. LITERARY CRITICISM AND RESEARCH METHODS. (4 cr) Spadaccini

8-970. DIRECTED READINGS IN ROMANCE LANGUAGES. (Cr ar) Hamilton

Spanish (Span)

LINGUISTICS, PHILOLOGY, HISTORY OF THE LANGUAGE, AND RESEARCH METHODS

5-011. SPANISH STYLISTICS. (4 cr; prereq 3-021 or equiv) Mantini, Narváez

5-711, 5-712, 5-713. THE STRUCTURE OF MODERN SPANISH: PHONOLOGY, MORPHOLOGY, SYNTAX. (4 cr per qtr; prereq 3-021, or ¶3-021 or ‡) Mantini, Narváez
A scientific approach to the structure of present-day Spanish, with special attention to syntax, phonology, word formation, and dialectal differences.

5-721. INTRODUCTION TO ROMANCE PHILOLOGY. (4 cr; prereq 3-721 or Port 3-721 or ‡) Mantini, Narváez

8-101. LITERARY CRITICISM AND RESEARCH METHODS. (4 cr) Spadaccini

8-701/8-702/8-703. HISTORY OF THE SPANISH LANGUAGE. (4 cr per qtr; prereq 1 yr Latin or ‡; required of all Ph.D. candidates) Mantini, Narváez

PENINSULAR LITERATURE

5-211. SPANISH LITERATURE OF THE 16TH CENTURY: THE NOVEL. (4 cr; prereq 3-211, 3-212, 3-213; offered 1972-73 and alt yrs) Jones, Spadaccini

5-212. SPANISH LITERATURE OF THE 16TH CENTURY: POETRY. (4 cr; prereq 3-211, 3-212, 3-213; offered 1972-73 and alt yrs) Jones, Spadaccini

5-213. SPANISH LITERATURE OF THE 16TH CENTURY: THE DRAMA. (4 cr; prereq 3-211, 3-212, 3-213; offered 1972-73 and alt yrs) Jones, Spadaccini

5-214. INTRODUCTION TO SPANISH MYSTIC LITERATURE OF 16TH AND 17TH CENTURIES. (4 cr; prereq 3-211, 3-212, 3-213) Spadaccini
Juan de Avila, Santa Teresa, P. Ribadeneira, Fr. Luis de León.

5-221. SPANISH LITERATURE OF THE 17TH CENTURY: THE DRAMA. (4 cr; prereq 3-211, 3-212, 3-213; offered 1973-74 and alt yrs) Jones, Spadaccini

5-222. SPANISH LITERATURE OF THE 17TH CENTURY: THE NOVEL. (4 cr; prereq 3-211, 3-212, 3-213; offered 1973-74 and alt yrs) Jones, Spadaccini

5-223. SPANISH LITERATURE OF THE 17TH CENTURY: POETRY. (4 cr; prereq 3-211, 3-212, 3-213; offered 1973-74 and alt yrs) Jones, Spadaccini

5-232. DEVELOPMENT AND METAMORPHOSIS OF THE "DON JUAN" THEME. (4 cr; prereq 3-211, 3-212, 3-213 or ‡) Floripe

5-241. THE 18TH CENTURY: STUDIES IN THE PRINCIPAL WRITERS. (4 cr; prereq 3-211, 3-212, 3-213) Feijoo, Jovellanos, Cadalso, Moratín, and others

5-251/5-252/5-253. SPANISH LITERATURE: 19TH CENTURY. (4 cr per qtr; prereq 3-211, 3-212, 3-213; offered 1972-73 and alt yrs)

5-271. 20TH-CENTURY SPANISH LITERATURE: DRAMA. (4 cr; prereq 3-211, 3-212, 3-213; offered 1973-74 and alt yrs) Floripe, Sullivan
Benavente, Martínez Sierra, Linares-Rivas, Alvarez Quintero, Valle Inclán, Marquina, García Lorca, and Casona.

5-272. 20TH-CENTURY SPANISH LITERATURE: PROSE. (4 cr; prereq 3-211, 3-212, 3-213; offered 1973-74 and alt yrs) Floripe, Sullivan
Unamuno, Azorín, Baroja, Valle Inclán, Ortega y Gasset, Perez de Ayala, Gomez de la Serna.

5-273. 20TH-CENTURY SPANISH LITERATURE: POETRY. (4 cr; prereq 3-211, 3-212, 3-213; offered 1973-74 and alt yrs) Floripe, Sullivan
Juan Ramón Jiménez, Unamuno, Antonio and Manuel Machado, Valle Inclán, García Lorca, Alberti, Moreno Villa, Aleixandre, León Felipe, Guillén, and Salmas.

5-311. THE BALLAD. (4 cr; prereq 3-211, 3-212, 3-213; offered when feasible)

5-312. THE CELESTINA. (4 cr; prereq 3-211, 3-212, 3-213; offered 1973-74 and alt yrs) Jones

5-315, 5-316, 5-317. GOLDEN AGE NOVEL. (4 cr per qtr; prereq 1 upper division literature course or ‡) Spadaccini
Novelistic forms of the Golden Age with an emphasis on the picaresque novel.

5-351. THE SPANISH NOVEL FROM VALERA TO PALACIO VALDEZ. (4 cr; prereq one survey course in Spanish literature) Floripe

5-371. MODERN SPANISH NOVEL. (1900-1936). (4 cr; prereq one Upper Division literature course or ‡) Sullivan

5-373. CONTEMPORARY SPANISH NOVEL SINCE THE CIVIL WAR. (4 cr; prereq one Upper Division literature course or ‡) Sullivan

5-381. CONTEMPORARY SPANISH THEATRE: 1939-1968. (4 cr; prereq one Upper Division literature course or ‡) Sullivan

5-392. CONTEMPORARY SPANISH POETRY: FROM 1936. (4 cr; prereq 3-211, 3-212, 3-213 or ‡) Floripe, Sullivan
Major post-Civil War poets of Spain.

5-501. HISPANO-ARABIC LITERATURE AND CULTURE: HISTORY OF ISLAMIC SPAIN. (4 cr)

5-502. HISPANO-ARABIC LITERATURE AND CULTURE: ARAB PHILOSOPHY IN SPAIN. (4 cr)

5-503. HISPANO-ARABIC LITERATURE AND CULTURE: HISPANO-ARABIC LITERATURE. (4 cr)

8-201/8-202/8-203. SPANISH LITERATURE OF THE MIDDLE AGES. (4 cr per qtr; prereq 1 yr Latin or ‡; required of all Ph.D. cand)

8-211. LA POESIA ELEGIACA EN LA LITERATURE ESPAÑOLA. (4 cr)
Introductory lectures and readings in Greek and Roman origins of elegy. Elegiac types of poetry in Spanish literature from Juan Ruiz to Lorca.

AUTHORS

5-411. CERVANTES: DON QUIJOTE. (4 cr; prereq 3-211, 3-212, 3-213) Jones

5-412. CERVANTES: NOVELAS EJEMPLARES AND ENTREMESES. (4 cr; prereq 3-211, 3-212, 3-213 or ‡) Jones

5-416. LOPE DE VEGA AND CALDERON. (4 cr; prereq one upper division course) Jones

LATIN-AMERICAN LITERATURE

5-521, 5-522, 5-523. COLONIAL AND 19TH-CENTURY LATIN-AMERICAN LITERATURE. (4 cr per qtr; prereq 3-211, 3-212, 3-213...or 3-253; offered 1972-73 and alt yrs) Floripe, Vidal

5-551. LATIN-AMERICAN LITERATURE: POETRY. (4 cr; prereq 3-211, 3-212, 3-213...or 3-253; offered 1972-73 and alt yrs) Floripe
Silva, Darío, Nervo, Chocano, Herrera y Reissig, Lugones, Agustini, Mistral, Ibarbourou, Storni, López Velarde, and Neruda.

5-552. LATIN-AMERICAN LITERATURE: ESSAY, SHORT STORY, DRAMA. (4 cr; prereq 3-211, 3-212, 3-213...or 3-253; offered 1972-73 and alt yrs) Floripe
Rodó, González Prada, Ricardo Rojas, Blanco Fombona, Ugarte, Vasconcelos, Alfonso Reyes, Quiroga, Gallegos, Florencio Sánchez.

5-553. LATIN-AMERICAN LITERATURE: NOVEL. (4 cr; prereq 3-211, 3-212, 3-213...or 3-253; offered 1972-73 and alt yrs) Floripe
Gallegos, Azuela, Riverá, Güiraldes, Barrios, Gálvez, Lynch, Ciro Alegría.

5-581, 5-582, 5-583. SPANISH-AMERICAN NOVEL AND SHORT STORY. (4 cr per qtr; prereq 3-211, 3-212, 3-213...or 3-253; offered 1973-74 and alt yrs) Floripe

5-584. CONTEMPORARY LATIN-AMERICAN NOVEL. (4 cr; prereq 3-211, 3-212, 3-213...or 3-252) Floripe, Vidal

SEMINARS

8-900.* SPANISH SEMINAR. (4 cr) Floripe, Jones, Spadaccini, Sullivan

8-930.* SPANISH DIALECTOLOGY. (4 cr) Narváez, Mantini
A contemporary dialectical study of Spanish. Fall: phonology. Winter: morphology. Spring: syntax.

8-950.* SEMINAR: LATIN-AMERICAN LITERATURE. (4 cr) Floripe, Vidal

DIRECTED READINGS

8-970. DIRECTED READINGS IN ROMANCE LANGUAGES. (Cr depends upon amount of work accomplished) Staff

See also:

Arab 5-501/5-502/5-503. HISPANO-ARABIC LITERATURE AND CULTURE

SPEECH AND HEARING SCIENCE, SPEECH PATHOLOGY, AND AUDIOLOGY (CDis)

Professor

Clark D. Starr, *chairman, director of graduate study*
Joseph B. Chaiklin
Frederic L. Darley
Frank M. Lassman
Richard R. Martin
Gerald M. Siegel
Charles E. Speaks
Mildred C. Templin
W. Dixon Ward

Associate Professor

Arnold E. Aronson
Robert H. Brookshire
Richard P. McDermott

Assistant Professor

Karlind Moller

Prerequisites—Courses in speech science, pathology, and audiology are open to all regularly enrolled graduate students who can meet course prerequisites as listed in the *Class Schedule*. Students seeking admission to the program generally have an undergraduate degree or course work in the field. However, students in other selected areas and related fields may be admitted. In such instances, the adviser may recommend background course work.

The Master of Arts degree is offered in two major fields (speech pathology and audiology). The Ph.D. degree may be earned in three major fields (speech and hearing science, speech pathology, or audiology).

Detailed information concerning graduate programs and/or financial assistance may be obtained by writing to the chairman of the Department of Communication Disorders, 110 Shevlin Hall, Minneapolis, Minnesota 55455.

5-202. SYMPOSIUM IN SPEECH SCIENCE, PATHOLOGY, AND AUDIOLOGY. (4 cr; prereq grad major or professional paid experience beyond undergrad major or ‡)

5-301. INTRODUCTION TO ACOUSTICS. (5 cr) Speaks
Elements of acoustics necessary to understanding quantitative aspects of speech pathology and audiology. Nature of sound, sound transmission, units of measurement, acoustic characteristics of speech, and use of elementary electroacoustic systems.

5-302. 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.

5-303. PHONEMICS LABORATORY. (2 cr) Speaks
Introduction to phonemic analysis of speech, the IPA classification system and articulatory correlates of English phonemes. Laboratory transcription of isolated sounds, words, and connected speech.

5-304. SPEECH AND HEARING SCIENCE. (5 cr; prereq 5-301, 5-302, 5-303, or ‡) Speaks
Critical analysis of experimental data concerning the physiologic, acoustic, and perceptual parameters of speech, and fundamental concepts in normal audition.

5-305. LABORATORY INSTRUMENTATION. (4 cr; prereq 5-301 or ‡) Speaks
Description of basic concepts in electronics and of electroacoustic systems appropriate to the study of speech and hearing.

5-306. HEARING SCIENCE. (4 cr; prereq 5-301 or Psy 3-031 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. With laboratory experience.

5-502. STUTTERING. (4 cr; prereq 3-101 or ‡) Martin
Consideration of the description, nature, and treatment of stuttering in children and adults. Students will be involved at various levels in actual therapeutic and research activities.

5-504. ARTICULATION DISORDERS. (4 cr; prereq 3-101, 5-301, 5-302) McDermott
Consideration of impaired articulation performance and associated factors. Principles of diagnosis and clinical management. Observation of clinical activities.

5-506. APHASIA. (2 cr; prereq 3-101, 5-302, or ‡) Brookshire
Ideology, diagnosis, and rehabilitation of speech and language disorders in adults. Brain damage is discussed. Students will be expected to observe evaluation and treatment sessions several times during the course.

5-507. CLEFT PALATE, ORAL-FACIAL ANOMALIES AND SPEECH. (4 cr; prereq 3-101 or ‡) Starr
Relationships between oral-facial structures and speech will be reviewed. Emphasis will be placed on speech problems associated with dental and palatal anomalies and on their clinical management. Observations of clinical activities will be provided.

5-508. VOICE DISORDERS. (4 cr; prereq 3-101 or ‡) Starr
Physical and physiological bases of normal voice production will be reviewed. Voice disorders (pitch, loudness, quality), their symptomatology, etiology, and clinical management will be discussed. Laryngectomy and other organic disorders will receive emphasis.

5-512. SPEECH DEVELOPMENT AND RETARDATION. (4 cr; prereq 3-101) Siegel
Theory and experimental research dealing with speech development as related to delayed or retarded speech.

5-513. SPEECH DELAY: PSYCHOLINGUISTIC APPROACHES. (4 cr; prereq 3-101 or ‡) Siegel
Basic concepts in psycholinguistics applied to delayed language. Three class meetings per week plus off-campus assignments.

5-514. SPEECH DELAY: DEVELOPMENT AND ASSESSMENT. (4 cr; prereq 5-513 or ‡) Siegel
Continued application of psycholinguistics to delayed speech and language, plus consideration of language assessment. Three class meetings per week plus off-campus assignments.

5-701. HEARING DISORDERS. (4 cr; prereq 3-101, 5-301, 5-302) Lassman, Chaiklin
Basic orientation to audiology with emphasis on hearing disorders; medical and surgical management, overview of major audiometric procedures, with laboratory demonstration; overview of audiologic and educational approaches to different types and degrees of hearing defects; psychological effects of hearing impairment.

5-702. HEARING MEASUREMENT. (4 cr; prereq 5-301, 5-302, 5-701) Chaiklin
Pure-tone audiometry, masking; bone-conduction theory; calibration; audiometer function; screening audiometry; emphasis on research bases of basic procedures. Four hours of lab experience each week in addition to lecture time.

5-703. COMMUNICATION PROBLEMS OF THE HEARING IMPAIRED. (4 cr; prereq 5-701 or ‡) Lassman
Effects of impaired hearing on speech and language development. Development of speech and language for hearing-impaired individuals through speech, speech-reading, auditory training, and other special methods and philosophies.

5-704. NOISE AND MAN. (3 cr; prereq 5-301 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; pre-employment testing and monitoring audiometry.

5-970. READINGS. (Cr ar [may be repeated]; prereq ‡) Staff
Directed readings and preparation of reports on selected topics.

8-210. SEMINAR: ADVANCED PROBLEMS. (3 cr [may be repeated for cr]; prereq ‡) Staff

8-307, 8-308, 8-309. SEMINAR: EXPERIMENTAL PHONETICS. (3 cr per qtr; prereq 5-304) Speaks
Critical analysis of significant research in physiological and acoustic phonetics. Examination of theory, method, instrumentation, and data.

8-502. SEMINAR: STUTTERING. (3 cr; prereq 5-502 or ‡) Martin
Intensive exploration of theoretical explanation of stuttering; research data and methodologies subserving the respective theories. Students independently design and, when feasible, execute research studies which derive from, and are consistent with, a particular theory of stuttering.

8-503. SEMINAR: VOICE. (3 cr; prereq 5-508 or ‡) Starr
Advanced study and independent research.

8-504. SEMINAR: ARTICULATION. (3 cr; prereq 5-504 or ‡) Templin, McDermott
Advanced study and independent research.

8-506. SEMINAR: APHASIA. (3 cr; prereq 5-506 or ‡) Darley
Review of principal theoretical treatments, instruments for evaluation, and methods of clinical management of acquired aphasia and related disorders. Independent investigation of parameters determinative of aphasic behavior.

8-507. SEMINAR: CLEFT PALATE. (3 cr; prereq 5-507 or ‡) Starr
Critical review of research on communication problems of persons with cleft palates.

8-508. SEMINAR: THE LARYNGECTOMIZED. (3 cr; prereq 5-508 or ‡)
Analysis of various research techniques and research findings relating to the laryngectomized person, the production of postlaryngectomy speech, and characteristics of this speech. Individual investigation in one of these areas.

8-509. SEMINAR: ANALYSIS OF LITERATURE IN SPEECH PATHOLOGY. (3 cr; prereq grad major in speech pathology or ‡)
Basic problems relating to evaluation of various types of literature in speech pathology. Individual projects designed to determine and evaluate the student's analytical procedures.

8-511. SEMINAR: CURRENT ISSUES IN SPEECH PATHOLOGY. (3 cr; prereq grad major in speech pathology or ‡)
Significant problem areas in speech pathology; relation to other rehabilitation programs and personnel. Class projects involving in-depth exploration of a specific problem.

8-512. SEMINAR: LANGUAGE RETARDATION. (3 cr; prereq 5-512 or ‡) Siegel
Analysis of causation, diagnosis, and current research techniques.

8-520. ADVANCED CLINICAL PRACTICE IN SPEECH PATHOLOGY. (2, 4 or 6 cr [may be repeated]; prereq ‡) Staff
Specialized clinical practice. Evaluation and clinical management of persons presenting communication disorders.

8-709. ADVANCED HEARING MEASUREMENT. (4 cr; prereq 5-301, 5-306, 5-702) Chaiklin
Advanced audiometrics: speech audiometry (including routine masking), tone decay, SISI, loudness matching, DL procedures, Bekesy audiometry, and procedures for assessing response validity. Research literature emphasized; laboratory projects in addition to lecture.

8-711. AUDIOMETRY III. (4 cr; prereq 5-306, 5-702, 8-709) Chaiklin
Continuation of advanced audiometrics. Additional specialized procedures used in comprehensive audiologic evaluations. Critical on- and off-time, aural overload, temporal integration, tympanometry, degraded speech tests, GSR, EER and delayed feedback audiometry among topics discussed. Laboratory projects in addition to lecture.

8-714. SELECTION AND USE OF HEARING AIDS. (3 cr; prereq 5-305 or ‡)
Nature and types of amplifying systems used with the hearing impaired. Electroacoustic characteristics including gain, power, acoustic response, distortion, etc. Principles and methods of selection and usage relative to types of hearing disorders.

8-715. PEDIATRIC AUDIOLOGY. (3 cr; prereq 8-709, 8-711, ‡) Lassman
Assessment and clinical management of infants and children with hearing disorders. Problems of differential diagnosis; screening, conditioning procedures; electrophysiologic methods. Selection and use of hearing aids for children. Guidance of parents.

8-716, 8-717, 8-718. SEMINAR: HEARING. (3 cr per qtr; prereq ‡) Staff
Major experimental research in psychoacoustical nature of hearing. Critical analysis of theory, experimental method, and treatment of data.

8-719. SEMINAR: CURRENT ISSUES IN AUDIOLOGY. (3 cr; prereq ‡) Staff
Analytical consideration of significant problem areas in audiology and its relation to other rehabilitation programs and personnel. Class projects involving in-depth exploration of a specific problem.

8-720. CLINICAL METHODS AND PRACTICE IN AUDIOLOGY. (2, 4 or 6 cr [may be repeated]; prereq ‡) Staff
Supervised internship experiences for graduate students working with communication disorders of persons with auditory impairments.

8-990. RESEARCH. (Cr ar [may be repeated]; prereq ‡) Staff
Open to grad students engaged in research.

SPEECH-COMMUNICATION (Spch)

Professor
Ernest Bormann, *director of graduate study*
Robert L. Scott, *chairman*
Donald R. Browne
Paul H. Cashman
William S. Howell
J. Vernon Jensen
George L. Shapiro
E. William Ziebarth

Associate Professor
Leonard D. Bart
Frank T. Benson
Bernard L. Brock
Sheldon Goldstein
Gene Piche

Assistant Professor
David L. Rarick

Prerequisites—For major work, a minimum of 18 undergraduate credits or their equivalent in speech-communication.

Research Technique Requirement—For the master of arts degree, there is no requirement for candidates beyond including the "Introduction to Research" course in their program. For the doctor's degree, candidates are expected to prepare a technique sufficient for carrying out research at the doctoral level. They must support their claim to this preparation by submitting no fewer than 9 credit-hours of work in relevant courses as part of their 3-year program. Foreign language, statistics, historiography, critical methods are among the techniques which will be considered.

Master of Arts Degree—Offered under both Plan A and Plan B. Most candidates will follow Plan B. Plan A will be elected only upon approval of the adviser and the director of graduate study.

A final written examination is required under both Plan A and Plan B. In addition, a final oral examination is required for Plan A.

Doctor's Degree—In consultation with the major adviser, Ph.D. candidates will elect a number of topics from a list supplied by the department, on which they will be expected to demonstrate special competence. At least one such topic must be elected from each of the areas of broadcasting, rhetoric and public address, and communication. The choice of a minor is subject to the approval of the major and minor advisers, or a supporting program may be substituted with the approval of the major adviser and the director of graduate study.

5-201. TELEVISION PRODUCTION: DRAMA. (3 cr; prereq 3-204)
Instruction and practice in the specialized area of television production of drama. Aesthetics and techniques of the use of television as a dramatic medium.

5-202. ADVANCED TELEVISION PRODUCTION. (4 cr; limited to 14 students; prereq 3-204 and ‡) Bart
Provides advanced students an opportunity to carry out creative problems in television production and direction. Special emphasis on advanced program design as well as lighting, audio, camera and electronic techniques.

5-204. WRITING RADIO AND TELEVISION DRAMA. (4 cr; prereq 3-201, ‡)
Physical, psychological and sociological aspects of radio and television and their influence on the writer. Script-writing in various forms from dramatic commercials to dramas and documentaries.

5-221. EDUCATION TELEVISION PRODUCTION. (4 cr; prereq 3-204 or ‡) Goldstein
Special emphasis on uses of television for instructional purposes, review of research literature as it applies to production of televised educational materials and experimentation in preparation of such materials.

5-222. EDUCATIONAL TELEVISION PROGRAMMING AND ADMINISTRATION. (4 cr; prereq 3-211, 5-221 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.

5-231. COMPARATIVE BROADCAST SYSTEMS. (4 cr; prereq 3-211 or ‡) Browne
Historical, sociological and political aspects of various systems of broadcasting throughout the world. Examination of American, Canadian, British, French, German, Soviet and other broadcast institutions to discover why and how they are regulated and what impact they have had on political, social and economic development.

5-232. INTERNATIONAL BROADCASTING. (4 cr; prereq 12 cr political science or ‡) Browne
Broadcasting as an international medium of communication in the U. S., Great Britain, U.S.S.R., Japan, others. 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.

5-233. BROADCASTING AND NATIONAL DEVELOPMENT. (4 cr; prereq 5-231 or ‡) Browne
Purposeful employment of radio and television to effect changes in the social, political, economic and cultural life of various peoples and nations. Particular concentration 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.

5-402. BREAKDOWN IN INTERPERSONAL COMMUNICATION. (4 cr; prereq 3-401 or ‡; offered alt yrs) Shapiro
Factors contributing to misunderstanding, not understanding, disagreement and cessation of contact in dyads.

5-403. THEORIES OF COMMUNICATION. (4 cr; prereq 3-401 or ‡) Rarick
Various theories of human communication. Analysis of their usefulness for particular purposes. Consideration of problems in development of communication theories.

5-404. SPEECH AND LANGUAGE IN HUMAN BEHAVIOR. (4 cr, §SeEd 5-404; prereq 1-102, 3-401 or grad) Piche
Basic orientation on place of speech and language in human behavior. Individual projects and collateral reading.

5-411. SMALL GROUP COMMUNICATION. (5 cr; S-N regis only; prereq 3-641 or ‡) Bormann, Howell
Communication and dynamics within the small, task-oriented group. Group cohesiveness, leadership, role structure, information processing, and decision making.

5-421. QUANTITATIVE RESEARCH IN COMMUNICATION. (4 cr; prereq 3-401 or 5-403, 8-101 or ‡)
Review and discussion of experimental and descriptive research; analysis of research design and procedures; individual research projects.

5-431. THE PROCESS OF PERSUASION. (4 cr; prereq 1-101 or 1-105, Psy 1-001, 10 cr in social science or ‡) Howell
Theories of modern motivational communication. Analysis of the process of social control through persuasive speech.

5-441. COMMUNICATION IN HUMAN ORGANIZATIONS. (4 cr; prereq 1-102 or 3-401, 3-641 or 5-411, or grad) Shapiro
Analysis of functions of communication in organizational settings. Organizational structure and dynamics and their effect upon communication process. Collateral readings and individual projects.

5-451. INTERCULTURAL SPEECH-COMMUNICATION. (3 cr; prereq 3-401, Anth 1-002, or other course in cultural anthropology, or ‡) Howell
Survey of factors important to successful interpersonal communication across cultures. Linguistic and non-verbal variables. Emphasis upon North Americans abroad, communication with host nationals.

5-602. CONTEMPORARY POLITICAL PERSUASION. (4 cr; prereq 1-101 or 1-105, 5-431 or ‡) Brock
Contemporary political speaking. Analysis of ideologies in political persuasion.

5-611. CLASSICAL RHETORIC. (4 cr; prereq 1-101 or 1-105) Scott
Greek and Roman theories of speech making; historical and philosophic context and influence on education.

5-615. INTRODUCTION TO RHETORICAL CRITICISM. (4 cr; prereq 1-101 or 1-105... 3-615 recommended) Brock, Scott
Introduction to traditional and contemporary rhetorical theory and its application to contemporary public address.

5-616. HISTORY AND CRITICISM OF BRITISH PUBLIC ADDRESS. (4 cr; prereq 1-101 or 1-105 or ‡) Jensen
British orators, their works, the historical setting. British rhetorical theory.

5-617. HISTORY AND CRITICISM OF AMERICAN PUBLIC ADDRESS. (4 cr; prereq 1-101 or 1-105, Psy 1-001) Bormann
Survey: history and criticism of religious and reform speaking in the United States from 1620 to 1920.

5-618. HISTORY AND CRITICISM OF AMERICAN PUBLIC ADDRESS. (4 cr; prereq 1-101 or 1-105, Psy 1-001) Bormann
Survey: history and criticism of political speaking in the United States from the time of the revolution to the present.

5-970. READINGS IN SPEECH. (Cr ar; prereq 9 cr in upper division speech and ‡)
Directed reading and preparation of reports on selected subjects.

8-101. INTRODUCTION TO RESEARCH. (3 cr; prereq 1-101, Psy 1-002) Bormann
Graduate research in speech; selection of topics and methods of investigation. Required of all graduate majors in speech.

8-110/8-120/8-130. SEMINAR: ADVANCED SPEECH PROBLEMS. (3 cr per qtr; prereq undergrad major in speech, or equiv, ‡)
Evaluation of research methods in speech and communication.

8-140. SEMINAR: PRESENTATION OF CLASSICAL TEXTS. (3 cr, §Th 8-140; prereq Spch 5-611 or Th 5-813 or Th 5-831 or Th 5-712) Sonkowsky
Problems in public presentation of English translation of classical Greek and Roman texts. Attention to ancient critical theory as related to performance. Topics vary with individual interests: directing, acting, oral interpretation, translating, adapting for modern audience.

8-201. SEMINAR: RADIO AND TELEVISION RESEARCH. (3 cr; prereq 8-101 or Jour 8-001 or ‡) Browne, Rarick
Evaluation of research methods in radio and television. Execution of team research project. Required of all graduate level broadcasting majors.

8-202/8-203. SEMINAR: RADIO AND TELEVISION RESEARCH. (1-3 cr; prereq 8-201 or ‡) Browne, Rarick
Research literature and studies. Execution of individual research projects.

8-411. SEMINAR: SMALL GROUP COMMUNICATION. (3 cr; prereq 1-101, 5-411) Bormann
Research problems and methods in small group communication.

8-421. SEMINAR: COMMUNICATION AND NEGOTIATION. (3 cr; prereq 5-411, 5-441, 5-403 or ‡)
Influence of communication patterns on bargaining outcomes. Formal negotiation as a model for situations of partial conflict.

8-425. RESEARCH SEMINAR IN SPEECH-COMMUNICATION. (3 cr; prereq 3-401, 8-101, 5-421, or ‡)
Planning, executing, and reporting speech-communication research projects.

8-431, 8-432, 8-433. SEMINAR IN PERSUASION. (3 cr per qtr; prereq 5-431) Howell
Literature of persuasion, methods in study of persuasion.

8-441. SEMINAR: ORGANIZATIONAL COMMUNICATION. (3 cr; prereq 5-441 or ‡; offered alt yrs) Shapiro
Directed projects in the study of organizational communication. Emphasis on studies conducted in real or simulated organizations.

8-451. SEMINAR: FACE-TO-FACE INTERCULTURAL COMMUNICATION. (3 cr; prereq, if U. S. citizen, Anth 5-101 or similar course in cultural anthropology or ‡; 5-451 recommended) Howell
Definition and investigation of factors influencing face-to-face communication in varied cultures, concentrating upon task-oriented communication between North Americans and nationals in the host country. Verbal (linguistic) and nonverbal (nonlinguistic) dimensions of communication.

8-471. SEMINAR: LISTENING COMPREHENSION. (1-3 cr; prereq undergrad speech major, ‡)
Research problems and methods. Evaluation of published research.

8-603/8-604. SEMINAR: ARGUMENTATION. (3 cr per qtr; prereq 1-101, Psy 1-002, 10 cr in social science) Brock, Howell
Theory of argumentation and debate. Use of argumentation in formal debate and in contemporary public address.

8-606. SEMINAR: RHETORICAL ANALYSIS OF CAMPAIGNS AND MOVEMENTS. (3 cr; prereq 5-431, 5-617 or 5-618, 10 cr in social science, or ‡) Brock
Literature and methodology in the study of historical and contemporary rhetorical campaigns and movements.

8-611, 8-612, 8-613. SEMINAR IN RHETORIC. (3 cr per qtr; prereq 5-611 or ‡) Scott
History and critical study of rhetorical theory. Examination of research in rhetoric.

8-621. SEMINAR: HISTORY AND CRITICISM OF PUBLIC ADDRESS. (3 cr; prereq 5-617, 5-618, or △) Bormann, Scott
Methods of rhetorical criticism. Application of method in individually selected research projects.

8-631. SEMINAR: BRITISH PUBLIC ADDRESS. (3 cr; prereq 5-616 or ‡) Jensen
Individual research projects in the theory, practice, or criticism of British public address.

8-990. RESEARCH. (Cr ar)
Open to graduate students engaged in research on special problems.

STATISTICS (Stat)

Professor

Seymour Geisser, *director*
Somesh Das Gupta, *director of graduate study*
Bernard W. Lindgren, *chairman, theoretical statistics*
Jacob E. Bearman (biometry)
Robert J. Buehler
John S. Chipman (economics)
Raymond O. Collier (educational psychology)
Clifford Hildreth (economics, statistics)
Leonid Hurwicz (economics)
Gopinath Kallianpur (mathematics)
Milton Sobel

Associate Professor

Stephen E. Fienberg, *chairman, applied statistics*
Morris L. Eaton
Michael D. Perlman
William D. Sudderth

Assistant Professor

Donald A. Berry
R. Dennis Cook
Kinley Larntz
Frank Martin

General Viewpoint—Any candidate for an advanced degree with a major in statistics will be expected to become familiar with modern statistical theory, its supporting mathematics, and its applications.

Prerequisite—Mathematics: familiarity with such topics as multiple integrals, partial differentiation, infinite series, vectors, matrices, determinants. (Students whose degree program will be oriented toward mathematical statistics should have more advanced preparation in mathematics.) Statistics: familiarity with basic statistical concepts and methods.

Adviser—The director of graduate study should be consulted for assistance in selecting an adviser.

Language Requirement—No foreign language is required for the Master's degree; for the Doctor's degree reading knowledge of one foreign language, or proficiency in a special research technique or a collateral field is required. The language is ordinarily chosen from Russian, French, or German.

Master's Degree—Offered under Plan B. (Plan A may be chosen when approved by the student's adviser and the director of graduate study.) A written examination is required, with the oral examination at the option of the student's committee. Programs will include at least 26 credits in statistics, including at least three courses from this list: 5-201, 5-211, 5-301, 5-302, 5-401, 8-152, 8-311, 8-501, 8-161/8-162/8-163.

Master's candidates in applied statistics who enter without the necessary mathematics or introductory statistics courses may need 5-071 or 5-021/5-022 as prerequisite material, but these are not to be counted as part of the 45 credits on the M.S. program.

Doctor's Degree—Students in the doctoral program are normally required to pass the written Master's examination after two quarters. The written examination for the Ph.D. is usually taken after 5 quarters and covers probability theory, mathematical statistics, applied statistics, and linear models. Preparatory courses for this examination are 8-151/8-152/8-153, 8-311/8-312, 8-161/8-162/8-163, Math 8-656/8-657/8-658. All students are expected to take a minimum of 21 credits in advanced statistics courses, in at least 3 areas; the director of graduate study should be consulted for more detailed information on this requirement.

Minor in Statistics, Ph.D.—The director of graduate study should be consulted in advance for planning and approval of a balanced program. Minimum programs will include one of the sequences 5-121/5-122 or 5-131/5-132/5-133, plus evidence of familiarity with various statistical methods (e.g. 5-101, 5-201, 5-301, 5-302, 5-401, 5-601); additional selections of courses (in particular, 8-151/8-152/8-153, 8-311/8-312) from the following course list may be taken as indicated by the student's needs and interests. Typical programs contain 21-27 credits.

5-021. STATISTICAL ANALYSIS I. (4 cr; prereq college algebra or ‡)
Frequency distributions, descriptive statistics, elementary probability; binomial, Poisson and normal distributions, estimation and testing, analysis of variance, multiple comparisons, linear regression.

5-022. STATISTICAL ANALYSIS II. (4 cr; prereq 3-081 or 5-021)
(Continuation of 5-021) Multiple regression and correlation. Multi-way analysis of variance, variance components, covariance. Basic non-parametric methods.

5-061. COMPUTERS IN AGRICULTURAL AND BIOLOGICAL RESEARCH. (3 cr; open only to Institute of Agriculture students; prereq 5-022)
Impact of computer on research, FORTRAN programming, use of current libraries in processing statistical data, simulation techniques.

5-071. STATISTICAL APPLICATION OF MATRIX ALGEBRA. (3 cr; prereq 5-021 or ‡; Math 3-142 or ‡)
Introduction to specific matrix operations with vector realizations, presuming no prior knowledge. Uses in analysis of variance and multivariate methods. Correlation structures, characteristic vectors, quadratic forms.

5-101. INTRODUCTION TO DECISION THEORY. (4 cr, §5-132; prereq Econ 5-111, or Math 1-142, or Math 1-211, or ‡)
Elements of probability; basic concepts in statistical decision theory; relationship to game theory and other types of decision problems; prediction and inference.

5-121/5-122. THEORY OF STATISTICS. (4 cr per qtr, §5-131/5-132/5-133, no cr for both 3-091 and 5-121; prereq Math 1-231 or 1-331 or 1-621)
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.

5-131/5-132/5-133. THEORY OF STATISTICS. (3 cr per qtr, §5-121/5-122; prereq Math 3-411 or 3-211 or ‡)
5-131: Probability models, univariate and bivariate distributions, independence, basic limit theorems. 5-132/5-133: 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 5-121/5-122.

5-201. SAMPLING METHODOLOGY IN FINITE POPULATIONS. (4 cr; prereq 5-021 or 5-121 or 3-091)
Simple random, systematic, stratified and unequal probability sampling. Ratio and regression estimation. Multistage and cluster sampling.

5-211. THEORY OF SAMPLE SURVEYS. (4 cr; prereq 5-122 or 5-133)
Mathematical treatment of survey sampling, including stratified and multistage sampling, models for nonsampling errors.

5-301. DESIGNING EXPERIMENTS. (4 cr; prereq 5-022 or 5-122 or 5-133)
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.

5-302. APPLIED REGRESSION ANALYSIS. (4 cr; prereq 5-022 or 5-071 or 5-122 or ‡)
Simple, multiple, and polynomial regression. Estimation, testing, and prediction. Stepwise and other numerical methods; examination of residuals; harmonic analysis; weighted least squares; nonlinear models; response surface; simultaneous regression equations. Emphasis on experimental research and economic applications.

5-401. INTRODUCTION TO MULTIVARIATE METHODS. (4 cr; prereq 5-071, 5-022 or 5-122)
Bivariate and multivariate distributions. Inference in multivariate analysis of variance. Partial, canonical correlation and independence. Topics from principal component analysis, factor analysis, analysis of repeated measurements, cluster analysis, profile analysis, categorical data.

5-601. NONPARAMETRIC METHODS. (4 cr; prereq 5-022 or 5-122 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.

5-900. TUTORIAL COURSE. (Cr ar; prereq ‡)
Students whose needs are not met by current offerings may obtain content of regular courses or special areas by directed study.

5-911/5-912/5-913. TOPICS IN STATISTICS. (3 cr per qtr; prereq 5-122 or 5-133)
Topics vary according to needs and available staff; may be repeated for credit.

8-151/8-152/8-153. MATHEMATICAL STATISTICS. (4 cr per qtr; prereq 5-133 or 5-122 and 5-101, advanced calculus and matrix algebra)
8-151: Probability distributions in statistical inference, derivations of sampling distributions. 8-152: Elements of decision theory, tests of hypotheses, principles and methods of estimation including confidence regions. 8-153: Introduction to sequential and nonparametric inference, and to large sample theory.

8-161/8-162/8-163. APPLIED STATISTICAL METHODS. (4 cr per qtr; prereq 5-131/5-132/5-133 or 5-121/5-122/5-101, 8-311/8-312 or ‡)
Experimental designs and analyses. Description and analysis of survey sampling procedures. Simulation and computer techniques. Analysis of variance, and categorical data; jackknife, gaps, outliers, robust estimation; multivariate analysis of variance; factor analysis; clustering; transformations, residuals. Data analysis. Statistical consultation.

8-171/8-172/8-173. THEORY OF INFERENCE. (3 cr per qtr; prereq 8-153 or ‡)
Elements of decision theory. Elements of Lebesgue theory. Conditional distributions and sufficiency. Theory of estimation. Neyman-Pearson theory of hypothesis testing and its extensions. Confidence regions. Invariance. Most stringent tests. Introduction to nonparametric and sequential inference.

8-191/8-192. LARGE SAMPLE THEORY. (3 cr per qtr; prereq 8-153, Math 8-658 or ‡)
Types of convergence. Limit theorems. Asymptotic properties of sampling distributions. Asymptotic efficiency. Likelihood and other methods of inference. Categorical data.

8-311/8-312. LINEAR MODELS AND EXPERIMENTAL DESIGN. (3 cr per qtr; prereq 5-122 or 5-133, matrix theory)
Theory and applications of the general linear model, regression, analysis of variance, randomization and design of experiments.

8-411/8-412. MULTIVARIATE ANALYSIS. (3 cr per qtr; prereq 8-153)
Multivariate normal distribution. Inference on the mean, covariance, and correlation and regression coefficients; and 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.

8-501/8-502. INTRODUCTION TO STOCHASTIC PROCESSES WITH APPLICATIONS. (3 cr per qtr; prereq 5-131 or ‡)
Markov chains. Markov processes, Poisson process, Brownian motion and other stochastic models encountered in applications.

8-611/8-612. NONPARAMETRIC INFERENCE. (3 cr per qtr; prereq ¶8-171/8-172/8-173 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.

8-731/8-732. STATISTICAL DECISION THEORY. (3 cr per qtr; prereq 8-173, Math 8-602 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.

8-751/8-752. SEQUENTIAL ANALYSIS. (3 cr per qtr; prereq 8-153 or Math 5-602)
Wald's sequential probability ratio test and modifications. Sequential decision theory. Martingales. Sequential estimation, design, and hypothesis testing. Recent developments.

8-900. SEMINAR IN STATISTICAL LITERATURE. (1-3 cr per qtr; prereq ‡)
Problems, current literature review, research.

8-931/8-932/8-933. ADVANCED TOPICS IN STATISTICS. (3 cr per qtr [may be repeated for cr]; prereq ‡)
Topics vary according to needs and available staff.

Math 5-681/5-682/5-683. INTRODUCTION TO PROBABILITY.

Math 8-656/8-657/8-658. MEASURE THEORY AND PROBABILITY.

Math 8-660/8-661/8-662. STOCHASTIC PROCESSES.

Math 8-690/8-691/8-692. 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. The approval of the director of graduate study 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 in a course program.

AgEc 5-010. STATISTICAL METHODS FOR SOCIAL SCIENCE

Agro 8-380. APPLIED STATISTICS

Econ 5-181/5-182/5-183. DECISION MAKING AND OPERATIONS ANALYSIS

Econ 5-261/5-262/5-263. APPLIED ECONOMICS

Econ 8-111/8-112/8-113. INTRODUCTION TO MATHEMATICAL ECONOMICS

Econ 8-211/8-212/8-213. ECONOMETRICS

Econ 8-291/8-292/8-293. SEMINAR: ECONOMETRICS AND STATISTICAL INFERENCE

EE 5-702. STOCHASTIC PROCESSES AND OPTIMUM FILTERING

EE 5-700/5-701. INFORMATION THEORY AND CODING

EE 8-200/8-201/8-202. TOPICS IN STATISTICAL THEORY OF COMMUNICATION

PsyF 8-110/8-111/8-112. STATISTICAL METHODS

PsyF 8-113. DESIGN AND ANALYSIS OF EXPERIMENTS

PsyF 8-114. CORRELATION AND REGRESSION METHODS

PsyF 8-115. MULTIVARIATE CORRELATIONAL METHODS

PsyF 8-910. PROBLEMS: STATISTICS FOR STUDENTS IN EDUCATION AND PSYCHOLOGY

IE 5-430/5-431. MATHEMATICAL METHODS IN OPERATIONS ANALYSIS

IE 5-510. QUALITY CONTROL

IE 5-530. INDUSTRIAL SAMPLING TECHNIQUES

IE 5-540. DESIGN AND ANALYSIS OF EXPERIMENTS I

IE 5-541. DESIGN AND ANALYSIS OF EXPERIMENTS II

PubH 5-450. BIOMETRY I

PubH 5-451. BIOMETRY LABORATORY I

PubH 5-452. BIOMETRY II

PubH 5-453. BIOMETRY LABORATORY II

PubH 5-454. BIOMETRY III

PubH 5-455. BIOMETRY LABORATORY III

PubH 5-457. STOCHASTIC MODELS IN BIOLOGY AND MEDICINE

PubH 5-462. LIFE TABLE TECHNIQUES

PubH 5-463. MATHEMATICAL DEMOGRAPHY

PubH 8-400. CONSULTING SEMINAR

QA 5-171. STATISTICAL METHODS FOR SAMPLE SURVEYS

QA 5-181. QUALITY CONTROL AND INDUSTRIAL STATISTICS

QA 8-191/8-192. STATISTICAL METHODS IN BUSINESS ADMINISTRATION

QA 8-193. STATISTICAL DESIGN OF EXPERIMENTAL RESEARCH IN BUSINESS

QA 8-231. MATHEMATICAL PROGRAMMING FOR BUSINESS ANALYSIS

QA 8-236. STOCHASTIC MODELS FOR BUSINESS ANALYSIS

STUDIO ART (ArtS)

Professor

Herman Rowan,
director of graduate study
Peter Busa
Allen Downs
Jerome Liebling
Warren MacKenzie
John G. Morrison
Malcolm H. Myers
Katherine Nash

Associate Professor

Raymond Hendler
Zigmunds Priede
Karl E. Bethke

Prerequisites—For the master of fine arts degree, admission to candidacy is limited to a selected group of students with a Bachelor's degree from an approved university or college or the equivalent and to those who provide evidence of exceptional promise as creative artists in one or more of the following subfields: painting, sculpture, printmaking, film and photography, and ceramics.

Master of Fine Arts Degree—Applicants for admission to the master of fine arts program must submit to the chairman of the Department of Studio Arts a portfolio of examples of their work in the performing medium which they wish to emphasize in the M.F.A. program. If actual examples of the student's work are

difficult to submit, color slides will be accepted. No recommendation concerning admission will be made on an application for admission until the portfolio has been received and evaluated in the department and the completed application for admission to the Graduate School has been received in the Graduate School office.

The candidates for the master of fine arts degree must complete a program of approximately 2 full years of graduate credits, 45 of which must be earned in graduate courses at the University of Minnesota. They must execute and present an acceptable record of a creative project (production, recital, or exhibition) which will be accompanied by a supporting paper that deals with the planning and/or execution of the creative work. A minimum of 9 credits will be required in history of art or literature and a further minimum of 9 credits in areas of study outside the department. Students can also acquire a minor by taking 15 credits in art history. The individual program must be approved by the M.F.A. committee. Candidates will be subject to final oral examinations.

Minor in Art—The faculty in fine arts offers work in the subfields of art history and the studio practice of arts which may be presented as the minor by candidates for the master of arts and Ph.D. degrees in other major fields.

5-100. PROSEMINAR: 20TH-CENTURY ART THEORIES IN PAINTING. (2 cr; prereq ‡) Lectures and discussion. Painting studio staff and student panels. Verbal presentation and analysis of contemporary trends as related to the actual process of creativity.

5-120. PROBLEMS IN PAINTING. (4 cr per qtr [24 cr max]; prereq 12 cr in 3-150 and ‡)

5-130f,w,s. ADVANCED DRAWING. (4 cr per qtr [12 cr max]; prereq 12 cr in 3-110 or equiv) Drawing in all mediums from life and from imagination. History of drawing.

5-170. DIRECTED STUDY IN PAINTING/DRAWING. (Cr ar)

5-300. PROSEMINAR: 20TH-CENTURY ART THEORIES IN SCULPTURE. (2 cr; prereq ‡)

5-310. DIRECT METAL SCULPTURE. (4 cr per qtr [8 cr max]; prereq 12 cr in 3-310)

5-313, 5-314. BASIC SCULPTURE. (4 cr; prereq ‡)

5-320. CARVING IN STONE AND WOOD. (4 cr per qtr [8 cr max]; prereq 12 cr in 3-320)

5-330w,s. METAL CASTING. (4 cr per qtr [8 cr max]; prereq 12 cr in 3-330)

5-340. EXPERIMENTAL MEDIA. (4 cr per qtr [12 cr max]; prereq 12 cr in 3-340)

5-370. DIRECTED STUDY IN SCULPTURE. (2-4 cr; prereq ‡)

5-400. PROSEMINAR: 20TH-CENTURY ART THEORIES. (2 cr; prereq ‡)

5-404H, 5-405H. HONORS THESIS. (2-4 cr; prereq ‡)

5-500. PROSEMINAR: 20TH-CENTURY ART THEORIES IN PRINTMAKING. (2 cr; prereq 5-501 and ‡)

5-510. ADVANCED INTAGLIO. (4 cr per qtr [12 cr max]; prereq 12 cr in 3-510 or ‡) Bethke, Myers

5-520. ADVANCED LITHOGRAPHY. (4 cr per qtr [12 cr max]; prereq 4 cr in 1-520) Priede
Specialized work in color printing and planographic techniques.

5-570. DIRECTED STUDY IN PRINTMAKING. (Cr ar)

5-700. PROSEMINAR: PHOTOGRAPHY. (2 cr; prereq 3-710 or 3-720 or ‡)
Lectures and discussion of advanced problems involved in appropriate mediums.

5-710. ADVANCED PROBLEMS IN PHOTOGRAPHY. (4 cr per qtr [12 cr max]; prereq ‡)

5-720. ADVANCED PROBLEMS IN FILM. (4 cr per qtr [12 cr max]; prereq ‡)

5-770. DIRECTED STUDY IN PHOTOGRAPHY. (Cr ar)

5-804, 5-805. GLASS WORKING. (4 cr per qtr; prereq ‡)
5-804: Introduces techniques involved in forming glass from its molten state. Primary concern is creative expression with technical understanding. 5-805: Greater emphasis on techniques involved in forming glass and personal expression in the medium.

5-807. CERAMICS. (4 cr; prereq grad)
Course designed for M.F.A. students not majoring in ceramics.

5-810. ADVANCED PROBLEMS. (4 cr per qtr [12 cr max]; prereq ‡)
Emphasis on aesthetic awareness and development with added emphasis on techniques and materials.

5-821. CERAMIC MATERIALS ANALYSIS. (4 cr; prereq ‡)
Glaze analysis and calculation. Investigation of glaze types, formulation, and materials. Development of procedures for investigation of unknown materials.

5-870. DIRECTED STUDY IN CERAMICS/GLASS. (Cr ar)

5-970. DIRECTED STUDIES. (1-3 cr; prereq ‡)

8-100. ADVANCED SEMINAR: PAINTING. (3 cr per qtr; prereq 8-110, ‡)

8-101/8-102/8-103. ADVANCED PROBLEMS IN PAINTING. (3 cr per qtr; prereq ‡) Busa, Hendler, Rowan, Morrison

8-104/8-105/8-106. ADVANCED PROBLEMS IN PAINTING. (3 cr per qtr; prereq ‡) Busa, Hendler, Rowan, Morrison

8-107/8-108/8-109. ADVANCED PROBLEMS IN DRAWING. (3 cr per qtr; prereq ‡) Staff

8-110. SEMINAR: THEORETICAL PROBLEMS IN ART. (3 cr per qtr; required of M.F.A. students; prereq consent of director of grad study) Graduate staff

8-300. ADVANCED SEMINAR: SCULPTURE. (1 cr per qtr [must be taken 3 qtrs to receive cr]; prereq 8-110, ‡)

8-304, 8-307, 8-311. ADVANCED PROBLEMS IN SCULPTURE. (3 cr per qtr; prereq ‡) Nash
8-304: Welding. 8-307: Experimental. 8-311: Casting.

8-305, 8-308, 8-312. ADVANCED PROBLEMS IN SCULPTURE. (3 cr per qtr; prereq 8-304 for 8-305, 8-307 for 8-308, 8-311 for 8-312, ‡) Nash
Individual research. 8-305: Welding. 8-308: Experimental. 8-312: Casting.

8-306, 8-309, 8-313. ADVANCED PROBLEMS IN SCULPTURE. (3 cr per qtr; prereq 8-305 for 8-306, 8-308 for 8-309, 8-312 for 8-313, ‡) Nash
Individual research. 8-306: Welding. 8-309, 8-313: Casting.

8-500. ADVANCED SEMINAR: PRINTMAKING. (3 cr per qtr; prereq 8-110, ‡)

8-501/8-502/8-503. PLATEMAKING—PLANOGRAPHIC PROCESSES. (3 cr per qtr; prereq 5-506, ‡) Myers, Bethke, Priede

8-504/8-505/8-506. ADVANCED PROBLEMS IN PRINTMAKING. (3 cr per qtr; prereq 5-503) Myers, Bethke, Priede

8-511/8-512/8-513. PRINTMAKING. (3 cr per qtr; prereq ‡) Myers, Bethke, Priede
For second-year M.F.A. students in any medium.

8-700. ADVANCED SEMINAR: PHOTOGRAPHY. (3 cr per qtr; prereq 8-110, ‡)

8-701/8-702/8-703. FILM. (3 cr; prereq 5-703, ‡) Downs

8-704/8-705/8-706. PHOTOGRAPHY. (3 cr; prereq 5-703, ‡) Downs

8-711/8-712/8-713. FILM. (3 cr per qtr; prereq 8-110, ‡) Downs

8-714/8-715/8-716. PHOTOGRAPHY. (3 cr; prereq 8-706 or ‡) Downs

8-800. ADVANCED SEMINAR: CERAMICS. (1 cr per qtr [must be taken 3 qtrs to receive cr]; prereq 8-110, ‡)

8-802/8-803/8-804. ADVANCED PROBLEMS IN CERAMICS. (3 cr per qtr; prereq ‡) MacKenzie

8-805/8-806/8-807. ADVANCED PROBLEMS IN CERAMICS. (3 cr per qtr; prereq 8-804) MacKenzie

8-821/8-822/8-823/8-824/8-825/8-826. ADVANCED PROBLEMS IN GLASS. (3 cr per qtr) Hoard
Investigation of glass chemistry and equipment design. Combined techniques using varying methods explored and produced with emphasis on professional achievement.

SURGERY (Surg)

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

THEATRE ARTS (Th)

Professor

Kenneth L. Graham, *chairman*
Wendell Josal,
director of graduate study
Arthur H. Ballet
John D. Hurrell
Robert D. Moulton
Ross D. Smith
Robert P. Sonkowsky
David W. Thompson
Frank M Whiting

Associate Professor

H. Lee Adey
H. Wesley Balk
Virginia Fredricks
Charles Nolte

Assistant Professor

George E. Bogusch
Jean G. Congdon
Mary K. Corrigan
Louis J. Dezseran
Warren L. Frost
Dale D. Huffington
Mary E. Wright

Instructor

Julien L. Phillips
Jean A. Montgomery
Richard V. Seifert

Prerequisites—For major work, a minimum of 18 undergraduate credits or their equivalent in speech or theatre. A comprehensive diagnostic examination is a prerequisite for graduate work in theatre and must be taken before or during the first quarter of residence.

Research Technique Requirement—8-101, "Introduction to Research," is required of all graduate degree candidates in theatre arts. For the master of arts and master of fine arts degrees, there is no requirement for candidates beyond including the "Introduction to Research" course in their program. For the Doctor's degree, candidates are expected to prepare a technique sufficient for carrying out research at the doctoral level. They must support their claim to this preparation by submitting no fewer than 9 credit-hours of work in relevant courses as part of their 3-year program. Foreign language, statistics, historiography, and critical methods are among the techniques which will be considered.

Master of Arts Degree—Offered under both Plan A and Plan B. For Plan B, the 27 minimum credits should be selected as follows:

3 credits—Introduction to Research
8 credits—from subfields 1-3
8 credits—from subfields 4-7
At least 8 credits from any subfield(s)

A final written examination is required under both Plan A and Plan B. In addition, a final oral examination is required for Plan A.

Additional reading requirements in dramatic literature are to be selected with the approval of the adviser.

Master of Fine Arts Degree—Students may apply for candidacy after one quarter's residency. Students must complete a program of approximately 2 full years of graduate credits, 45 of which must be earned in graduate courses at the University of Minnesota. They must execute and leave a record of a creative project (production, recital, or exhibition) which will be accompanied by a supporting paper that deals with the planning and/or execution of the creative work. A minimum of 9 credits is required in history or literature within the major field. A minimum of 9 credits is required outside the major field of theatre. The individual program must be approved by the department M.F.A. committee and the Graduate School M.F.A. committee. The candidate will be subject to a final oral examination.

Doctor's Degree—The Ph.D. degree may be earned in the major field: theatre arts. Comprehensive written and oral examinations must be passed showing competency in all subfields with special competence in subfield one (1) and any four of

the remaining six agreed upon by the candidate and the adviser. The choice of a minor is subject to the approval of the major and minor advisers, or a supporting program may be substituted with the approval of the major adviser and the director of graduate study. Additional reading requirements in dramatic literature are to be selected with the approval of the adviser.

Theatre Limitation—Of the following practicum and performance courses—5-100, 8-311/8-312/8-313, 8-321, 8-322, 8-323, 8-326/8-327/8-328—the maximum number of credits for graduate degrees is: M.F.A., unlimited; M.A. (Plan A), 6 credits; M.A. (Plan B), 9 credits; and Ph.D., 18 credits.

General

0-100f,w,s. THEATRE HOUR. (No cr; required each qtr for Upper Division theatre arts majors and grad theatre arts majors in residence) Staff

5-100. THEATRE PRACTICUM. (2-6 cr; prereq △; ♯) Josal and staff
Arranged individual creative projects in production of a play meeting approval of a faculty committee in one or more of these areas: playwriting, directing, acting, and design.

5-970. DIRECTED READING. (2-6 cr; prereq 9 cr in theatre, ♯ and △)
Directed reading and preparation of reports on selected subjects.

8-101. INTRODUCTION TO RESEARCH. (3 cr; required of all majors in theatre arts; prereq theatre major or ♯) Bogusch
Graduate research in theatre arts; selection of topics and methods of investigation.

8-140. SEMINAR: PRESENTATION OF CLASSICAL TEXTS. (3 cr [may be repeated for cr], §Spch 8-140; prereq Spch 5-611 or 5-813 or 5-831 or 5-712) Sonkowsky
Problems in public presentation of English translation of classical Greek and Roman texts. Attention to ancient critical theory as related to performance. Topics vary with individual interests: directing, acting, oral interpretation, translating, adapting for modern audience.

8-990. RESEARCH. (Cr ar; ♯ and △) Staff
Open to graduate students engaged in research on special problems.

Subfields

1. HISTORY AND THEORY

5-171, 5-172, 5-173. HISTORY OF THEATRE. (4 cr per qtr; prereq sr or grad theatre major or ♯) Nolte
Plays, arts and crafts of theatre from their beginnings to present. Reports and projects. 5-171: Ancient and Medieval. 5-172: Renaissance through mid-19th century. 5-173: Late 19th and 20th century.

5-177, 5-178. THEATRE BACKGROUNDS. (4 cr per qtr; prereq sr with ♯, grad, 1-101 or equiv, 9 upper div cr in English, speech, classics, or modern language; offered when feasible) Bogusch
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 time. 5-177: Origins through 18th century. 5-178: 19th, 20th century.

5-180. THEATRE SYMPOSIUM. (6 cr)
Intensive study of the art of theatre with particular emphasis on productions and production methods of the Tyrone Guthrie Theatre. Conducted by professional critics, actors, directors, and designers as well as University faculty members.

5-186. AMERICAN THEATRE. (4 cr; prereq sr or grad theatre major or ♯) Nolte
Theatre as an aspect of American culture from 1752 to present.

8-157/8-158/8-159. SEMINAR: DRAMATIC THEORY. (4 cr per qtr, §Engl 8-691, 8-692, 8-693; prereq 5-171, 5-172, 5-173 or ♯, 9 cr dramatic literature) Hurrell
Critical theory of dramatic arts, classical to modern. 8-157: Classical, Renaissance, and Neoclassical dramatic theory and criticism, with special attention to Shakespeare criticism. 8-158: 19th and 20th century dramatic theory and criticism. 8-159: Special problems in theory and criticism of drama.

8-174/8-175. SEMINAR: EUROPEAN THEATRE HISTORY. (3 cr; prereq 5-171, 5-172, 5-173 or ‡) Bogusch
Selected research topics in theatre of England and Europe. 8-174: 16th, 17th, or 18th centuries. 8-175: 19th and 20th centuries.

8-176. SEMINAR: AMERICAN THEATRE HISTORY. (3 cr; prereq 5-186, ‡) Bogusch
Selected research topics from the 18th, 19th, or 20th century American theatre.

2. ORAL INTERPRETATION

5-802. ORAL INTERPRETATION OF POETRY. (4 cr; prereq 3-801 or grad)
Study of selected lyric poems. Solo and group readings.

5-803. ORAL INTERPRETATION OF DRAMA. (4 cr; prereq 3-801 or grad)
Study of selected plays. Solo and group readings.

5-811. HISTORY OF ORAL INTERPRETATION. (4 cr; prereq 3-801 or ‡)
Selected oral and literary traditions from ancient times to the present.

5-813. THEORY OF READING AND ACTING. (4 cr; prereq 5-802 or 5-803 or grad)
Exploration of aesthetic and literary theories as they relate to oral interpretation and acting.

5-821. GROUP READING. (4 cr; prereq 5-802, 5-803, or grad)
Advanced course in oral interpretation of imaginative literature. Problems in aesthetic analysis and ensemble performance. Readers theatre presentations.

5-831. ORAL INTERPRETATION OF CLASSICAL LATIN LITERATURE. (4 cr; Lat 5-038; prereq 2 yrs Latin or equiv and 3-801 or 3-321 or ‡) Sonkowsky
Phonetics, prosody, and oral performance of selected texts in classical Latin.

8-801, 8-802, 8-803. SEMINAR: ORAL INTERPRETATION OF LITERATURE. (3 cr per qtr; prereq 5-813) Thompson, Fredricks and staff
Problems of silent and oral reading. Speech in relation to language and types of literature. 8-801: Fiction; 8-802: Poetry; 8-803: Drama.

3. PLAYWRITING

5-115/5-116/5-117. PLAYWRITING. (4 cr per qtr; prereq 1-321 or ‡) Nolte, others
After evidence of thorough groundwork in the established techniques of the well-made play, the student is encouraged to use other, more experimental forms. 5-115: One-act play; 5-116/5-117: Full-length play.

8-110. SEMINAR: PLAYWRITING. (2-6 cr per qtr; limited to students of exceptional promise; prereq 5-117 and ‡) Nolte, Thompson
Advanced work in creative writing for the stage.

4. ACTING

5-330. DIRECTED PROJECTS IN ACTING. (1-3 cr, ¶8-711, 8-712, 8-713 not permitted; prereq jr, sr, 3-321 or grad theatre major)
Correlates with (and may not be taken in concurrent registration with) 8-711, 8-712, 8-713. Students will prepare roles in scenes directed by students in direction seminar as laboratory demonstration of direction techniques.

5-334/5-335/5-336. ACTING FOR MUSIC-THEATRE. (4 cr per qtr; prereq Mus 5-470 or ‡) Balk
Acting and staging problems in music-theatre.

5-501. SHOWBOAT LABORATORY. (2-6 cr; prereq △, ‡) Whiting
Arranged voice and movement sessions open to members of current Showboat Company.

8-311/8-312/8-313. VOICE PRODUCTION FOR THE THEATRE. (3 cr per qtr; prereq grad and theatre major) Corrigan and staff
Physical exercises designed to free the human voice from unnecessary inhibitions and tensions. Work on prose, poetry, and drama. Vocal exercises with piano.

8-321, 8-322, 8-323. PROBLEMS IN ACTING. (3 cr per qtr; prereq 3-321 or ‡) Dezseran and staff
Classical dramaturgy with scene study from the Greek, Roman and Medieval periods. Emphasis on intensive scene and character analysis and on skill in communicating character and concept to an audience in individual and group performances.

8-326/8-327/8-328. HISTORY AND TECHNIQUE OF STAGE MOVEMENT. (3 cr per qtr; prereq 5-171, 5-172, 5-173 or ‡) Moulton
Application of historical research in the area of manners, games, and dances to techniques of body movement for the stage.

8-329. EXPERIMENTAL LABORATORY. (3 cr; prereq 8-328 or ‡) Moulton
Advanced techniques in voice and movement.

5. CREATIVE DRAMA AND CHILDREN'S THEATRE

5-131. CREATIVE DRAMA. (4 cr; prereq 1-101 or ¶1-101 or elementary education major or ‡...1-321 rec) Graham, Wright
Principles and methods of developing original dramatizations with children. Observation of children's classes in creative dramatics. Readings, projects, term papers.

5-132. THEATRE FOR CHILDREN. (4 cr; prereq 3-708, 3-711, or 5-711 or ‡) Graham
Selection, direction, and production of plays for children's audiences, co-ordinated with current productions of the Young People's University Theatre.

5-133. PRODUCING THEATRE FOR CHILDREN. (2-4 cr; prereq 1-101 or ¶1-101, ‡) Graham and staff
Techniques and practice of performing for audiences of children.

5-134. ADVANCED CREATIVE DRAMA. (4 cr; prereq 5-131, teaching experience and ‡; limited to 15 students) Graham
In-depth study of philosophy, techniques and materials; experience in creating, leading and criticizing beginning and advanced sessions with classmates and children.

6. DESIGN AND TECHNICAL

5-512. ADVANCED PROBLEMS IN COSTUMING. (4 cr; prereq 3-515, 3-711 or ‡) Phillips
Theory and design of costumes; special projects.

5-514. ADVANCED PROBLEMS IN SCENE DESIGN. (4 cr; prereq 3-513, 3-711 or ‡) Josal, Miller
Theory and design of stage scenery; special reports and projects.

5-516. ADVANCED PROBLEMS IN STAGE LIGHTING. (4 cr; prereq 3-515, 3-711 or ‡) Montgomery
Theory of stage lighting. Special projects and reports.

5-518. ADVANCED PROBLEMS IN STAGE PROPERTIES. (4 cr; prereq 3-513, 3-711 or ‡) Josal
Theory and design of stage properties. Special projects and reports.

5-519. SOUND FOR THE THEATRE. (2 cr; prereq ‡) Seifert
Theory and technique of producing and amplifying sound for the theatre.

5-520. COSTUMING CRAFTS AND TECHNIQUES. (4 cr; prereq 3-515, 5-512 or ‡) Garceau
Guthrie Theatre Costume Shop. Specialized theory and practice in costuming in professional and repertory theatres.

8-518. SEMINAR: VISUAL ARTS OF DRAMA. (3 cr; prereq theatre major or ‡; offered when feasible) Josal
Examination of selected aesthetic theories of plastic and poetic arts; relationship to visual aspects of the dramatic production. Theory of art as a symbol.

8-519. SEMINAR: THEATRE PLANNING. (3 cr; prereq 5-512, 5-514, 5-516 or equiv...‡; 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.

8-520. SEMINAR: STAGE COSTUMING. (3 cr; prereq 3-515, 5-512 or ‡; offered when feasible) Phillips
Research in specialized areas in costume design; projects and reports.

8-540. SEMINAR: SCENE DESIGN. (3 cr; prereq 3-513, 5-514 or ‡; offered when feasible) Josal
Research in specialized areas in scene design; projects and reports.

8-560. SEMINAR: STAGE LIGHTING. (3 cr; prereq 3-515, 5-516 or equiv...‡; offered when feasible) Montgomery
Research in specialized areas in stage lighting, projects and reports.

7. DIRECTING

5-711. STAGE DIRECTION. (4 cr, §3-708, §3-711, prereq 1-321) Adey and staff
Theory of direction: concept and analysis. Exercises in blocking and production of short scenes.

5-712. STAGE DIRECTION. (4 cr, §3-709; prereq 3-708 or 3-711 or 5-711) Whiting and staff
Theory of rehearsal and production problems and direction of two one-act plays.

5-716. STAGE MANAGEMENT FOR THE THEATRE. (4 cr; prereq 3-711 or 5-711 and △) Montgomery
Stage management as a specialized area of theatre with emphasis on theory and technique of rehearsal and performance, organization and management in educational, repertory and regional theatre.

5-718. THEATRE MANAGEMENT AND PROMOTION. (4 cr; prereq 1-504 or ¶1-504 or ‡) Loppnow
Theory and practice in ticket office procedures, house management, publicity, and promotion; special problems in college, community, children's and professional theatre.

5-721, 5-722. PRODUCTION OF TELEVISION DRAMA. (4 cr per qtr; prereq 3-711 or equiv) Frost
Televised drama produced and analyzed with reference to adaptation of techniques and theory from stage production. Intended primarily for theatre majors.

8-711, 8-712, 8-713. SEMINAR: STAGE DIRECTION. (3 cr; prereq 5-712 or equiv or ‡) Balk
Great plays and their potentials for meaningful and effective production in modern theatre.

UROLOGY (Urol)

For information on staff, program, and courses, see the bulletin, *Graduate Programs in the Health Sciences.*

VETERINARY MEDICINE

Programs leading to the M.S. and Ph.D. degrees are offered in the various departments of the College of Veterinary Medicine. Major or minor work leading to the master of science and doctor of philosophy degree may be taken in the following fields: veterinary anatomy, veterinary microbiology, veterinary medicine, veterinary obstetrics and gynecology, veterinary parasitology, veterinary pathology, veterinary physiology and pharmacology, and veterinary surgery and radiology.

Prerequisites—Graduate students who major or minor in the clinical fields of veterinary medicine must have a D.V.M. degree or its equivalent.

Language Requirement—Foreign languages of scientific interest may or may not be required for both the M.S. and Ph.D. degrees. Requirements vary among departments.

Master's Degree—Offered under Plan A and Plan B.

Doctor's Degree—Work for the Ph.D. degree is offered in the fields listed below. Students who major in any field of veterinary medicine must choose a minor in a field outside of veterinary medicine or a supporting program of study.

Veterinary Anatomy (VAna)

Professor
Alvin F. Weber, D.V.M., Ph.D., *head*

Associate Professor
Caroline M. Czarnecki, Ph.D.
Thomas F. Fletcher, D.V.M., Ph.D.

Assistant Professor
James C. Vanden Berge, Ph.D.
Everett H. Heath, D.V.M., Ph.D.
Robert F. Hammer, D.V.M., Ph.D.
Walter J. Mackey, D.V.M., M.P.H.

5-120. ESSENTIALS OF VERTEBRATE DEVELOPMENT AND STRUCTURE. (5 cr; prere Biol 1-002 or 3-011 or ‡)
Principles and patterns of vertebrate anatomy, based on developmental approach.

5-120.* SEMINAR: VETERINARY ANATOMY. (1 cr; prereq 5-201, 5-261 or ‡)

5-140. COMPARATIVE VERTEBRATE MICROSCOPIC ANATOMY. (5 cr; prereq 5-120 or ‡)
Comparative studies of tissues and organs of representative examples of vertebrates.

5-201. ANATOMY OF THE DOG. (5 cr; prereq ‡)
Detailed study of gross anatomical structure and function. The dog is utilized as a type species to introduce nomenclature and principles of mammalian gross anatomy; comparisons are made with the cat.

5-202. VETERINARY COMPARATIVE ANATOMY. (5 cr; prereq ‡)
Comparative study of structural and functional gross morphologic features of domestic animals, including horses, cattle, sheep, swine. Survey of avian structure is included.

5-230. VETERINARY NEUROANATOMY. (3 cr; prereq ‡)
Structural and functional features underlying organization of the central nervous system and special senses. The canine is utilized as a type species to study gross and microscopic relationship.

5-250. COMPARATIVE PRENATAL DEVELOPMENT OF DOMESTIC ANIMALS. (3 cr; prereq ‡)
Fundamental concepts of embryonic development; microscopic and gross anatomical studies of the origin and development of organ systems; morphological consideration of fetal-maternal relationship; study of developmental anomalies.

5-261/5-262/5-263. MICROSCOPIC ANATOMY OF DOMESTIC ANIMALS. (3 cr for 5-261, 4 cr for 5-262, 4 cr for 5-263; prereq ‡)
Light microscopic and relevant ultrastructural studies of cells, tissues and organ systems.

5-406. VETERINARY CLINICAL ANATOMY. (3 cr; prereq 5-201, 5-202, or ‡)
Topographical anatomy of domestic animals relating structure to clinical veterinary medicine and surgery.

5-407. TOPICS IN CLINICAL ANATOMY. (1 cr; prereq 5-406, ‡)
Each student prepares a paper based on morphologic investigation of clinical interest.

5-504. ANATOMY OF LABORATORY ANIMALS. (3 cr; prereq 5-201 or ‡) Staff
Gross structural and functional features of common laboratory animals.

5-534. CANINE CLINICAL NEUROLOGY. (1 cr; prereq ‡)
Anatomic and physiologic basis for neurologic examination of the dog.

5-791x.* TOPICS IN ORGANOLOGY. (1-5 cr per qtr [may be repeated for cr]; prereq 5-261 or equiv, ‡)
Lecture and laboratory presentations regarding selected organ systems of domestic and laboratory animals.

8-201, 8-202. COMPARATIVE VETERINARY NEUROLOGY. (4 cr per qtr; prereq 5-201, ‡)
Correlated studies of central nervous system of domestic animals. Emphasis on relating neuroanatomy to neurophysiology.

8-203. EXPERIMENTAL COMPARATIVE VETERINARY NEUROLOGY. (3 cr; prereq 8-202, ‡)
Principles, methods, and laboratory exercises in investigating central nervous system of domestic animals.

8-220. FUNCTIONAL MORPHOLOGY AND ADAPTATION. (4 cr; prereq 5-140 or equiv, ‡)
Topical approach to vertebrate morphology relating structure and function to vertebrate development, form, adaptation, and evolution; vertebrate morphology and animal model system research.

8-261. MORPHOLOGY OF ANIMAL CELLS AND INTERCELLULAR SUBSTANCES. (3 cr; prereq 5-263, ‡)
Components of basic tissues of the animal body.

8-280. HISTOLOGICAL AND ULTRAHISTOLOGICAL TECHNIQUES. (3 cr; prereq 5-263, ‡)
Principles and methods in preparing animal tissues for histological and ultrahistological observation.

8-331, 8-332, 8-333. RESEARCH PROPOSITION IN MORPHOLOGY. (2 cr per qtr; prereq ‡)
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 are evaluated by departmental graduate faculty.

Veterinary Medicine (VM)

Professor

Dale K. Sorensen, D.V.M., Ph.D., *dean, director of graduate study*
Donald W. Johnson, D.V.M., Ph.D., *acting head*
Thor Kommedahl, Ph.D.
George W. Mather, D.V.M., Ph.D.
Robert H. Monahan, M.D.
Samuel Schwartz, M.D.
Hank L. Stoddard, D.V.M., D.T.V.M.
Edward A. Usenik, D.V.M., Ph.D.

Associate Professor

Kirk N. Gelatt, V.M.D.
LaRue W. Johnson, D.V.M., Ph.D.
Vaughn L. Larson, D.V.M., Ph.D.
Carl A. Osborne, D.V.M., Ph.D.
Richard E. Shope, Jr., D.V.M., Ph.D.

Assistant Professor

John F. Anderson, D.V.M., M.S.
Paul E. Zollman, D.V.M.

5-101. VETERINARY PHYSICAL DIAGNOSIS. (2 cr; prereq ‡)
Fundamentals of clinical veterinary medicine, procedures in physical diagnosis and restraint of animals.

5-102/5-103. DIAGNOSTIC AND THERAPEUTIC TECHNIQUES AND PROCEDURES. (2 cr for 5-102, 1 cr for 5-103; prereq ‡)
Demonstration and application of diagnostic techniques and procedures. Discussions of therapeutic regimens and demonstrations of therapeutic procedures.

5-201. LARGE ANIMAL MEDICINE. (5 cr; prereq 5-101 or ‡)
Diseases of the cutaneous, musculoskeletal, respiratory, cardiovascular, hemic, and lymphatic systems of large domestic animals.

5-202. LARGE ANIMAL MEDICINE. (7 cr; prereq 5-201 or ‡)
Diseases of the digestive, urinary, endocrine, and nervous systems, and organs of special sense of large domestic animals.

5-203. LARGE ANIMAL MEDICINE. (6 cr; prereq 5-202 or ‡)
Nutritional, metabolic, and infectious diseases of large domestic animals.

5-210.* HERD HEALTH MANAGEMENT OF DAIRY CATTLE. (3 cr, §VObs 5-311; prereq regis veterinary medicine, 4th yr or grad or ‡)
Principles and applications of programmed veterinary service to dairy herds.

5-211. HERD HEALTH MANAGEMENT OF BEEF CATTLE, SWINE, SHEEP, AND HORSES. (3 cr, §VObs 5-312; prereq regis veterinary medicine, 4th yr or grad or ‡)
Principles and applications of programmed veterinary service to these species of animals.

5-220. POISONOUS PLANTS. (1 cr; prereq regis veterinary medicine, 4th yr or grad or ‡)
(Same as PlPa 5-200) Important plants poisonous to animals; identification, toxicology, diagnosis, and treatment.

5-230. DISEASES OF ZOO ANIMALS AND EXOTIC PETS. (1 cr; prereq regis veterinary medicine, 4th yr or grad or ‡)
Common disease problems and management procedures of reptiles, fish, primates, felines, rodents, large and small animals. Includes procedures utilized in the restraint, medication and diagnosis of these animals.

5-301. SMALL ANIMAL MEDICINE. (3 cr; prereq 5-101 or ‡)
Introductory discussions of breeds, care, feeding, nutritional problems, and management of companion pet animals. Study of diseases of the cutaneous, musculoskeletal, respiratory, and cardiovascular systems of companion animals.

5-302. SMALL ANIMAL MEDICINE. (4 cr; prereq 5-301 or ‡)
Diseases of the hemic, lymphatic, digestive, urinary, genital, endocrine, and nervous systems of companion animals.

5-303. SMALL ANIMAL MEDICINE. (3 cr; prereq 5-302 or ‡)
Diseases of organs of special sense and a discussion of infectious and toxic diseases of companion animals. Also includes discussions of diseases affecting pet birds and laboratory animals.

5-320. HOSPITAL MANAGEMENT. (1 cr; prereq regis veterinary medicine, 4th yr or grad or ‡)
Lectures on managing a small animal hospital, including zoning restrictions, employee supervision, drug purchases, facilities, fees, and other information pertinent to a modern veterinary medical hospital.

5-325.* VETERINARY OPHTHALMOLOGY. (2 cr; prereq regis veterinary medicine, 4th yr or grad or ‡)
Lectures, seminars, and laboratory exercises on diseases of the animal eye. Topics include ocular anatomy, physiology, pharmacology, and therapeutics, pathology, examination procedures, and medical and surgical treatment of common ophthalmic diseases.

5-335. DISEASES OF THE KIDNEY. (2 cr; prereq regis veterinary medicine, 4th yr or grad or ‡)
(Same as VPaP 5-301) Illustrated discussions, integrating lesions, pathogenesis, and signs of the diseases of the kidney.

5-336. DISEASES OF THE LIVER AND PANCREAS. (2 cr; prereq regis veterinary medicine, 4th yr or grad or ‡)
(Same as VPaP 5-311) Illustrated discussions, integrating lesions, pathogenesis, and signs of the diseases of the liver and pancreas.

5-340. SMALL ANIMAL DERMATOLOGY. (2 cr; prereq regis veterinary medicine, 4th yr or grad or ‡)
Detailed discussions of the pathogenesis, clinical features, diagnosis, and therapy of skin diseases of dogs and cats.

5-401. A SURVEY OF LAW AND BUSINESS METHODS. (3 cr; prereq ‡)
Business and legal procedures applicable to veterinary practice. Responsibilities of the veterinarian to the client, the public, and the profession.

5-402. INVESTMENTS AND INSURANCE. (1 cr; prereq regis veterinary medicine, 4th yr or grad or ‡)
Fundamental of investments in bonds, common and preferred stocks, and mutual funds, and the fundamentals of general and life insurance.

5-410. PREVENTIVE MEDICINE AND APPLIED IMMUNOLOGY. (2 cr; prereq regis veterinary medicine, 4th yr or grad or ‡)
Principles and applications of preventive medical procedures for specialized practices. Review of principles of immunology and their clinical application.

5-510, 5-511/5-512/5-513. CLINICS. (6 cr for 5-511 or 5-510, 8 cr for 5-512, 8 cr for 5-513; prereq 5-502 or ‡)
Laboratory for the application of principles and techniques of medicine, surgery, obstetrics, radiology, pathology, clinical pathology, parasitology, pharmacology, and physiology to the diagnosis, prognosis, treatment, prevention, and eradication of disease in domestic animals. 5-510, 5-511 and 5-512 also include the application of principles of public health.

5-520. SPECIAL CLINICS. (8 cr; prereq 5-513 or ‡)
(Same as VM 5-513 except that students may elect large animal clinic, small animal clinic, or a combination of both.

5-535. EXTERNSHIP SEMINAR. (1 cr; prereq regis veterinary medicine, 4th yr or grad or ‡)
Clinical problems which students experienced during their externship with veterinarians in private practice. Major emphasis will be discussion of diseases of food-producing animals and horses.

5-790. SEMINAR: WORLD FOOD SUPPLY PROBLEMS. (4 cr; limited enrollment; prereq major in agriculture, veterinary medicine, nutritional sciences, social science field, or ‡...grad students by △ only)
(Same as AgEc 5-790, HE 5-395, PlPa 5-220, Soc 5-675) A multi-disciplinary approach to social, economic, and technical problems of feeding the world's growing population. Principles from social and economic sciences, plant sciences, animal sciences, and nutritional sciences applied to food problems.

8-210x. ADVANCED VETERINARY MEDICINE. (Cr ar; prereq 5-203, 5-210, ‡)
Detailed discussions of the diseases of organs or systems in animals. One of the following etiologic group—prenatal, metabolic, toxic, infectious, or physical influences—will be selected for discussion for any quarter.

8-220x. ADVANCED DIAGNOSIS AND THERAPEUTICS OF ANIMAL DISEASES. (Cr ar; prereq 5-203, 5-303, ‡)
Detailed examination, discussions, and treatment of cases of animal diseases.

8-230x.* SEMINAR. (Cr ar; prereq ‡)

8-240x.* MEDICAL CONFERENCE. (Cr ar; prereq 5-203, ‡)
Medical, surgical, or obstetrical cases supported by anatomic, bacteriologic, pathologic, physiologic, pharmacologic, and radiologic evaluations whenever applicable.

8-250. COMPARATIVE VETERINARY MEDICAL OPHTHALMOLOGY. (3 cr; prereq grad or ‡)
Consists of lectures, seminars, and laboratory exercises of diseases of the eye of domestic animals. Routine and experimental diagnostic procedures for the dog and horse will be emphasized. A research project in experimental or clinical medical ophthalmology with subsequent presentation to the faculty or publication is also required.

8-252. COMPARATIVE VETERINARY SURGICAL OPHTHALMOLOGY. (3 cr; prereq grad or ‡)
Consists of lectures, seminars, and surgical exercises on diseases of the animal eye. Common and experimental surgical procedures for the dog and horse will be emphasized. A research project in experimental or clinical surgical ophthalmology with subsequent presentation to the faculty or publication is also required.

Veterinary Microbiology and Public Health (VMic)

Professor

Benjamin S. Pomeroy, D.V.M., Ph.D., *head, director of graduate study*
Robert K. Anderson, D.V.M., M.P.H.
John M. Higbee, D.V.M.
R. K. Lindorfer, Ph.D.
Keith I. Loken, D.V.M., Ph.D.

Associate Professor

Donald K. Barnes, D.V.M., Ph.D.
Stanley L. Diesch, D.V.M., M.P.H.
James A. Libby, D.V.M., M.S.
Glen H. Nelson, D.V.M.
R. F. Shope, Jr., D.V.M., M.S.

Assistant Professor

S. K. Maheswaran, D.V.M., M.S., Ph.D.

5-101. GENERAL VETERINARY BACTERIOLOGY AND IMMUNOLOGY. (5 cr; prereq 10 cr zoology, 13 cr chemistry, ‡)
Lectures and laboratory on classification, morphology, and physiology of bacteria; bacteriology of water, sewage, milk, and food. Basic principles of infection and immunity.

5-102. PATHOGENIC BACTERIA AND FUNGI. (5 cr; prereq 5-101 or equiv, ‡)
Lectures and laboratory on animal pathogens; basic mechanisms of infection.

5-103. VETERINARY VIROLOGY. (5 cr; prereq 5-102 or equiv, ‡)
Basic techniques of virology; viral and rickettsial agents which cause animal diseases.

5-210. VETERINARY EPIDEMIOLOGY. (4 cr; prereq 10 cr biology, 12 cr chemistry, ‡)
Principles of epidemiology, ecology, and veterinary public health. Biostatistics applied to measurement of health and disease in populations.

5-220. VETERINARY PUBLIC HEALTH. (4 cr; prereq 5-103, VPaP 5-203 or equiv, ‡)
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 man.

5-230. LABORATORY ANIMAL MEDICINE. (2 cr)
Lectures, discussions, and demonstrations on various aspects of care and management of numerous species of laboratory animals found in a research situation. Includes disease, nutrition, zoonoses, gnotobiotics, restraint, anesthesia, and environmental practices. Tours of laboratory animal colonies, both commercial and institutional.

5-240. EPIDEMIOLOGY OF ZOONOSES. (2 cr)
Zoonotic diseases of companion animals. Emphasis on reservoirs, sources, transmission, and specific prevention and control programs.

5-241. EPIDEMIOLOGY OF ZOONOSES. (1 cr; prereq regis veterinary medicine, 4th yr or grad or ‡)
Zoonotic diseases of food producing animals. Reservoirs, sources, transmission and specific prevention and control programs.

5-300. POULTRY HYGIENE. (3 cr; prereq Biol 1-002, AnSc 1-100, MicB 3-103; offered 1973-74 and alt yrs)
General anatomy of the fowl, physiology of digestion and reproduction, and prevention and control of the more important diseases affecting poultry.

5-320. COMPARATIVE MEDICINE AND PUBLIC HEALTH. (2 cr; not open to veterinary medicine students; prereq PubH 5-002)
(Same as PubH 5-300) Man's relationship to the biologic environment. Interrelationships of animal and human health; occurrence of animal diseases; ecology of zoonoses; food production and hygiene; laboratory animal medicine.

5-331. POULTRY DISEASES. (3 cr; prereq 5-103, VPaP 5-203 or equiv or ‡)
Lectures dealing with diseases, management, and feeding practices in current poultry production.

5-332. POULTRY DISEASE PREVENTION AND NUTRITION. (3 cr)
Principles and applications of poultry disease preventive programs; management and nutrition.

5-410x.* **PROBLEMS IN VETERINARY BACTERIOLOGY AND PUBLIC HEALTH.** (Cr ar; prereq 5-103 or equiv, ‡)

5-520. VETERINARY SCIENCE. (3 cr; prereq College of Pharmacy sr, or Phsl 3-070, Phcl 5-102 or equiv, ‡)
(Same as VPP 5-520, Phm 5-520) Professional interrelationships between pharmacists and veterinarians; disease problems of domestic animals; veterinary pharmacotherapeutics.

8-205x.* **ADVANCED VETERINARY BACTERIOLOGY.** (Cr ar; prereq ‡)
Special topics, techniques, collateral reading, and conferences.

8-210x.* **ADVANCED POULTRY DISEASE.** (Cr ar; prereq 5-331, ‡)
Investigations of specific infectious disease problems of poultry.

8-211. SEMINAR: VETERINARY BACTERIOLOGY. (1 cr; prereq ‡)

8-221. ZOONOSES AND COMPARATIVE MEDICINE. (Cr ar; prereq ‡)

Veterinary Obstetrics and Gynecology (VObs)

Professor

Raimunds Zemjanis, D.V.M., Ph. D., *head*
Edmund F. Graham, Ph.D.
Francis A. Spurrell, D.V.M., Ph.D.
Edward F. Usenik, D.V.M., Ph.D.

Associate Professor

Melvyn L. Fahning, D.V.M., Ph.D.
Allan G. Hunter, Ph.D.
Richard Schultz, D.V.M., Ph.D.

5-001. VETERINARY OBSTETRICS. (4 cr; prereq VM 5-101 or ‡)
Lectures covering physiology and pathology of pregnancy, obstetrics, and diseases of the newborn. Laboratory practices in manipulative obstetrics.

5-103. CLINICAL DIAGNOSIS IN ANIMAL REPRODUCTION. (4 cr; prereq VM 5-101 or ‡)
Lectures, demonstrations, and laboratory practices covering diagnostic techniques and procedures.

5-105. INFERTILITY CLINICS. (Cr ar; prereq 5-211, 5-103 or ‡)
Investigation of hospital cases and field problems of infertility of domestic animals. Includes clinical examination, discussion of diagnosis, prognosis, and therapy. Assignment of special study of certain reproductive disorders.

5-120. HEREDITY IN ANIMAL DISEASE. (3 cr; prereq GCB 3-022 or equiv or ‡)
Application of genetic principles to animal disease problems with emphasis on specific inheritable and familial conditions in domesticated species.

5-211. REPRODUCTIVE DISEASES OF DOMESTIC ANIMALS. (4 cr; prereq VM 5-101 or ‡)
Lectures covering physiology and pathology of reproduction, artificial insemination, and breeding management.

5-305. BREEDING PATTERNS, BREEDING TECHNOLOGY, AND INFERTILITY IN CATTLE. (2 cr; prereq 5-001, 5-211, 5-103, regis veterinary medicine, 4th yr or grad or ‡)
Lectures and demonstrations involving breeding patterns, breeding practices, artificial insemination, synchronization of heat, economics of reproductive performance and infertility in cattle. Emphasis placed on diagnosis, prognosis, and therapy.

5-307. INFERTILITY IN CATTLE. (1 cr; prereq 5-211 or ‡)
Lectures covering infertility of cattle. Emphasis directed toward clinical approach to diagnosis, prognosis, and therapy.

5-310. REPRODUCTION AND INFERTILITY IN THE BULL. (1 cr; prereq 5-211, regis veterinary medicine, 4th yr or grad or ‡)
Lectures and demonstrations covering reproductive patterns, management, fertility, and infertility in the bull. Emphasis on clinical approach to diagnosis, prognosis, and treatment.

5-311.* **HERD HEALTH MANAGEMENT OF DAIRY CATTLE.** (3 cr, §VM 5-210; prereq regis veterinary medicine, 4th yr or grad or ‡)
Principles and application of programmed veterinary service.

5-312. HERD HEALTH MANAGEMENT OF BEEF CATTLE, SWINE, SHEEP, AND HORSES. (3 cr; prereq regis veterinary medicine, 4th yr or grad or ‡)
Principles and applications of programmed veterinary service to these species of animals.

5-324. REPRODUCTION AND INFERTILITY IN SWINE. (1 cr; prereq 5-211, regis veterinary medicine, 4th yr or grad or ‡)
Lectures and demonstrations involving reproductive patterns, breeding practices, management, artificial insemination, synchronization of estrus, economics of reproductive performance and infertility in swine.

5-405. REPRODUCTION AND INFERTILITY IN THE HORSE. (1 cr; prereq 5-211, regis veterinary medicine, 4th yr or grad or ‡)
Lectures and demonstrations involving reproductive patterns, breeding practices, management, artificial insemination, economics of reproductive performance and infertility in horses.

5-505. REPRODUCTIVE PATTERNS AND INFERTILITY IN THE DOG AND CAT. (1 cr; prereq 5-211, regis veterinary medicine, 4th yr or grad or ‡)
Lectures and demonstrations involving reproductive patterns, management, artificial insemination, and infertility in dogs and cats.

8-100x.° ADVANCED DIAGNOSTIC METHODS. (Cr ar; prereq 5-211 or ‡)
Discussion and laboratory practices of methods for determination of fertility status of female and male animals.

8-200x. SEMINAR. (1 cr)

8-210, 8-211, 8-212.° ADVANCED ENDOCRINOLOGY OF REPRODUCTION. (1 cr per qtr; prereq VPP 5-310, MdBc 5-100, MdBc 5-101)
Physiological aspects of endocrinology involved in sex function. 8-210: Pituitary and pregnancy gonadotrophins. 8-211: Gonadal hormones. 8-212: Interaction between endocrine and nervous systems.

8-600x.° SPECIAL PROBLEMS IN ANIMAL REPRODUCTION. (Cr ar; prereq 5-211 or ‡)
Detailed discussion and laboratory study of specific reproductive disorders.

Veterinary Pathology and Parasitology (VPaP)

Professor
Victor Perman, D.V.M., Ph.D., *acting head*
Henry J. Griffiths, D.V.M., Ph.D.
J. H. Sautter, D.V.M., Ph.D.

Associate Professor
William J. Bemrick, Ph.D.
K. H. Johnson, D.V.M., Ph.D.
H. J. Kurtz, D.V.M., Ph.D.
J. C. Schlotthauer, D.V.M., Ph.D.

Assistant Professor
L. D. McGill, D.V.M., Ph.D.
T. P. O'Leary, D.V.M., Ph.D.

5-101. VETERINARY PARASITOLOGY. (5 cr; prereq ¶5-201 or ‡)
Systemic and biologic study of protozoan and arthropod parasites of animals. Emphasis placed on their relationships to disease and principles of parasite control.

5-102. VETERINARY PARASITOLOGY. (4 cr; prereq ‡)
Helminth parasites and parasitic diseases of animals with emphasis on principles of control.

5-103. PARASITES OF WILDLIFE. (3 cr; prereq ‡)
Economics and biologic relationships of protozoa, helminths and arthropods to wildlife.

5-104. DISEASES OF WILDLIFE. (3 cr; prereq ‡)
Economic and biologic relationships of infectious and noninfectious diseases of wildlife.

5-201. GENERAL VETERINARY PATHOLOGY. (5 cr; prereq ‡)
Basic mechanisms and concepts relating to reaction of tissue to injury with emphasis on gross and microscopic interpretation of retrogressive cellular changes, cell death, cellular infiltrations, inflammation, and neoplasia.

5-202/5-203. SPECIAL VETERINARY PATHOLOGY. (5 cr for 5-202, 4 cr for 5-203; prereq 5-201 or ‡)
Reactions of specific systems to injury with emphasis on gross and microscopic changes associated with specific infectious and noninfectious diseases of domestic animals.

5-204. VETERINARY CLINICAL PATHOLOGY. (3 cr; prereq 5-203 or ‡)
Technique, application, and interpretation of laboratory tests used in clinical diagnosis.

5-205x. VETERINARY CLINICAL PATHOLOGY. (1-3 cr; prereq 5-204, ‡)
Application of clinical laboratory methods.

5-301. DISEASES OF THE KIDNEY. (1 cr)
(Same as VM 5-335) Illustrated discussions integrating lesions, pathogenesis, and signs of the diseases of the kidney.

5-302s. DISEASES OF THE PIG. (2 cr)
Illustrated lectures on the pathogenesis and pathology of porcine diseases with emphasis on the differential etiologic diagnosis of common clinical disease symptoms.

5-303. INFECTIOUS AND NONINFECTIOUS DISEASES OF THE CAT. (1 cr)
Illustrated discussions of the gross and microscopic pathology and pathogenesis of common nutritional, viral, bacterial, mycotic, and neoplastic diseases of cats.

5-308. DISEASES OF FUR-BEARING ANIMALS. (2 cr; prereq 5-203, VM 5-511, ‡)
Etiology, symptomatology, and treatment of diseases of fur-bearing animals

5-309. DIAGNOSTIC POULTRY PATHOLOGY. (2 cr)
Diagnosis of spontaneous diseases of chicken, turkey, ducks, geese, captive and wild gamebirds.

5-310. DIAGNOSTIC GROSS PATHOLOGY OF INFECTIOUS DISEASES IN LARGE ANIMALS. (2 cr)
Diagnostic procedures relating to gross lesions and background of disease outbreak.

5-402x. SURGICAL PATHOLOGY. (3 cr; prereq ‡)
Preparation and interpretation of surgical and necropsy specimens.

5-404x. DIAGNOSTIC PATHOLOGY. (5 cr; prereq ‡)
History, necropsy lesions, laboratory results, and histopathology in the diagnosis of animal diseases.

5-405s. PATHOLOGY OF SPONTANEOUS DISEASES OF LABORATORY ANIMALS. (2 cr; prereq ‡; offered 1972-73 and alt yrs)
Gross and microscopic pathology of laboratory animals.

5-406. PATHOLOGY OF SPONTANEOUS DISEASES OF POULTRY. (3 cr; prereq ‡; offered 1973-74 and alt yrs)
Gross and microscopic pathology of spontaneous diseases of chickens, turkeys, and gamebirds.

8-801f.° SEMINAR: VETERINARY PATHOLOGY. (1-3 cr; prereq 5-203, ‡)

8-802x.° ADVANCED VETERINARY PARASITOLOGY. (Cr ar; prereq 5-102 or ‡; offered 1972-73 and alt yrs)
Parasites of domestic animals, their identification, life histories, economic importance, and relation to disease.

8-803x.° PROBLEMS IN VETERINARY PARASITOLOGY. (Cr ar; prereq 5-102 or equiv, ‡)

8-804su. ONCOLOGY. (4 cr; prereq ‡; offered 1972-73 and alt yrs)
Spontaneous and induced avian and mammalian neoplasms with emphasis on diagnosis.

8-805su. COMPARATIVE NEUROPATHOLOGY. (2 cr; prereq ‡; offered 1973-74 and alt yrs)
Gross and microscopic pathology of spontaneous neurologic diseases of animals.

8-806. VETERINARY NECROPSIES. (Cr ar; prereq ‡)
Necropsy techniques, examination of tissue sections, and preparation of records.

Veterinary Physiology and Pharmacology (VPP)

Professor
Harold E. Dziuk, D.V.M., Ph.D., *head*
Archie L. Good, D.V.M., Ph.D.
Clarence M. Stowe, D.V.M., Ph.D.

Associate Professor
Gary E. Duke, Ph.D.
Grace W. Gray, Ph.D.
Edward F. Jankus, D.V.M., Ph.D.
Everett C. Short, D.V.M., Ph.D.

Assistant Professor
John P. Sullivan, D.V.M., Ph.D.

5-150/5-160/5-170/5-180. ANIMAL PHYSIOLOGY. (4 cr for 5-150 [lect], 2 cr for 5-160 [lab], 3 cr for 5-170 [lect], 2 cr for 5-180 [lab]; prereq VAna 5-120, MdBc 5-601, or equiv, ‡)
Physiology of circulation, respiration, digestion, kidney function, nervous system, and special senses in domestic animals.

5-310. MAMMALIAN ENDOCRINOLOGY AND REPRODUCTION. (3 cr; prereq 1-300 or 6 cr systemic physiology, or ‡)
(Same as AnSc 5-310) The physiological effects of the endocrine organs and hormones.

5-314. BEHAVIORAL PHYSIOLOGY. (3 cr; prereq 1-300 or 6 cr systemic physiology, Biol 5-051, or ‡)
(Same as AnSc 5-314) 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.

5-320. AVIAN PHYSIOLOGY. (3 cr; prereq 1-300 or 6 cr systemic physiology or equiv, ‡; offered 1973-74 and alt yrs)
(Same as AnSc 5-320) Physiology of various species of wild and domestic birds.

5-321. ADVANCED AVIAN PHYSIOLOGY. (1 cr; offered 1973-74 and alt yrs)
(Same as AnSc 5-321) Survey of physiology of some phenomena characteristic of nondomestic avian and mammalian species, such as physiology of flying, diving, migration, annual reproductive cycles, circadian rhythms, hibernation, and torpidity.

5-322. PHYSIOLOGY OF REPRODUCTION. (5 cr; prereq 6 cr systemic physiology) Crabo
(Same as AnSc 5-322) Principles of reproductive physiology with emphasis on endocrinological aspects.

5-323. COMPARATIVE PATTERNS OF VERTEBRATE REPRODUCTION. (4 cr; prereq 5-322 or ‡, offered 1973-74 and alt yrs) Burke
(Same as AnSc 5-323) Comparative patterns, endogenous and exogenous rhythms and the control of the estrus cycles.

5-324. SEMEN PRESERVATION AND ARTIFICIAL INSEMINATION. (4 cr; prereq 5-322 or ‡, offered 1973-74 and alt yrs) Burke
(Same as AnSc 5-324) Chemistry of gametes and reproductive secretions; preservation of spermatozoa, with emphasis on cryogenic methods; artificial insemination; and factors influencing reproductive performance.

5-325. PHYSIOLOGY OF FERTILIZATION AND GESTATION. (4 cr; prereq 5-322 or ‡, offered 1972-73 and alt yrs) Hunter
(Same as AnSc 5-325) Physiological events occurring during gametogenesis, capacitation, fertilization, the period of embryo, the period of fetus and parturition will be discussed.

5-326. IMMUNOREPRODUCTION. (4 cr; prereq 5-322 or ‡, offered 1972-73 and alt yrs)
(Same as AnSc 5-326) Blood groups and polymorphic proteins affecting reproduction, immunoglobulin formation, antigens of semen, ova and genital secretions, immunopathology, maternal-fetal incompatibility, antibodies to hormones.

5-440. CANINE CARDIOLOGY. (1 cr; prereq sr, grad, or ‡)
Clinical application of physiological and radiological parameters for diagnosing congenital and acquired cardiovascular diseases of the dog.

5-520. VETERINARY SCIENCE. (3 cr; prereq College of Pharmacy sr, or Phsl 3-070, Phcl 5-102, or equiv, ‡)
(Same as VMic 5-520, Phm 5-520) Professional interrelationships between pharmacists and veterinarians; disease problems of domestic animals; veterinary pharmacotherapeutics.

5-650. VETERINARY PHARMACOLOGY. (6 cr; prereq 5-180 or equiv, ‡)
Local and general anesthetic, antipyretic, analeptic, and autonomic drugs.

5-660. VETERINARY PHARMACOLOGY. (4 cr; prereq 5-650 or equiv, ‡)
Cardiovascular, chemotherapeutic, anthelminthic, and gastrointestinal drugs.

5-960. VETERINARY TOXICOLOGY. (3 cr; prereq 5-660 or equiv, ‡)
Toxicology of minerals, pesticides, herbicides, poisonous plants.

8-100. SEMINAR. (Cr ar; prereq ‡)

8-510. PHYSIOLOGICAL AND PHARMACOLOGICAL RESEARCH TECHNIQUES IN LARGE ANIMALS. (2 cr; prereq 5-180 or ‡)
Student participation in laboratory procedures involving the cardiovascular system, drug distribution, and renal function.

8-830. RESEARCH IN ANIMAL PHYSIOLOGY. (Cr ar; prereq ‡)
Individual research under faculty direction. Topics to be 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.

8-920x.* PROBLEMS IN VETERINARY PHARMACOLOGY. (Cr ar; prereq 5-660 or equiv, ‡)

Veterinary Surgery and Radiology (VSR)

Professor

Donald L. Piermattei, D.V.M., Ph.D., *head*
John P. Arnold, D.V.M., Ph.D.
Joseph M. Janes, M.D., M.S.
George W. Mather, D.V.M., Ph.D.
Francis A. Spurrell, D.V.M., Ph.D.
Edward A. Usenik, D.V.M., Ph.D.
Frederick H. Van Bergen, M.D.
Alvin F. Weber, D.V.M., Ph.D.
Raimunds Zemjanis, D.V.M., Ph. D.

Associate Professor

Griselda F. Hanlon, D.V.M., M.S.
Carl R. Jessen, D.V.M., Ph.D.
Victor S. Myers, Jr., D.V.M., M.S.
Theodore T. Smith, D.V.M., M.S.

5-001. ANESTHESIOLOGY. (2 cr; prereq VM 5-101, ‡)
Training in fundamentals of anesthesia in animals as used in veterinary hospitals and clinics.

5-011. PRINCIPLES OF VETERINARY SURGERY. (4 cr; prereq VM 5-101, ‡)
General fundamentals of surgery as applied to various tissues and systems of the body; principles of anesthesia, preoperative evaluation, and postoperative care. Laboratory practices in application of these principles.

5-021. VETERINARY SURGERY. (5 cr; prereq 5-011, ‡)
Common surgical procedures of large and small animals.

5-101. SMALL ANIMAL SURGERY. (3 cr; prereq 5-011, ‡)

5-121. SMALL ANIMAL ORTHOPEDICS. (2-3 cr; prereq regis veterinary medicine, 4th yr or grad, or ‡)
Discussion of small animal orthopedic problems with application of surgical procedures to effect their correction.

5-201. LARGE ANIMAL SURGERY. (3 cr; prereq 5-011, 5-021, ‡)

5-231. LARGE ANIMAL ORTHOPEDICS. (2-3 cr; prereq regis veterinary medicine, 4th yr or grad, or ‡)
Equine gaits and lamenesses. Detailed discussions of specific lamenesses. Signs, causes, diagnostic principles, and treatment. Visual aids used.

5-241. ABDOMINAL SURGERY IN THE BOVINE AND EQUINE SPECIES. (2 cr; prereq regis veterinary medicine, 4th yr or grad, or ‡)
Specific diagnosis, diagnostic procedures, and surgical treatments of abdominal diseases in the cow and horse.

5-251. SURGICAL DISEASES OF THE MAMMARY GLAND. (2 cr; prereq regis veterinary medicine, 4th yr or grad, or ‡)
Etiology, diagnosis, and treatment of congenital and acquired surgical diseases of the mammary gland, with emphasis on the bovine species.

5-301. HEREDITY IN ANIMAL DISEASE. (3 cr; prereq GCB 3-022 or equiv or ‡)
Application of genetic principles on animal disease problems with emphasis upon specific inheritable and familial conditions in domesticated species.

5-401. VETERINARY RADIOLOGY. (3 cr; prereq VM 5-101 or ‡)
Preparation and interpretation of radiographs and fluoroscopic examinations; consideration of radiant energy as a therapeutic agent; discussion of protective measures against radiation hazards.

5-421. ROENTGEN DIAGNOSIS OF DISEASES OF THE SKELETAL SYSTEM OF SMALL ANIMALS. (1 cr; prereq 5-401, regis veterinary medicine, 4th yr or grad, or ‡)

5-431. ROENTGEN DIAGNOSIS OF DISEASES OF THE SKELETAL SYSTEM OF LARGE ANIMALS. (1 cr; prereq 5-401, regis veterinary medicine, 4th yr or grad, or ‡)

8-110. SEMINAR: VETERINARY SURGERY. (Cr ar; prereq 5-101, 5-201, or equiv, ‡)

8-121.* ADVANCED SMALL ANIMAL SURGERY. (Cr ar; prereq 5-101 or equiv)
Surgery of various systems in small animals with preoperative and postoperative evaluation and treatment.

8-221.* ADVANCED LARGE ANIMAL SURGERY. (Cr ar; prereq 5-201 or equiv, ‡)
Surgery of various systems in large animals with preoperative and postoperative evaluation and treatment.

8-231.* PROBLEMS IN LARGE ANIMAL ORTHOPEDICS. (3 cr; prereq 5-201 or equiv, ‡)

8-241.* SURGERY OF THE GASTRO-INTESTINAL SYSTEM. (Cr ar; prereq 5-201 or equiv, ‡)

8-251.* SURGICAL DISEASES OF THE MAMMARY GLAND OF DOMESTIC ANIMALS. (3 cr; prereq 5-201 or equiv, ‡)

8-401x.* PROBLEMS IN DIAGNOSTIC ROENTGENOLOGY. (Cr ar; prereq 5-401 or equiv, ‡)
Problems associated with diagnostic procedures and their interpretation.

8-421. FUNDAMENTALS OF NUCLEAR MEDICINE. (3 cr; prereq ‡)
Lecture and laboratory exercises to orient the graduate student in medical sciences on principles and application of radioisotopes in medicine. See Rad 5-511.

8-441. RADIATION BIOLOGY. (3 cr; prereq 8-421 or equiv, ‡)
Lectures on effects of irradiation on living systems, especially diseases of the animal kingdom.

8-501.* ANESTHESIA. (Cr ar; prereq 5-021 or equiv)
Principles of anesthesia; administration of local, regional, and general anesthesia in large or small animals.

8-541.* LARGE ANIMAL ANESTHESIA. (Cr ar; prereq 5-201 or equiv, ‡)
Consideration of special problems associated with anesthesia of large animals.

WATER RESOURCES

There is no department of water resources, and no graduate major or minor has been established in water resources. Rather, graduate education in water resources is a multidisciplinary effort involving departments in the physical, biological, and social sciences, and the graduate degree will be earned in a graduate major field already established in one of the departments listed. The principal departments involved and their areas of specialization as related to water resources are:

DEPARTMENT	AREA OF SPECIALIZATION
Physical Sciences	
Agricultural Engineering	Irrigation and drainage, hydrology, erosion control, agricultural waste management, environmental control
Civil Engineering and Hydraulics	Hydrology, hydromechanics, sanitary engineering, water resources management
Geology and Geophysics	Hydrogeology, geophysics, limnology
Soil Science	Soil physics, climatology, nutrient and residue pollution
Biological Sciences	
Ecology and Behavioral Biology	Ecology, freshwater ecology
Entomology, Fisheries, and Wildlife	Fisheries biology and management, wildlife biology and management
Environmental Health	Environmental biology, groundwater supply, water quality
Forestry (College of)	Forest hydrology, outdoor recreation, watershed management
Plant Pathology and Physiology	Plant-water relationships
Zoology	Aquatic ecology, ichthyology
Social Sciences	
Agricultural and Applied Economics	Resource economics, recreation economics
Geography	Climatology, cartography, environmentalism
Law (School)	Resource law, environmental regulation
Public Affairs	Resource policy

A student interested in water resources should consult with the graduate faculty of the above departments. The student's choice of major will depend on the baccalaureate background; that is, a student with a Bachelor's degree in the physical sciences would normally choose to work in one of the departments listed above within the physical sciences group. However, a baccalaureate in one of the above specific disciplines is not required in order to pursue graduate education in water resources. For example, a physics, chemistry, biology, or mathematics major

will be considered for graduate study in the major fields in a number of the above departments. Nor is specific prior training in water resources required. (However, certain course work required of undergraduates in the major chosen may have to be taken without graduate credit by a student newly entering that discipline.) The graduate major fields offered by the Graduate School in the various departments are listed in the General Information section of this bulletin.

Minor interests are most often chosen within the same broad science group as the major to take advantage of the student's undergraduate preparation. The student may, however, find it desirable to broaden his background by taking a minor or supporting program in a different science area.

Courses pertinent to water resources are listed under the various departments named above. In addition, the University has a number of research facilities concerned with water resources research, some of them world renowned, and the resources of these facilities are available in connection with thesis work.

ZOOLOGY (Zool)

Professor

Magnus Olson, *head*
Huai-Chang Chiang
Alexander Hodson
Norman Kerr
Robert G. McKinnell
David J. Merrell
A. Glenn Richards
Murray D. Rosenberg
Otto H. Schmitt
Nelson T. Spratt, Jr.
Harrison B. Tordoff
James C. Underhill
Franklin G. Wallace
Dwain W. Warner

Associate Professor

William D. Schmid, *director of graduate study*
Franklin H. Barnwell
Marion A. Brooks
Donald E. Gilbertson
William S. Herman
Alan B. Hooper
Charles W. Huver
D. Frank McKinney
Judson D. Sheridan

Assistant Professor

Elmer C. Birney
Stuart F. Goldstein
Ross G. Johnson
Philip J. Regal

Prerequisites—For major work, 10 credits in a general zoology or biology course and at least 22 credits of advanced work approved by the graduate faculty in zoology—prerequisites for minor work, 10 credits in a general zoology or biology course. It is strongly recommended that students have a background in chemistry, mathematics, and physics.

Language Requirement—For the Master's degree, no foreign language is required. For the Doctor's degree, one foreign language.

Master's Degree—Offered under both Plan A and Plan B.

Doctor's Degree—Every candidate for the Ph.D. in zoology is expected to complete a period of residence at a marine biological station.

5-052f. GENERAL AND COMPARATIVE EMBRYOLOGY. (5 cr; prereq 1-013 or Biol 1-106 or Biol 1-002 or Biol 3-011) Spratt
Embryological development of vertebrate forms.

5-066f,s. HISTOLOGY. (5 cr; not open to regular 3-yr premed or predent students; prereq 1-013 or Biol 1-106 or Biol 1-002 or Biol 3-011) Olson
Microscopic structure of tissues and organs.

5-071s. INVERTEBRATE BIOLOGY. (5 cr; prereq 1-013 or Biol 1-106 or Biol 1-002 or Biol 3-011 or ‡) Barnwell
Morphology, physiology, behavior, ecology and evolution of the invertebrate groups. Laboratory consists of study of living marine, freshwater and terrestrial representatives.

5-077s. INTRODUCTORY ORNITHOLOGY. (5 cr; prereq 1-013 or Biol 1-106 or Biol 1-002 or Biol 3-011) Warner
Laboratory and field course in structure, classification, distribution, migration, habits, habitats, and identification of birds.

5-093f. INTRODUCTION TO ANIMAL PARASITOLOGY. (5 cr; prereq 1-013 or Biol 1-106 or Biol 1-002 or Biol 3-011) Wallace
Elementary course on parasitic protozoa, worms, and arthropods, and their relation to diseases of man and animals.

5-104f. COMPARATIVE ANIMAL PHYSIOLOGY. (5 cr; prereq 1-013 or Biol 1-106 or Biol 1-002 or Biol 3-011, Chem 3-302 or ‡) Schmid
Introduction to animal physiology, emphasizing functional aspects of organ systems from a comparative viewpoint.

5-107f. PROTOZOOLOGY. (4 cr; prereq ‡; offered 1973-74 and alt yrs) Kerr
Introduction to taxonomy, morphology, physiology, development, and genetics of free-living protozoa.

5-113. PHYSIOLOGY OF EXCITABLE CELLS. (4 cr; prereq 5-104 or Biol 5-052 and ‡) Sheridan
Basic electrical and chemical properties of nerve, muscle, and sensory receptor cells.

5-121s. ICHTHYOLOGY. (4 cr; prereq 15 cr incl 1-013 or Biol 1-106 or Biol 1-002 or Biol 3-011) Underhill
Taxonomy and habits of North American fishes, especially those of upper Mississippi drainage.

5-124f. VERTEBRATE BIOLOGY. (3 cr; prereq 1-013 or Biol 1-106 or Biol 1-002 or Biol 3-011 and ‡) Underhill
Survey of the vertebrates, their biology, taxonomy, and distribution.

5-125f. VERTEBRATE FAUNA LABORATORY. (3 cr; prereq 5-124 or ¶5-124, equiv and ‡) Underhill
Comparative study of vertebrate systems.

5-128s. HERPETOLOGY. (5 cr; prereq 5-124) Regal
Laboratory and lectures on distribution, classification, and evolution of amphibians and reptiles. Physiological, morphological, and behavioral aspects of adaptive trends.

5-129s. ADVANCED MAMMALOGY. (5 cr; prereq 5-124 or ‡; offered 1973-74 and alt yrs) Birney
Recent families and orders of all mammals; genera and species of mammals of North America, with emphasis on morphology, evolution, and zoogeographic history.

5-134w. GENERAL AND COMPARATIVE ENDOCRINOLOGY. (3 cr; prereq Biol 3-011, Zool 3-021, Chem 3-302 or ‡; offered 1973-74 and alt yrs) Herman
Structure, function of invertebrate and vertebrate endocrine systems.

5-135s. GENERAL AND COMPARATIVE ENDOCRINOLOGY LABORATORY. (2 cr; prereq 5-134 and ‡; offered 1973-74 and alt yrs) Herman
Individual laboratory investigations of selected problems of endocrinology. Topics arranged by consultation with instructor.

5-136w. GENERAL AND COMPARATIVE ENDOCRINOLOGY. (2 cr; prereq 5-134 and 5-135, or ‡; offered 1972-73 and alt yrs) Herman
Lectures on several specific areas of current endocrinologic interest. Topics will vary, but will normally include such subjects as endocrinology of special taxonomic groups, neurosecretion, hormone action, pheromones, hormone-like substances, plant hormones, hormone chemistry, etc.

5-144w.* PARASITIC PROTOZOA. (4 cr; prereq 15 cr incl Biol 1-013 or Biol 1-002 or Biol 3-011, ‡) Wallace
Structure, life histories, and economic relations of protozoal parasites of humans and animals. Laboratory diagnosis.

5-146s.* EXPERIMENTAL PARASITOLOGY. (4 cr; prereq 5-093 or ‡) Gilbertson
Discussion sessions and laboratory investigations to illustrate relationships between metazoan parasites and their hosts.

5-164s. FINE STRUCTURE OF ANIMAL CELLS. (4 cr; prereq Biol 5-601, ‡) R Johnson
Cell structure and function on an organelle basis, emphasizing ultrastructural research. Macromolecular synthesis, bioenergetics, cell movement, and cell division.

5-165s. ADVANCED CYTOLOGY LABORATORY. (2 cr; prereq 5-164 or ¶5-164, ‡) R Johnson
Emphasis on individual projects such as autoradiography, cell fractionation, or electron microscopy.

5-169s. PHYSIOLOGICAL ECOLOGY. (4 cr; prereq 5-104, Biol 3-041 or Biol 5-052, ‡...statistics recommended) Schmid
Functional adaptations of organisms to various physical and biotic factors of the natural environment.

5-171w. GENETICS AND SPECIATION. (4 cr; prereq 15 cr biology incl genetics) Merrell
Application of genetic principles to problems of speciation and evolution.

5-814su. NATURAL HISTORY OF INVERTEBRATES. (5 cr; prereq 1-013 or Biol 1-106 or Biol 1-002; offered in Lake Itasca Biology Session)
Advanced taxonomic and ecological survey of local fauna, detailed and independent ecological study of several taxonomic groups.

5-819su. NATURAL HISTORY OF VERTEBRATES. (5 cr; prereq 1-013 or Biol 1-106 or Biol 1-002; offered in Lake Itasca Biology Session)
Taxonomic and biological survey of local fauna, detailed and independent study of the vertebrate classes, exclusive of birds.

5-834su. FIELD ORNITHOLOGY. (5 cr; prereq 1-013 or Biol 1-106 or Biol 1-002; offered in Lake Itasca Biology Session)
Field and laboratory studies of ecology and life histories of birds in Itasca Park region.

5-843su. ANIMAL PARASITES. (5 cr; prereq 1-013 or Biol 1-106 or Biol 1-002; offered in Lake Itasca Biology Session)
Parasites of local fauna with special reference to helminths.

8-134s. SPECIAL TOPICS IN COMPARATIVE ENDOCRINOLOGY. (2 cr; prereq 5-136, or ‡; offered 1972-73 and alt yrs) Hermanˇ
Seminar-type discussions of selected areas of current research in comparative endocrinology. Topics will be announced in advance.

8-261w. WINTER ECOLOGY. (4 cr; prereq ‡; offered 1972-73 and alt yrs) Underhill, Schmid
Seminar discussions of characteristics of subnivean environment and of adaptations by plants and animals to winter stress. Three lectures, with field work on weekends.

8-271s. TOPICS IN ECOLOGICAL GENETICS. (2 cr; prereq ‡) Merrell, Underhill
Ways in which natural populations are adapted to their environments and mechanisms by which they respond to environmental change. Different topic of current interest considered each year.

8-282f, 8-283f, 8-284f. PHYSIOLOGY OF DEVELOPMENT. (4 cr per qtr; prereq ‡; 8-282 offered 1974-75, 8-283 offered 1972-73, 8-284 offered 1973-74) Spratt
Organization, presentation, and evaluation of results of research in experimental embryology. 8-282: Chemical embryology, metabolic aspects of growth, differentiation, and morphogenesis. 8-283: Embryonic differentiation including neuroembryology. 8-284: Endocrines in development, including sex differentiation.

8-970f,w,s. GRADUATE SEMINAR.

8-980.* SEMINAR: SPECIAL RESEARCH FIELDS. (Cr ar) Staff

8-990f,w,s. GRADUATE RESEARCH. (Cr ar) Staff

Note—See also sections on biology, biochemistry, genetics and cell biology, ecology and behavioral biology, and entomology, fisheries, and wildlife in this bulletin.

RELATED COURSES RECOMMENDED FROM OTHER COLLEGES

AnSc 5-314. BEHAVIORAL PHYSIOLOGY

Ent 5-025. INSECT MORPHOLOGY

Ent 5-026. EMBRYOLOGY, DEVELOPMENT OF INSECTS

Ent 5-027. INSECT METABOLISM, COORDINATION

Ent 5-150. PRINCIPLES OF SYSTEMATIC ENTOMOLOGY

Ent 5-275. MEDICAL ENTOMOLOGY

VAna 5-120. ESSENTIALS OF VERTEBRATE DEVELOPMENT AND STRUCTURE

VPP 5-310. GENERAL ENDOCRINOLOGY

VPP 5-311. REPRODUCTIVE PHYSIOLOGY

VPP 5-313. AVIAN PHYSIOLOGY

COURSES CARRYING GRADUATE CREDIT WHEN PROGRAM RELATED

FS 5-960. SEMINAR: FOREIGN STUDY I. (6 cr [grad students pay for 6 cr but receive 3 cr on grad records]; prereq approval before December by faculty selection committee ...grad students must also have approval of faculty adviser) Stavrou
Directed field study in selected foreign countries, investigating current economic, political, educational, cultural, and religious patterns of life. Each student will study the country carefully before embarking and write a comprehensive report of findings upon returning.

FS 5-960. SEMINAR: FOREIGN STUDY II. (6 cr [grad students pay for 6 cr but receive 3 cr on grad records]) Stavrou
Continuation of FS 5-960.

Hum 5-030. HUMANITIES PROSEMINAR. (3 cr per qtr)
Selected interdisciplinary topics in the humanities.

LAS 5-101. LATIN AMERICAN STUDIES: SOURCE MATERIALS. (5 cr; prereq reading knowledge of Spanish and/or Portuguese or #) Johnson, staff
Orientation to 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.

LAS 5-970. DIRECTED STUDIES. (Cr ar; prereq #)

NSci 5-171, 5-172, 5-173. DEVELOPMENT OF THE SCIENCES. (3 cr per qtr; prereq 1 yr biology and physical science or #) Graubard
Seminar on works of great scientists from Hippocrates to modern times.

GRADUATE OFFERINGS, DULUTH CAMPUS

The Graduate School offers at the University of Minnesota, Duluth, a full program for the master of arts degree with majors in art, education, educational administration, educational psychology (school counseling), English, history, and speech pathology and audiology; and master of science degrees in chemistry, biology, botany, geology, physics, and zoology. A 2-year program leading to the specialist certificate in education in elementary, secondary, and general school administration is offered. The education program is designed to serve elementary and secondary school teachers and principals. Students work under advisers at Duluth.

Graduate work at Duluth is under the jurisdiction of the dean of the Graduate School and is identical in admission, candidacy, and degree requirements with the parallel program on the Minneapolis Campus. Refer to the General Information section of this bulletin for details. Blanks for use in applying for admission may be secured by writing to: Assistant Dean of the Graduate School, 403 Administration Building, University of Minnesota-Duluth, Duluth, Minnesota 55812.

Inquiries regarding counseling and testing, scholarships, fellowships and loan funds, living accommodations, employment, and placement should be addressed to Student Personnel Services, 247 Administration Building, University of Minnesota-Duluth, Duluth, Minnesota 55812.

Master's Degree—Botany, physics, and zoology are offered only under Plan A; chemistry, history and geology majors may select either Plan A or Plan B. All other majors are offered under Plan B only.

Examinations—Final examinations and all other work for the degree are conducted by the graduate faculty at Duluth.

Note—Some of the following courses are scheduled in the late afternoon and on Saturday mornings to enable teachers in the Duluth area to carry graduate work during the academic year.

Except in cases where course descriptions are included here, course descriptions will be found in the departmental listing in this bulletin.

Art

Professor
William G. Boyce, *head*
Glenn C. Nelson, *director of graduate study*
Arthur E. Smith

Associate Professor
Philip K. Meany
Freddy M. Munoz
Rudolph I. Schauer

Assistant Professor
Harold B. Christensen

Lecturer
Maynard B. Stone

Art 5-150. PAINTING. (3 cr per qtr [may be repeated for a maximum of 6 cr]; prereq 3-101 or ‡) Munoz
Painting in the area of specialized interest.

Art 5-151. ADVANCED PAINTING. (3 cr per qtr [may be repeated for a maximum of 6 cr]; prereq 5-150 or ‡) Munoz
Individually supervised projects using both traditional and contemporary painting media and techniques.

Art 5-173. WORKSHOP IN ADVANCED PAINTING. (6 cr [may be repeated for a maximum of 12 cr]; prereq ‡; offered summer only)
Creative work in oil or watercolor with criticism by a nationally recognized American artist.

Art 5-250. SCULPTURE. (3 cr per qtr [may be repeated for a maximum of 6 cr]; prereq 3-201 or ‡) Christensen, G Nelson
Sculpture in the area of specialized interest.

Art 5-251. ADVANCED SCULPTURE. (3 cr per qtr [may be repeated for a maximum of 6 cr]; prereq 5-250 or ‡) Christensen, G Nelson
Advanced sculpture in the area of specialized interest.

Art 5-273. WORKSHOP IN ADVANCED SCULPTURE. (6 cr [may be repeated for a maximum of 12 cr]; prereq 3-201 or ‡; offered every third summer) Christensen or guest artist
Development of previously acquired skills in wood, stone, metal, or clay; emphasis on creative discipline.

Art 5-350. PRINT PROCESSES. (3 cr per qtr [may be repeated for a maximum of 6 cr]; prereq 3-301 or ‡) Meany
Printmaking in the area of specialized interest.

Art 5-351. ADVANCED PRINT PROCESSES. (3 cr per qtr [may be repeated for a maximum of 6 cr]; prereq 5-350 or ‡) Meany
Advanced printmaking in the area of specialized interest.

Art 5-373. WORKSHOP IN ADVANCED PRINT PROCESSES. (6 cr [may be repeated for a maximum of 12 cr]; prereq 5-350 or ‡; offered every third summer only) Meany or guest artist
Concentrated experience in one or more of the disciplines of printmaking, i.e., woodcut (relief), etching (intaglio), lithography and silkscreen (stencil).

Art 5-450. CERAMICS. (3 cr per qtr [may be repeated for a maximum of 6 cr]; prereq 3-401 or ‡) G Nelson
Research in studio projects; glaze and body chemistry; ceramic sculpture.

Art 5-451. ADVANCED CERAMICS. (3 cr per qtr [may be repeated for a maximum of 6 cr]; prereq 5-450 or ‡) G Nelson
Kiln operation and design; studio management; practical problems involving the professional potter and teacher.

Art 5-473. WORKSHOP IN ADVANCED CERAMICS. (6 cr [may be repeated for a maximum of 12 cr]; prereq 3-401 or ‡; offered every third summer) G Nelson or guest artist
Individual supervised study; creative projects in ceramics and ceramic sculpture and study of glazes and body chemistry.

Art 5-550. DESIGN. (3 cr per qtr [may be repeated for a maximum of 6 cr]; prereq 3-501 and ‡) Schauer
Opportunity to apply design to creative aesthetic problems on an advanced experimental level.

Art 5-551. ADVANCED DESIGN. (3 cr per qtr [may be repeated for a maximum of 6 cr]; prereq 5-550 or ‡) Schauer
Individual supervised study; research and application of contemporary design theory in precious and nonprecious metals, gem cutting, leather, wood, fiber and any other design materials.

Art 5-573. WORKSHOP IN ADVANCED CRAFTS. (6 cr [may be repeated for a maximum of 12 cr]; prereq ‡; offered every third summer only) Schauer
Creative work in any of the major crafts of jewelry, casting, gem cutting, weaving, textiles, leather, mosaics and other crafts of interest.

Art 5-650. ADVANCED PHOTOGRAPHY. (3 cr per qtr [may be repeated for a maximum of 6 cr]; prereq 3-601 or ‡) Brutger
Advanced photography in the area of specialized interest.

Art 5-651. INDEPENDENT STUDY IN PHOTOGRAPHY. (1-3 cr [may be repeated for a maximum of 9 cr]; prereq 3-601 or ‡) Brutger
Individualized study involving photographic media.

Art 5-673. WORKSHOP IN EXPERIMENTAL PHOTOGRAPHY. (6 cr [may be repeated for a maximum of 12 cr]; prereq ‡; offered every third summer) Brutger
In-depth approach to the use of photographic equipment and media as a means of fine art expression.

Art 5-910. ART SEMINAR. (4 cr, §5-950; prereq sr art standing or △)
For senior and graduate art majors. Discussions, readings, and reports in the area of the arts and aesthetic interest.

Art 5-990. INDEPENDENT FOREIGN STUDY. (6 to 15 cr with △; sr or grad standing in art advisable) G Nelson
Travel and research in foreign museums, schools, handcraft industries, and art centers. Advanced planning and supervision of planning necessary. Credit allowed will depend upon nature and scope of the project.

Art 8-160. ADVANCED PAINTING. (3 cr per qtr [may be repeated for a maximum of 9 cr]; prereq 6 cr of 5-151 or ‡) Munoz
Individually supervised independent projects.

Art 8-260. ADVANCED SCULPTURE. (3 cr per qtr [may be repeated for a maximum of 9 cr]; prereq 6 cr of 5-251) Christensen
Development of personal expression in sculpture.

Art 8-460. ADVANCED CERAMICS. (3 cr per qtr [may be repeated for a maximum of 9 cr]; prereq 6 cr in 5-450) G Nelson
Development of an individual style in decoration and form.

Art 8-461. CERAMIC GLAZE FORMULATIONS. (3 cr per qtr [may be repeated for a maximum of 9 cr]; prereq 6 cr in 5-451) G Nelson
Research in glazes and related decorating techniques.

Art 8-462. CLAY AND CERAMIC BODIES. (3 cr; prereq 6 cr in 5-451) G Nelson
Characteristics of clay and compounded bodies.

Art 8-463. KILNS, CONSTRUCTION AND OPERATION. (3 cr [may be repeated for a maximum of 6 cr]; prereq 6 cr in 5-451) G Nelson
Theory of kiln design, construction and firing.

Art 8-560. MULTIMEDIA RESEARCH IN CRAFTS. (3 cr per qtr [may be repeated for a maximum of 6 cr]; prereq 6 cr in 5-550) Schauer
Individualized study in crafts and design leading to intermixing of media and concepts in creative art expression.

Art 8-660. RESEARCH IN PHOTOGRAPHY. (3 cr per qtr [may be repeated for a maximum of 6 cr]; prereq 5-630 or ‡) Brutger
Individualized study of a particular photographic technique or media leading to a fine art expression.

ArtH 5-166. CLASSICAL ART. (4 cr, §5-165)
History and development of Greek, Etruscan and Roman painting, sculpture, and architecture.

ArtH 5-206. MEDIEVAL ART. (4 cr, §5-205)
Christian art and architecture from late antiquity to the Renaissance.

ArtH 5-305. RENAISSANCE ART. (5 cr, §5-315, §5-325)
Painting, sculpture, and architecture during the 15th and 16th centuries.

ArtH 5-406. BAROQUE ART. (4 cr, §5-405)
The art of Europe during the 17th century.

ArtH 5-506. EIGHTEENTH AND NINETEENTH-CENTURY ART. (4 cr, §5-505)
European art from the rococo period to postimpressionism.

ArtH 5-615. MODERN PAINTING TO WORLD WAR II. (5 cr, §5-616, §5-617)
Painting and other two-dimensional arts from postimpressionism to abstract expressionism.

ArtH 5-618. TRENDS IN CONTEMPORARY ART. (4 cr; prereq ‡)
Painting and sculpture from abstract expressionism to the present day.

ArtH 5-706. ORIENTAL ART. (4 cr, §5-705)
Survey of the art of India, China, and Japan with an introduction to the religions and philosophies influencing the art.

ArtH 5-950. ANCIENT AND CLASSICAL CERAMICS. (2 cr; must be taken concurrently with ceramic studio; 1 hr lect plus studio project)
Survey of the aesthetic and technical development of ceramics.

ArtH 5-951. ORIENTAL CERAMICS. (2 cr; must be taken concurrently with ceramic studio; 1 hr lect plus studio project)
Survey of the aesthetic and technical development of ceramics.

ArtH 5-952. ISLAMIC AND RENAISSANCE CERAMICS. (2 cr; must be taken concurrently with ceramic studio; 1 hr lect plus studio project)
Survey of the aesthetic and technical development of ceramics.

ArtH 5-953. PRE-COLUMBIAN CERAMICS. (2 cr; must be taken concurrently with ceramic studio; 1 hr lect plus studio project)
Survey of the aesthetic and technical development of ceramics.

ArEd 5-850. CURRICULUM BUILDING. (3 cr; prereq sr and ‡) Boyce, A Smith
Functions of art in education; selection, evaluation, and organization of subject matter to create original teaching units and projects.

ArEd 5-860. IMPLEMENTING INSTRUCTIONAL PROGRAM. (3 cr, prereq sr and ‡) Boyce, A Smith
Relation of the instructional program to administrative and supervisory policies; study of facilities and policies for improving the instructional program in art.

ArEd 5-870. ADVANCED COURSE IN TEACHING ART. (3 cr; prereq sr and ‡) Boyce, A Smith
Evaluation of current practices; utilization of research findings; introduction of new materials; development of cooperation between classroom teachers and art education specialists.

ArEd 5-880. DEVELOPMENT OF ART EDUCATION. (3 cr; prereq sr and ‡) Boyce, A Smith
Effect of various 20th-century art movements on the teaching of art in the public schools.

ArEd 8-890.* PROBLEMS IN ART EDUCATION. (Cr ar; prereq consent of major adviser) A Smith
Independent projects under staff guidance; may include advanced studio practice or technical problems requiring experimental or library research.

Biology, Botany, and Zoology

Professor

John B. Carlson (biology and botany)
Pershing B. Hofslund (biology and zoology)
Blanchard O. Krogstad (biology and zoology)
Paul H. Monson (biology and botany)
Theron O. Odlaug (biology and zoology)

Associate Professor

Hollie L. Collins (biology and zoology), *director of graduate study*

Assistant Professor

George E. Ahlgren (biology and botany)
Walter Fluegel (biology and botany)
Stephen C. Hedman (biology)
Andrew F. Robinson, Jr.

Biol 5-051. HUMAN GENETICS. (5 cr, §3-153; prereq 5 cr general biology or ‡; 4 hrs lect, 2 hrs lab-discussion; will not satisfy requirements for major or minor in biology; offered summer only) Hedman
Fundamentals of genetics with emphasis on aspects of human genetics encountered in areas of education, psychology, and sociology.

Biol 5-100. BASIC BOTANY AND ZOOLOGY. (1 to 9 cr)
Enables graduate students to make up certain deficiencies in background course work.

Biol 5-155. ORGANIC EVOLUTION. (3 cr, §3-155; prereq 10 cr general biology; 3 hrs lect) Hofslund
History, opposition, evidence, causes, and conclusions.

Biol 5-243.* CELL METABOLISM. (5 cr; prereq college algebra and 3-243; 3 hrs lect, 6 hrs lab; offered 1972-73 and alt yrs) Hedman
Biological and biochemical aspects of selected topics in molecular biology.

Biol 5-253.° BIOCHEMICAL GENETICS. (3 cr; prereq 3-153 and 3-243; 3 hrs lect; offered 1972-73 and alt yrs) Hedman
Survey of current concepts concerning gene structure, gene regulation, and gene expression.

Biol 5-403. GENERAL MICROBIOLOGY. (5 cr, §3-403; prereq 10 cr general biology and 10 cr in chemistry or ‡...organic chemistry and cell biology recommended; 3 hrs lect, 6 hrs lab) Fluegel
Classical and current information on bacteria, viruses, yeasts, and other microorganisms.

Biol 5-771. FRESHWATER ECOLOGY. (3 cr, §5-773; prereq 10 cr general biology and general chemistry or ‡; offered summer only) H Collins
Analysis of freshwater lake and stream ecosystems. Laboratory and field examination of aquatic communities. Interrelationships of biological, physical, and chemical parameters.

Biol 5-772. ECOLOGY OF MINNESOTA I. (10 cr; prereq 10 cr general biology and ‡; offered summer only) H Collins, Monson
Biology of the prairie, mixed hardwood forest, boreal forest, and transition zones including both aquatic and terrestrial ecosystems.

Biol 5-773.° LIMNOLOGY. (4 cr; prereq general chemistry, 10 cr general biology and 5-411 or 5-523; 2 hrs lect, 4 hrs lab; offered 1973-74 and alt yrs) H Collins
Biological, chemical, and physical aspects of lakes and streams. Extensive laboratory and field analysis of the ecological relationships between aquatic organisms and their environment.

Biol 5-801. MICROTECHNIQUE. (4 cr, §3-801; prereq 10 cr general biology and ‡; 2 hrs lect, 6 hrs lab ar; offered 1973-74 and alt yrs) J Carlson
Methods of preparing materials for microscopic study; freehand and paraffin procedures; practice in methods of fixation, sectioning and staining of botanical and zoological materials; principles of photomicrography.

Biol 8-960.° GRADUATE SEMINAR. (1 to 3 cr; prereq △)
Reports on recent developments in biology and on research projects in the department.

Biol 8-990.° GRADUATE RESEARCH. (Cr ar; prereq ‡)

Bot 5-213. PLANT ANATOMY. (5 cr; prereq 10 cr general biology; 3 hrs lect, 4 hrs lab; offered 1973-74 and alt yrs) J Carlson
Origin, development, and structure of tissue systems of vegetative and reproductive organs of vascular plants.

Bot 5-411. MORPHOLOGY OF NONVASCULAR PLANTS. (5 cr, §3-413; prereq 10 cr general biology; 3 hrs lect, 4 hrs lab) J Carlson
Phylogeny, structure, and life histories of algae, fungi, mosses, and liverworts.

Bot 5-412. MORPHOLOGY OF VASCULAR PLANTS. (5 cr, §3-414; prereq 10 cr general biology; 3 hrs lect, 4 hrs lab) J Carlson
Phylogeny, structure, and life histories of ferns, fern-allies, and seed plants.

Bot 5-413.° GENERAL MYCOLOGY. (4 cr; prereq organic chemistry or ‡; 2 hrs lect, 4 hrs lab; offered when feasible) Fluegel
Life histories, ecology, physiology, morphogenetic studies, control, and practical uses of the fungi.

Bot 5-421. PLANT DIVERSITY. (5 cr, §5-411, §5-412; prereq 10 cr general biology or ‡; 3 hrs lect, 4 hrs lab; offered summer 1974 and alt summers) J Carlson
Laboratory and field studies on the phylogeny, structure, and life histories of algae, fungi, mosses, ferns, fern-allies, and seed plants; emphasis on Minnesota species.

Bot 5-443.° PLANT PHYSIOLOGY. (3 cr; prereq 3-243 or ‡...¶5-444 by undergrad students; 3 hrs lect; offered 1972-73 and alt yrs) Ahlgren
Plant function with emphasis on the higher plants. Biochemical and physical aspects of plants, their growth, nutrition, metabolism, and relationship to light, water, and other environmental factors. Research paper required of graduate students.

Bot 5-444. PLANT PHYSIOLOGY LABORATORY. (2 cr; prereq ¶5-443; 3 hrs lab; offered 1972-73 and alt yrs) Ahlgren
Experimental basis for interpretation of certain physiological phenomena in plants, research problems, methods, and techniques in plant physiology. Research problem required of graduate students.

Bot 5-461. PLANT TAXONOMY. (5 cr, §3-463; prereq 10 cr general biology; 3 hrs lect, 4 hrs lab) Monson
Introduction to taxonomy of vascular plants with emphasis on seed plants; representative families; terminology; literature; use of keys.

Bot 5-463.* ADVANCED PLANT TAXONOMY. (4 cr; prereq 5-461 or ‡; 3 hrs lect, 2 hrs lab; offered 1973-74 and alt yrs) Monson
Principles of plant classification; literature of systematic botany with emphasis on bibliographic tools; methods of collection, preservation, and study of vascular plants.

Bot 5-465.* FLORA OF MINNESOTA. (4 cr; prereq 5-461 or ‡; 2 hrs lect, 4 hrs lab; offered summer only) Monson
Collection, identification, classification, and relationships among flowering plants of the state.

Bot 5-467.* AQUATIC FLOWERING PLANTS. (3 cr; prereq 10 cr in botany or ‡; 2 hrs lect, 4 hrs lab; offered summer only) Monson
Higher plants of aquatic and marsh habitats; identification; adaptive morphology; food value to wild life.

Bot 5-775.* PLANT ECOLOGY. (5 cr; prereq 3-243, 3-773, 5-461, and college algebra; 3 hrs lect, 4 hrs lab; offered 1972-73 and alt yrs)
Plant-environment relationships; local and North American communities; succession; abiotic factors and their measurement.

Zool 5-215. HISTOLOGY. (5 cr, §3-213; prereq 10 cr general biology; 2 hrs lect, 6 hrs lab; offered when feasible)
Microscopic structure of the vertebrate body.

Zool 5-241. ANIMAL PHYSIOLOGY. (5 cr; prereq 3-243 or ‡; 3 hrs lect, 4 hrs lab) Pozos
Principles of animal physiology with emphasis on structure-function relationships in mammalian organ systems.

Zool 5-514. PHYSIOLOGY OF DEVELOPMENT. (5 cr; prereq 3-153, 3-513, 3-243; 3 hrs lect, 6 hrs lab) Firling
Selected topics in the analysis of development: biochemistry of fertilization, morphogenetic movements, induction, cell differentiation, gene expression and control mechanisms. Laboratory study of growth and differentiation using tissue culture, autoradiographic, cytological and biochemical techniques.

Zool 5-515. COMPARATIVE ANATOMY OF INVERTEBRATES. (5 cr, §3-515; prereq 10 cr general biology; 2 hrs lect, 6 hrs lab; offered 1973-74 and alt yrs) Krogstad
Review of the invertebrate groups with emphasis on morphology and phylogeny.

Zool 5-517. COMPARATIVE ANATOMY OF VERTEBRATES. (5 cr, §3-517; prereq 10 cr general biology; 3 hrs lect, 4 hrs lab) Odlaug
Review of vertebrate groups with emphasis on phylogeny.

Zool 5-523. NATURAL HISTORY OF INVERTEBRATES. (4 cr, §3-523; prereq 10 cr general biology; 2 hrs lect, 4 hrs lab and field) Krogstad
Collection, identification, life histories, and ecological relationships of local invertebrates; emphasis on aquatic species.

Zool 5-524. NATURAL HISTORY OF VERTEBRATES. (4 cr, §3-524; prereq 10 cr general biology or ‡; 2 hrs lect, 4 hrs lab) Hofslund
The way of life of vertebrate animals, including their origins, principles of taxonomy, population dynamics, and adaptations to living within their environment.

Zool 5-526. ICHTHYOLOGY. (4 cr, §3-526; prereq general ecology or ‡; 2 hrs lect, 4 hrs lab) H Collins
Physiologic, taxonomic, ecologic, economic and behavioral aspects of fishes. Laboratory emphasis of fishes of the Great Lakes Region including field conducted independent study.

Zool 5-527. ORNITHOLOGY. (5 cr, §3-527; prereq 10 cr general biology; 3 hrs lect, 5 hrs lab and field) Hofslund
Laboratory and field identification of birds, their migration and habitats; biological, taxonomic, and economic considerations.

Zool 5-528. MAMMALOGY. (4 cr, §3-528; prereq general ecology or ‡; 2 hrs lect, 4 hrs lab; offered 1972-73 and alt yrs) H Collins
Origin, taxonomy, distribution, physiology, ecology, and behavior of mammals; laboratory and field work in techniques of collecting, preparing specimens, and identification of Minnesota species. Independent field project on mammal ecology.

Zool 5-561. INTRODUCTORY ENTOMOLOGY. (5 cr, §3-563; prereq 10 cr general biology; 2 hrs lect, 6 hrs lab and field) Krogstad
Structure, life history, ecology, classification, evolution, principles of control, and the significance of insects in our society. Field collections.

Zool 5-562. ADVANCED INSECT BIOLOGY. (4 cr, §5-563; prereq 5-561; 2 hrs lect, 4 hrs lab and field; offered 1972-73 and alt yrs) Krogstad
Studies in specific areas such as insect parasitism, distribution, diapause and immature insects. Independent laboratory and field problems.

Zool 5-564. ANIMAL PARASITOLOGY. (5 cr, §3-565; prereq 10 cr general biology; 3 hrs lect, 4 hrs lab) Odlaug
Common protozoan, worm, and arthropodan parasites of vertebrates; parasites considered from taxonomic, morphological, and physiological viewpoints; methods of transfer from host to host, symptoms of parasitic diseases, economic importance to man, and general methods of control; laboratory techniques useful in determining the presence of parasites.

Zool 5-565.° HELMINTHOLOGY. (3 cr; prereq 5-564 or ‡; 2 hrs lect, 4 hrs lab; offered 1972-73 and alt yrs) Odlaug
Worm parasites of man and other animals, their structure, life histories, and biological relationships.

Zool 5-573.° FISH BIOLOGY. (4 cr; prereq 5-526; 2 hrs lect, 4 hrs lab; offered 1972-73 and alt yrs) H Collins
Biology of fish populations. Analysis of problems concerned with commercial and sport fisheries and their management. Laboratory analysis of methods for studying fish growth, food habits, population estimation, and mortality rates. Field trips.

Zool 5-575.° ECOLOGY OF BIRDS. (4 cr; pereq 5-527 or equiv; 2 hrs lect, 4 hrs lab) Hofslund
Relationships of birds to their environment. Individual and group field and laboratory studies with an introduction to specific ornithological techniques.

Zool 5-583.° ANIMAL BEHAVIOR. (3 cr; prereq 10 cr general biology; 3 hrs lect) H Collins
Description of the known behavior of the various vertebrate and invertebrate phyla with emphasis on adaptive significance and the genetics and ontogeny of behavioral patterns. Focus on mating, aggressive, nutritive, and nurturing behavior. Behavior related to ecology of animal populations will be presented.

Zool 5-584. ANIMAL BEHAVIOR LABORATORY. (2 cr; prereq 5-583 or ¶5-583; 4 hrs lab) H Collins
Laboratory analysis of animal behavior. Student projects will be assigned for demonstration of behavior principles.

Zool 5-777.° ECOLOGY OF ANIMAL POPULATIONS. (3 cr; prereq 3-773 and ‡; 3 hrs lect; offered 1973-74 and alt yrs) Krogstad
Concepts of population structure, growth, competition, predator-prey relationship, life tables and sampling; review of current literature.

Zool 5-779. ECOLOGY OF ANIMAL POPULATIONS LABORATORY. (2 cr; prereq ¶5-777 or ‡; 4 hrs lab; offered 1973-74 and alt yrs) Krogstad
Laboratory, field, and independent studies in animal populations.

Chemistry

Professor
Larry C. Thompson, *head*
James C. Nichol, *director of graduate study*
Thomas J. Bydalek
Edward J. Cowles
Francis B. Moore

Associate Professor
Paul M. Anderson
Ronald Caple
Robert M. Carlson
F. James Glick
Donald K. Harriss

Assistant Professor
Vincent R. Magnuson
Wilmar L. Salo

Chem 5-220. QUANTITATIVE ANALYSIS. (4 cr; prereq 5-230; 2 hrs lect, 6 hrs lab) Moore
Theory and practice in classical and instrumental methods of chemical analysis, including methods of separation.

Chem 5-230. QUANTITATIVE ANALYSIS. (5 cr [3, 4 cr with ‡]) Bydalek
Theory and practice in classical and instrumental methods of chemical analysis.

Chem 5-234. METHODS OF SEPARATION. (4 cr, §5-231; prereq grad standing or ‡) Bydalek
Theory and applications of various separation techniques including solvent extraction, chromatography, and ion exchange.

Chem 5-236. ELECTROCHEMICAL METHODS OF ANALYSIS. (4 cr, §5-235; prereq grad standing or ‡) Bydalek
Treatment of electrochemical methods including potentiometry, voltametry, and coulometry.

Chem 5-238. ANALYTICAL TECHNIQUES, LABORATORY. (1 to 3 cr [may be repeated for a maximum of 3 cr], §5-237; prereq grad standing or ‡) Bydalek
Quantitative laboratory work in instrumental and separation techniques.

Chem 5-332/5-333. BIOCHEMISTRY. (5 cr per qtr [may be taken for 4 cr each by attending lect only], §5-330/5-331; prereq 3-511 or 3-522 and Math 1-286...physical chemistry recommended; 4 hrs lect, 3 hrs lab)
Significance of the structure and reactivities of biochemically important compounds and their interactions in living systems with emphasis on bioenergetics, enzyme activities, and control of metabolic processes. Laboratory in various biochemical techniques.

Chem 5-335. BIOCHEMICAL TECHNIQUES. (1 to 3 cr [three areas will be covered separately with 1 cr for each...the student may take any combination of a, b, and c]; prereq 5-333 or ‡; 3 hrs lab per cr) Salo
Laboratory in biochemical techniques with emphasis on (a) chromatography and electrophoresis, (b) radioisotopes, and (c) enzymes and metabolism.

Chem 5-399. RESEARCH TOPICS FOR HIGH SCHOOL CHEMISTRY TEACHERS. (3 to 6 cr [may be repeated for a maximum of 12 cr]; prereq admission to M.A. program in education and approval of chemistry department)
Experimental work and philosophy associated with a selected research topic in chemistry.

Chem 5-410/5-411. INORGANIC CHEMISTRY. (3 cr for 5-410, 2 cr for 5-411; prereq 5-610 or 5-620; 3 hrs lect for 5-410, 2 hrs lect for 5-411) L Thompson
5-410: Atomic structure and properties of elements based thereon. Chemical bonding. Chemistry of coordination compounds. 5-411: Mechanisms of selected inorganic reactions; survey of the chemistry of the representative elements.

Chem 5-413. INORGANIC CHEMISTRY LABORATORY. (2 cr; prereq 5-410 and 5-411 or ‡; 5 hrs lab, 1 hr discussion) L Thompson
Preparation of typical inorganic compounds, illustrating special and more advanced techniques.

Chem 5-430. ADVANCED INORGANIC CHEMISTRY. (3 cr; prereq 5-410 and 5-411 or ‡) Magnuson, L Thompson
Descriptive inorganic chemistry of the nontransition elements interpreted in terms of modern theory. Symmetry and chemical applications of group theory.

Chem 5-440. THEORETICAL INORGANIC CHEMISTRY. (3 cr; prereq 5-430 or ‡) Magnuson, L Thompson
Discussion of structure, reactions and bonding in inorganic compounds in terms of valence bond, molecular orbital and ligand field theories. Theory and application of absorption spectroscopy.

Chem 5-441. PHYSICAL METHODS IN INORGANIC CHEMISTRY. (3 cr; prereq 5-440) Magnuson, L Thompson
Continuation of Chem 5-440 with emphasis on physical methods as applied to organometallic and transition metal complexes.

Chem 5-530. STRUCTURAL ORGANIC CHEMISTRY. (4 cr; prereq 3-522, 5-622, and grad standing or equiv; 3 hrs lect, 3 hrs lab) Caple, Cowles
Applications of absorption spectroscopy in molecular structure determination.

Chem 5-531. ORGANIC REACTION MECHANISMS I. (4 cr; prereq 3-522, 5-622, and grad standing or equiv; 3 hrs lect, 1 hr problem session) Caple
Methods and theory of establishing organic mechanisms, with examples.

Chem 5-532. ORGANIC SYNTHESIS I. (4 cr; prereq 3-522 and grad standing or ‡; 3 hrs lect, 1 hr seminar) R Carlson
Study of reagents and reactions and their applications in organic synthesis.

Chem 5-540. ORGANIC REACTION MECHANISMS II. (3 cr; prereq 5-531 and grad standing or ‡; 3 hrs lect) Caple
Continuation of Chem 5-531 with emphasis on carbonium ion chemistry and rearrangements.

Chem 5-541. ORGANIC SYNTHESIS II. (3 cr; prereq 5-532 and grad standing or ‡; 1 hr lect, 2 hrs seminar) R Carlson
Continuation of Chem 5-532 with specific examples from chemical literature.

Chem 5-610/5-611. PHYSICAL CHEMISTRY. (4 cr for 5-610, 3 cr for 5-611 [may be taken for 3 cr each qtr by omitting lab work]; prereq 3-511 or ‡, Math 1-286; 3 hrs lect 5-610 and 5-611, 3 hrs lab 5-610) Harriss, Nichol
Properties of gases, liquids, and solutions; thermodynamics and equilibria; electrochemistry; chemical kinetics.

Chem 5-620/5-621/5-622. PHYSICAL CHEMISTRY. (3 cr for 5-620, 4 cr for 5-621, 5 cr for 5-622 [may be taken for 3 cr each qtr by omitting lab work]; prereq 2 yrs chemistry, incl 3-210 or ‡, Phys 3-061, Math 3-288; 3 hrs lect for 5-620, 5-621 and 5-622, 3 hrs lab for 5-621, 6 hrs lab for 5-622) Nichol
Quantitative treatment of physical principles and theories underlying chemistry. Laboratory, physico-chemical measurements.

Chem 5-632. CLASSICAL, STATISTICAL THERMODYNAMICS. (4 cr, §5-631; prereq 5-622 and grad standing or ‡; 4 hrs lect) Harriss, Nichol
Review of classical thermodynamics and introduction to the principles of equilibrium statistical thermodynamics.

Chem 5-635. INTRODUCTION TO QUANTUM THEORY. (3 cr; prereq 5-622 and grad standing or ‡; 3 hrs lect) Harriss
Electronic structure and spectra of atoms, principles of wave mechanics, and theoretical aspects of the chemical bond.

Chem 5-636. INTRODUCTION TO MOLECULAR STRUCTURE. (3 cr; prereq 5-635; 3 hrs lect) Harriss
Applications of quantum mechanics to molecular structure, spectra, and spectroscopic methods.

Chem 5-643. CHEMICAL KINETICS. (4 cr, §5-641; prereq 5-632 and grad standing or ‡; 4 hrs lect) Bydalek, Harriss, Nichol
Reaction velocity and mechanisms of reactions in gases and in solution. Absolute reaction rate theory, relationship between kinetics and thermodynamics, catalysis.

Chem 8-180. SEMINAR. (1 cr [may be repeated for cr])
Practice in the preparation and oral presentation of reports on articles from the literature or on graduate research.

Chem 8-199. RESEARCH IN CHEMISTRY. (Cr ar)

Chem 8-250. SELECTED TOPICS IN ANALYTICAL CHEMISTRY. (Cr ar; prereq grad standing or ‡) Bydalek

Chem 8-260. GENERAL SURVEY IN ANALYTICAL CHEMISTRY. (1 cr; by proficiency exam only)
Independent reading which is prerequisite to candidacy for the M.S. degree in analytical chemistry.

Chem 8-350. SELECTED TOPICS IN BIOCHEMISTRY. (Cr ar; prereq ‡) Salo

Chem 8-450. SELECTED TOPICS IN INORGANIC CHEMISTRY. (Cr ar; prereq ‡) Magnuson, L Thompson

Chem 8-460. GENERAL SURVEY IN INORGANIC CHEMISTRY. (1 cr; by proficiency exam only)
Independent reading which is prerequisite to candidacy for the M.S. degree in inorganic chemistry.

Chem 8-550. SELECTED TOPICS IN ORGANIC CHEMISTRY. (Cr ar; prereq ‡) Caple, R Carlson

Chem 8-560. GENERAL SURVEY IN ORGANIC CHEMISTRY. (1 cr; by proficiency exam only)
Independent reading which is prerequisite to candidacy for the M.S. degree in organic chemistry.

Chem 8-650. SELECTED TOPICS IN PHYSICAL CHEMISTRY. (Cr ar; prereq grad standing or ‡) Harriss, Nichol

Chem 8-660. GENERAL SURVEY IN PHYSICAL CHEMISTRY. (1 cr; by proficiency exam only)
Independent reading which is prerequisite to candidacy for the M.S. degree in physical chemistry.

Education and Educational Psychology

Professor

Moy F. Gum, *director of graduate study* (educational psychology)
Harry C. Johnson, *head, director of graduate study* (elementary)
John E. Verrill, *head, director of graduate study* (secondary)
Thomas W. Chamberlin
Dean A. Crawford
John A. Dettmann
Henry J. Ehlers
Maude L. Lindquist
William R. McEwen
R. Dale Miller
James R. Murphy
Valworth R. Plumb
Lewis J. Rickert
Richard O. Sielaff
Vernon L. Simula
Arthur E. Smith
Anna L. Stensland
Armas W. Tamminen
Ward M. Wells

Associate Professor

Iver Bogen
Thomas G. Boman
Sylvan D. Burgstahler
William C. Gemeinhardt
A. Dean Hendrickson
Richard G. Lidberg
Cyril M. Milbrath
Alvin W. Ollenburger
Stella B. Schulz

Assistant Professor

Ajit K. Das
Robert V. Krejcie
Karl J. Vander Horck

ArEd 5-850. CURRICULUM BUILDING. (3 cr; prereq sr and ‡) Boyce, A Smith
Functions of art in education; selection, evaluation, and organization of subject matter to create original teaching units and projects.

ArEd 5-860. IMPLEMENTING INSTRUCTIONAL PROGRAM. (3 cr; prereq sr and ‡) Boyce, A Smith
Relation of the instructional program to administrative and supervisory policies; study of facilities and policies for improving the instructional program in art.

ArEd 5-870. ADVANCED COURSE IN TEACHING ART. (3 cr; prereq sr and ‡) Boyce, A Smith
Evaluation of current practices; utilization of research findings; introduction of new materials; development of cooperation between classroom teachers and art education specialists.

ArEd 5-880. DEVELOPMENT OF ART EDUCATION. (3 cr; prereq sr and ‡) Boyce, A Smith
Effect of various 20th-century art movements on the teaching of art in the public schools.

ArEd 8-890.* PROBLEMS IN ART EDUCATION. (Cr ar; prereq consent of major adviser) A Smith
Independent projects under staff guidance; may include advanced studio practice or technical problems requiring experimental or library research.

Educ 5-169. LEARNING DIFFICULTIES. (3 cr; prereq tchg exper or ‡)
Evaluation of results of teaching; diagnosis of pupil learning difficulty; development and prevention; tests as aids to teaching; following up a testing program.

Educ 5-200. EXPERIMENTAL STUDY OF CHILDREN. (3 cr; prereq sr or tchg exper or ‡)
Experience with various techniques of observing behavior, record keeping, and methods of analyzing and interpreting behavior records; lectures, discussions, and laboratory exercises.

Educ 5-201. PIAGET FOR TEACHERS. (3 cr; prereq tchg exper or ‡)
Piaget's theory of intellectual development; experience with developing, administering and interpreting conversation and other performance tasks; application of the theory to teaching in areas such as mathematics and science.

Educ 5-223. SUPERVISION OF STUDENT TEACHING. (3 cr; prereq 15 cr in education and ‡)
For persons planning to supervise or administer student teaching and other professional laboratory experiences in elementary and secondary education.

Educ 5-231. PROGRAMMED INSTRUCTION IN THE CLASSROOM. (3 cr; prereq tchg exper and ‡; offered summer only)
Introduction to the principles and techniques of programmed instruction; survey of available programs and devices; problems in development and use of programs in elementary and secondary school classrooms.

Educ 5-285. THE COMMUNITY SCHOOL. (3 to 6 cr; prereq ‡)
For experienced elementary and secondary school teachers and administrators, and other professional leaders in education from rural village communities. Role of the school as a learning situation for students and as an agency responsible for the continuous growth of adults; analysis of a wide range of community school situations; relationships with other agencies. Description of a particular community school and the solving of a problem within its famework is a part of the responsibility of each class member.

Educ 5-290. PERSONALIZED TEACHING: INTRODUCTION. (3 cr; prereq tchg exper or ‡)
Survey course primarily for in-service teachers with emphasis on more flexible classroom organization, scheduling, and grouping for instruction, on effective education, and on greater student involvement in learning experiences.

Educ 5-305. MEASUREMENT IN THE CLASSROOM. (3 cr; prereq Psy 3-811 or ‡)
Principles of measurement applied to the construction and evaluation of tests and to the interpretation of scores; illustrations from achievement, intelligence, interest, attitude, and personality tests. Each student constructs an examination in the field of major interest.

Educ 5-370. READING DISABILITIES. (3 cr; prereq ElEd 3-377, ElEd 5-379, or basic training in counseling or school psychology, tchg exper, and ‡)
Causes, prevention, and correction; remedial practices in reading useful to the classroom teacher, school counselor, and reading specialist.

Educ 5-376. THE CULTURALLY DIFFERENT PUPIL. (3 cr, §5-375; prereq 9 cr in education)
Educational needs of pupils with cultural backgrounds different from those of the majority of pupils; study of educational programs designed to meet such needs.

Educ 5-379. HUMANIZING EDUCATION. (3 cr; prereq 10 cr in education)
Provides theory and practice opportunities for developing more human-centered approaches to learning. Emphasis on the affective domain.

Educ 5-386. DEVELOPING COMMUNITY LEADERSHIP. (3 cr; prereq 10 cr in education)
Appraisal of community educational agencies; process of and responsibilities for community leadership; role of the school in the rural community; coordination of the school with nonschool educational agencies.

Educ 5-391. DATA PROCESSING. (3 cr, §BA 1-204; prereq ‡)
History, basic philosophy; types of operations performed and machines used in these operations; actual writing of several standard data processing computer programs.

Educ 5-392. APPLIED DATA PROCESSING. (3 cr; prereq 5-391 or ‡)
Systems analysis, systems design, coding, programming, field testing, and implementation of student selected projects.

Educ 5-400. WORKSHOP: (Various titles to be assigned). (1 to 6 cr each offering [no more than a total of 6 cr can be applied to a Master's degree program]; prereq tchg exper and ‡)
Opportunities for experienced teachers to concentrate study on common curricular and instructional problems.

Educ 5-651. DRUG ABUSE INFORMATION. (3 cr, §3-201, §3-203, §5-400 [Workshop: Drug Education] prereq tchg exper or working exper in a human services occupation or ‡) Boman
Multimedia instructional program designed to provide persons who work with young people the basic information about the psychological and physiological effects of common drugs of abuse. The program also probes into the reason for drug use and abuse in our society and provides an opportunity for the participants to begin the design of a drug abuse prevention program appropriate for their situation.

Educ 5-672. PRACTICUM: READING DIAGNOSIS. (3 cr; prereq 5-370, SpEd 5-371, tchg exper, and ‡)
The relationship of reading difficulties to psychological factors, and their clinical remedial correction.

Educ 5-673. PRACTICUM: READING REMEDIATION. (3 to 6 cr; prereq 5-370, SpEd 5-371, tchg exper, and ‡)
Remedial tutoring of individual children who have experienced difficulty in school learning.

Educ 5-750. SPEECH IMPROVEMENT IN THE CLASSROOM. (4 cr, §5-700; not open to speech pathology majors)
Recognition and management of speech and hearing problems by the elementary and secondary classroom teacher; voice and articulation models; theory and practice of speech improvement in the classroom.

Educ 5-801. PROGRAMS AND PROCEDURES OF CURRICULUM DEVELOPMENT. (3 cr; prereq SeEd 5-233 or ElEd 5-401 and/or ‡)
Leadership in procedures, operational processes; major consideration in planning and organizing, interpersonal relationship, and evaluation of improvement programs.

Educ 5-821. LOGIC FOR TEACHERS. (3 cr; prereq 9 cr in education)
Ways to clarify meaning, to give better structure to a body of knowledge, and to encourage critical thinking. Case studies in elementary and secondary education.

Educ 5-841. HISTORY OF AMERICAN EDUCATION. (3 cr; prereq 9 cr in education or ‡)
Selected readings in American intellectual, political, economic, and social development; special reference to an emerging system of public education.

Educ 5-891. CRUCIAL ISSUES IN EDUCATION. (3 cr; prereq 9 cr in education)
Several controversial issues in contemporary American education.

Educ 5-915. READING GUIDANCE FOR CHILDREN. (3 cr; prereq 5-913)
Reading interests of children; materials that meet these interests. Knowledge of sources, selection, evaluation, and methods of introducing books to children.

Educ 5-917. READING GUIDANCE FOR ADOLESCENTS. (3 cr; prereq 5-913)
The library's relationship to the teenager in terms of interests and needs. Methods of introducing books and developing and guiding reading.

Educ 5-921. AUDIO-VISUAL MATERIALS. (3 cr; prereq 9 cr in education or ‡)
Characteristics, advantages, limitations, and practical use of audio-visual materials of nonprojected and projected types; practice in the operation of audio-visual equipment.

Educ 5-922. AUDIO-VISUAL MATERIALS LABORATORY. (3 cr; prereq 5-921 or ‡)
Practice in planning and making materials for audio-visual education in the use of machines and equipment.

Educ 8-950.* PROBLEMS IN CURRICULUM CONSTRUCTION. (3 to 9 cr per qtr; prereq admission to candidacy for Master's degree and ‡)
Opportunity for students to work individually on specific problems in elementary or secondary education.

ElEd 5-312. TRENDS IN LANGUAGE ARTS—ELEMENTARY. (3 cr; prereq 9 cr in education)
Improvement of instruction in language, grammar, spelling and handwriting; results of scientific investigations; use of standardized and informal tests; remedial work.

ElEd 5-344. TEACHING SCIENCE—ELEMENTARY. (3 cr; prereq 9 cr in education)
Emphasis on resources and materials and their application to the elementary grades.

ElEd 5-345. TRENDS IN SCIENCE—ELEMENTARY. (3 cr; prereq 5-344 or ‡)
Contemporary curriculum developments in materials and methods for elementary school science. Criteria for science program evaluation.

ElEd 5-355. TEACHING MATHEMATICS—ELEMENTARY. (3 cr; prereq Math 1-080)
Functions of mathematics instruction; curriculum studies; development of socialized units, measurement and diagnosis; experimental research on methods of mathematics instruction; literature on mathematics.

ElEd 5-356. MODERN MATHEMATICS—ELEMENTARY. (3 cr; prereq Math 1-080 or equiv)
Discussion of modern programs in elementary mathematics, with an inclusion of newer content growing out of current experimental activities in this area of learning.

ElEd 5-357. TRENDS IN MATHEMATICS—ELEMENTARY. (3 cr; prereq 5-355 or ‡)
Contemporary literature, trends and experimentation with content; criteria for program evaluation.

ElEd 5-358. LABORATORY MATHEMATICS TEACHING. (3 cr; prereq 5-355 or ‡; 2 hrs lect, 2 hrs lab)
Theory and materials for development of a laboratory approach to elementary school mathematics instruction. Criteria for evaluation of materials; development of instructional units and programs.

ElEd 5-366. TEACHING SOCIAL STUDIES—ELEMENTARY. (3 cr)
Content and organization of social studies programs; understanding and improving the learning situation; effective use of materials.

ElEd 5-367. TRENDS IN SOCIAL STUDIES—ELEMENTARY. (3 cr; prereq tchg exper, ‡, and 5-366)
Printed, audio-visual, and other materials; investigation and evaluation of teaching materials and devices.

ElEd 5-378. TRENDS IN READING—ELEMENTARY. (3 cr; prereq Educ 5-370, Educ 5-672, Educ 5-673, and ‡)
Objectives, techniques, and materials of elementary reading; survey of reading research; principles of supervision and curriculum development in reading.

ElEd 5-379. MATERIALS IN READING—ELEMENTARY. (3 cr; prereq tchg exper or ‡)
Analysis and evaluation of materials for reading instruction; consideration of programmed, basal, linguistic, and other types of materials. Laboratory projects and demonstrations of techniques of instruction; criteria for selection of materials and techniques for students with special needs.

ElEd 5-394. TRENDS IN KINDERGARTEN EDUCATION. (3 cr; prereq 3-395 or tchg exper)
Current practices in kindergarten teaching, evaluated in light of research in child development and kindergarten teaching.

ElEd 5-401. ELEMENTARY SCHOOL CURRICULUM. (3 cr; prereq ‡)
Curriculum practices, issues, and trends in the modern elementary school; survey of research studies relating to all areas of instruction and analysis of representative programs.

ElEd 5-402. ELEMENTARY SCHOOL SUPERVISION. (3 cr; prereq ‡)
Functions and duties of supervisors in improving instruction; specific techniques; likely problems; means of evaluating practical teaching situations.

SeEd 5-212. LITERATURE FOR ADOLESCENTS. (4 cr; prereq ‡)
Background for pupil guidance in extensive reading in junior and senior high schools; analysis of studies of adolescent choices in literature; principles of selection; critical reading in broad fields of literary, biographical, historical, scientific, and vocational interests of boys and girls.

SeEd 5-221. ADMINISTERING DISTRIBUTIVE PROGRAMS. (3 cr; offered summer only)
Principles, practices, and legislation followed in developing cooperative part-time and adult programs under federal vocational acts. Basic course for teacher-coordinators and vocational administrators.

SeEd 5-223. ADVANCED COURSE: MATHEMATICS TEACHING. (3 cr; prereq exper in tchg mathematics and/or ‡)
Methods, materials, and curriculum development; preparation and evaluation of tests, individually prescribed instructional programs and other materials of instruction; principles of mathematics learning; problem solving; organization of programs for the slow learner and gifted.

SeEd 5-225. MATHEMATICS EDUCATION: CURRENT TRENDS. (3 cr; prereq 5-223, ‡)
Trends and experimentation with content; criteria for local program development and evaluation; review of research and current literature; new school organizational patterns; in-service responsibilities.

SeEd 5-227. COMPUTERS IN MATHEMATICS INSTRUCTION. (3 cr; prereq ‡)
Role of the computer in mathematics instruction; the contribution of the computer to concept formation, computational skill and problem solving; equipment and programming language; programming; instructional materials.

SeEd 5-233. SECONDARY SCHOOL CURRICULUM. (3 cr; prereq ‡)
Organization and design of the curriculum with special consideration of the issues, problems, trends, and recommendations for a modern high school program; analysis of selected curricula and core curriculum plans.

SeEd 5-234. CURRENT SECONDARY SCIENCE TEACHING. (3 cr; prereq 3-233, or exper in science tchg or ‡)
New science curricula, their philosophy, materials, and methods of instruction, evaluation of the curricula.

SeEd 5-235. TEACHING COOPERATIVE CLASSES. (3 cr; offered when feasible)
For cooperative part-time distributive, office, miscellaneous trades, and diversified occupations classes.

SeEd 5-241. SOCIAL STUDIES MATERIALS LABORATORY. (3 cr; prereq tchg exper, ‡, and 3-244)
Printed and audio-visual materials useful in social studies classes.

SeEd 5-243. CURRENT SOCIAL STUDIES DEVELOPMENTS. (3 cr; prereq sr, 3-244 or ‡)
Survey of contemporary literature, curricular trends, and developments in methods.

SeEd 5-261. TEACHING SECRETARIAL SUBJECTS. (3 cr; prereq 3-263 and 3-267 or ‡)
Recent research and trends in teaching typewriting, shorthand, and office practice.

SeEd 5-262. TEACHING DATA PROCESSING SUBJECTS. (3 cr; prereq 3-265 or ‡)
Advanced course in methods of teaching bookkeeping and related data processing courses at the secondary and collegiate levels, guidance information, recent research and trends.

SeEd 5-263. TEACHING BASIC BUSINESS SUBJECTS. (3 cr; prereq ‡)
Recent trends and development in teaching junior business training, economic geography, marketing, business law, consumer education, and bookkeeping.

SeEd 5-265. COORDINATION TECHNIQUE. (3 cr; prereq ‡; offered when feasible)
Problems of coordinators in the cooperative part-time program. Guidance and selection; placing of students in work stations; assisting job adjustments; developing the training program.

SeEd 5-271. STUDENT ORGANIZATIONS AND ACTIVITIES. (3 cr; prereq ‡)
Types of organizations and activities in junior and senior high schools; aims and values; practices in organizing, administering, and supervising; evaluation.

SeEd 5-281. DRIVER EDUCATION I. (4 cr [no more than 4 cr of 5-281/5-283 may be applied toward the M.A. degree])
History, background, and general theory of driver education and traffic safety. Preparation for the classroom phase of driver education with an introduction to the in-car program.

SeEd 5-283. DRIVER EDUCATION II. (4 cr [no more than 4 cr of 5-281/5-283 may be applied toward the M.A. degree]; prereq 5-281)
Overview of SeEd 5-281. Thorough study of all phases of the in-car program and the traffic safety problem as they relate to driver education; application of theory in practical laboratory experience.

SeEd 5-285. BEHAVIORAL FACTORS: TRAFFIC PROBLEM. (3 cr; prereq Ind 3-950, SeEd 5-281, SeEd 5-283)
Emphasis on attitudes, motivation, and adjustment and their relationship to unsafe driving. Principles and methods appropriate in identifying, understanding, and modifying unsatisfactory behavior. Review of research on behavioral aspects of accident causation and behavioral change.

SeEd 5-287. PHYSICAL FACTORS: TRAFFIC PROBLEM. (3 cr; prereq Ind 3-950, SeEd 5-281, SeEd 5-283)
Planning, design, and operation of the highway transportation system in the United States with emphasis on the implication for safe, efficient, and economic driving.

SeEd 5-289. HIGHWAY TRAFFIC ADMINISTRATION. (3 cr; prereq Ind 3-950, SeEd 5-281, SeEd 5-283)
United States highway transportation system, with emphasis on safe, efficient, and economic motor vehicle operation. Activities and agencies concerned with increasing efficiency of the transportation system. System's development; components; social, economic, and political impacts.

SeEd 8-222. SUPERVISION OF SECONDARY INSTRUCTION. (3 cr; prereq PsyF 5-611 or ‡)
Present status, proper scope and function, principles, application to improvement of instruction.

SpEd 5-221. PROBLEMS IN MENTAL DEFICIENCY. (3 cr; prereq 5-301 or ‡; offered when feasible)
Diagnosis, care, training; social and vocational problems; legal aspects.

SpEd 5-222. INTRODUCTION TO MENTAL RETARDATION. (3 cr; prereq 5-301; offered when feasible)
Issues which relate to educational practices; community planning; educational philosophy, administration and organization, and programming.

SpEd 5-223. ELEMENTARY EDUCABLE RETARDED. (3 cr; prereq 5-222 or ‡; offered when feasible)
Curriculum content, materials, and methods of instruction for educable mentally retarded children. Preparation of units and development of teaching aids.

SpEd 5-300. SPECIAL EDUCATION SEMINAR. (1 cr [may be repeated for a maximum of 6 cr]; prereq ‡)
Opportunity for in-depth dialogue on practices, trends, issues, and problems pertinent to the student's selected area in special education.

SpEd 5-301. EXCEPTIONALITY AND CURRICULUM. (3 cr, §5-220; prereq ¶5-300 and ¶5-600 or ‡)
Information base dealing with the range of exceptionalities requiring instructional differentiation. Includes selected aspects of sensory, motor, cognitive, and social functioning.

SpEd 5-302. ANALYSIS OF INSTRUCTION. (3 cr; prereq ¶5-600 or ‡)
Specific procedures for analysis of curriculum, teacher, and student interactions for evaluating the learning processes of exceptional children.

SpEd 5-303. DIAGNOSTIC INSTRUCTION. (3 cr; prereq ¶5-600 or ‡)
Specific procedures for assessing individual perceptual, cognitive, and social functions of exceptional children. Acquisition of selected instructional competencies.

SpEd 5-304. BEHAVIOR DISORDERED CHILDREN. (3 cr; prereq 9 cr in education or psychology or ‡; offered when feasible)
Theoretical approaches to viewing behavior disordered children. Implications of each for educational management.

SpEd 5-305. EXCEPTIONALITY IN THE CLASSROOM. (3 cr; prereq 9 cr in education or psychology or ‡; offered when feasible)
Practical methods, materials, and managerial skills to assist the classroom teacher in differentiating instruction for exceptional children in the regular classroom.

SpEd 5-371. CLINICAL PROCEDURES WITH CHILDREN. (3 cr; primarily for students not majoring in clinical psychology; prereq 12 cr in psychology, educational psychology, sociology, or child psychology; offered when feasible)
Methods of clinical psychology; basic concepts and research problems in clinical work with children.

SpEd 5-400. WORKSHOP: (Various titles to be assigned). (1 to 6 cr each offering [no more than a total of 6 cr can be applied to a Master's degree program]; prereq tchg exper and ‡)

SpEd 5-600. SPECIAL AREA PRACTICUM. (1 to 4 cr [may be repeated for a maximum of 12 cr]; prereq ‡)
Direct observational and instructional experience with exceptional children.

SpEd 5-900. SPECIAL AREA PROJECT. (1 to 4 cr; prereq ‡)
Opportunity for an advanced student to undertake an independent project which would serve to substantially further either theoretical knowledge base or professional competencies.

HE 5-568. HOUSING PROBLEMS OF THE FAMILY. (3 cr; prereq sr, Soc 1-100 or Soc 1-400, Econ 1-004 or ‡; offered when feasible)
Problems of urban and rural homes; evaluation of economic, art, and social aspects. Discussions, field trips, and classroom analyses.

HEEd 5-100. WORKSHOP: (Various titles to be assigned). (1 to 4 cr each offering; prereq tchg exper or ‡)
Opportunities for inservice teachers to concentrate study on new materials and curriculum problems in various aspects of home economics.

HEEd 5-300. HOME ECONOMICS CURRICULUM. (3 cr; prereq HE 3-861, tchg exper or ‡; offered when feasible)
Examination of research and literature; development of units of study and programs at the elementary and secondary level; production and evaluation of materials.

HEEd 5-320. ADULT EDUCATION IN HOME ECONOMICS. (3 cr; prereq sr, HE 3-861, SeEd 3-503 or ‡)
Adult education in homemaking; problems affecting community and family life; methods and techniques in helping adults and out-of-school youths to solve problems in home living; for teachers, extension workers, and other workers in adult education.

Ind 5-890. SEMINAR: NEW ELECTRONIC DEVICES. (3 to 6 cr; prereq 3-833 or ‡; 3 to 6 hrs lect, 3 to 6 hrs lab; offered when feasible)
Operation of new electronic devices and how they are incorporated in circuits.

Ind 5-922. TESTS IN VOCATIONAL SUBJECTS. (3 cr)
Study and application of principles of evaluation to shop and drawing subjects.

Ind 5-923. GENERAL SHOP. (3 cr; offered when feasible)
Theory of multiple shop organization; current practice as to types of shops; equipment; instructional materials and procedures; pupil personnel plans.

Ind 5-924. AUDIO-VISUAL MATERIALS. (3 cr, §Educ 5-921; prereq 9 cr in education or ‡)
Characteristics, advantages, limitations, and practical use of audio-visual materials of nonprojected and projected types; practice in the operation of audio-visual equipment.

Ind 5-926. COORDINATION TECHNIQUES. (3 cr; prereq 5-928 or ‡)
Coordination in trade schools, part-time programs, and cosmopolitan high schools; information, guidance, and training for coordinators.

Ind 5-928. PHILOSOPHY AND PRACTICES OF VOCATIONAL EDUCATION. (3 cr)
Development and characteristics of vocational education; social and economic significance; plans of organizational types of schools and classes; state and federal aid; teacher preparation.

Ind 5-929. ANALYSIS AND COURSE ORGANIZATION. (3 cr)
Need for and types of instructional analysis; content of courses selected and arranged for common and special teaching situations; both general and vocational applications considered.

Ind 5-930. ADMINISTRATION OF INDUSTRIAL EDUCATION. (3 cr, §5-925; prereq 5-928 or ‡)
General and vocational phases; objectives, programs, and practices; laws, rulings and standards for aid; significant literature.

Ind 5-950. VOCATIONAL EDUCATION SURVEYS. (3 cr; prereq grad or ‡)
Analysis of various surveys, need for survey findings and survey techniques; preparation of plans for making surveys; interpretation and use of findings.

Ind 5-952. INDUSTRIAL EDUCATION WORKSHOP. (1 to 6 cr [may be repeated for a maximum of 6 cr]; prereq tchg exper or ‡)
Intensive study of problems in industrial education; areas of concentration vary with each offering.

Ind 5-953. CONFERENCE LEADING TECHNIQUES. (3 cr; prereq ‡)
Purposes, advantages, and limitations of conference method; instruction in techniques of conference; experience in planning, leading, and evaluating conferences and in writing summaries.

Ind 5-955. INDEPENDENT STUDY. (1 to 9 cr [may be repeated for a maximum of 9 cr]; prereq jr or sr or ‡)
Individualized research or design in electronics, power, metals, design, drafting, graphic arts, woods, or professional studies related to the candidate's professional and/or technical concentration.

Ind 5-956. VOCATIONAL GUIDANCE. (3 cr; prereq 0-900 and 3-921 or ‡; offered when feasible)
History of educational and vocational guidance movement; typical public school means and methods; types and uses of occupational information; duties of the teacher and counselor; organization and relationships.

Hlth 5-140. ADMINISTRATION OF THE PROGRAM. (3 cr; prereq 1-101 or 3-101 and ‡)
Health education in public elementary and secondary schools; special reference to curriculum construction, health supervision, and guidance; relationships between public schools and governmental health organizations and agencies; evaluation; assistance in solution of individual professional problems.

Hlth 5-300. ADVANCED INSTRUCTION — SECONDARY. (3 cr; prereq ‡)
Instructional and individual problems.

PE 5-110. SUPERVISION OF PHYSICAL EDUCATION. (3 cr)
Supervisory activities of the physical education teacher including setting up a program, establishing rapport between the teacher and supervisor, and providing a program of in-service training for the physical education teacher.

PE 5-120. ADVANCED KINESIOLOGY. (3 cr; prereq undergrad course in kinesiology or ‡)
Techniques of kinesiological analysis of basic movements and skills in physical education; evaluation of pertinent research methods and devices; application to individual projects.

PE 5-121. CONTRIBUTIONS OF BASIC SCIENCES. (3 cr; prereq ‡)
Pertinent research in basic sciences; applications in selected areas.

PE 5-151. CURRICULUM. (3 cr)
For students without previous experience in curriculum; objectives, content, organization, evaluation, and trends.

PE 5-160. TESTS AND MEASUREMENTS. (3 cr; prereq Educ 5-305 or ‡)
Construction and interpretation of evaluative procedures; place and limitation of measurement.

PE 5-161. SCIENTIFIC INTERPRETATIONS. (2 cr; prereq 3-150 or ‡)
Interpretation of current professional literature and statistical treatments in current research. Written test construction and item analysis.

PE 5-170. PRINCIPLES OF PHYSICAL EDUCATION. (3 cr; prereq 3-327)
Aims, scope, and biological aspects of physical education with special treatment of its place in education.

PsyF 5-111. PERSONALITY AND ADJUSTMENT. (3 cr; prereq 9 cr in education or ‡)
Current conceptions of personality and adjustment, factors involved in adjustment, stresses of modern life, failures of adjustment, development of human effectiveness.

PsyF 5-121. PSYCHOLOGY OF BEHAVIOR DISORDERS. (4 cr; prereq Psy 1-003, Psy 3-531, or Psy 3-111 and ‡) Das, Tamminen
Study of abnormal behavior; concepts of normality and abnormality; types of abnormal behavior, their dynamics and treatment.

PsyF 5-211. GROUP PROCEDURES IN GUIDANCE. (3 cr; prereq grad, 5-511 or ‡) Gum
Problems of group work in guidance; study of group dynamics and group procedures; laboratory experience and materials for group guidance in school situations.

PsyF 5-221. GROUP DYNAMICS IN EDUCATION. (3 cr) Tamminen
Review of literature; practical application of social-psychological concepts to analysis of group behavior.

PsyF 5-311. THEORIES OF CHILD DEVELOPMENT. (3 cr; prereq ElEd 3-101 or Psy 3-311 or ‡) Das, Smaby
An introduction to the neoanalytic, cognitive, and social learning theories of child development with special reference to the work of Erickson, Piaget, and Robert Sears.

PsyF 5-312. CHILD DEVELOPMENT: RESEARCH, ISSUES. (3 cr; prereq 5-311) Das
Critical evaluation of current research and issues in the areas of behavior genetics, early experience, cognitive development, socialization, and personality development.

PsyF 5-321. ADOLESCENT PSYCHOLOGY. (3 cr; prereq 12 cr in psychology, sociology, or home economics) Gum, Smaby
Physical, social, emotional, intellectual, and personality development of the adolescent.

PsyF 5-511. PUPIL PERSONNEL SERVICES. (3 cr; prereq 9 cr in psychology or education) Bogen, Gum, Smaby
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.

PsyF 5-512. DEVELOPMENTAL GUIDANCE. (4 cr; prereq 9 cr in psychology or ‡) Gum, Smaby
Developmental task theory and the tasks of the child, adolescent, and young adult. Application of the developmental task theory to guidance and learning situations.

PsyF 5-521. COUNSELING PROCEDURES. (3 cr; prereq 5-511, 5-811 and ‡) Bogen, Gum, Smaby
Introductory course in counseling for school and community personnel; basic theories and principles; counseling procedures, case studies, and role playing as they relate to counseling situations.

PsyF 5-522. DYNAMICS OF INTERVIEWING. (4 cr; prereq 12 cr in psychology or ‡) Smaby
Provides theory and practice opportunities for learning to interview effectively or improving interviewing skills.

PsyF 5-611. PSYCHOLOGY OF HUMAN LEARNING. (3 cr; prereq 12 cr in psychology or ‡) Smaby, Tamminen
Principles and research in human learning and implications for curriculum and instruction.

PsyF 5-811. STATISTICAL METHODS IN EDUCATION. (3 cr; prereq ‡ and ¶5-821) Hayes
Descriptive statistics, introduction to correlational analysis and regression, sampling techniques and statistical inference; application of simple analysis of variance and chi square in educational research.

PsyF 5-821. STATISTICAL METHODS LABORATORY. (2 cr; prereq ¶5-811) Hayes

PsyF 5-831. BASIC PRINCIPLES OF MEASUREMENT. (3 cr; prereq 5-811 or equiv or ‡) Covner, Tamminen
Principles underlying construction and use of psychological tests; theory and practice of testing related to statistical methods; types and uses of derived scores; factors influencing reliability and validity.

PsyF 8-041. METHODS IN EDUCATIONAL RESEARCH. (3 cr; prereq candidate for M.A. degree, 5-811) Hayes
Methods and techniques in the design, execution, analysis, and reporting of educational research problems.

PsyF 8-050.* RESEARCH PROBLEMS. (1 to 9 cr; prereq ‡) Bogen, Gum, Tamminen
Independent study.

PsyA 5-711. OCCUPATIONAL INFORMATION LABORATORY. (3 cr; prereq ‡)
Using, reviewing, and evaluating occupational information. Consideration of career development and vocations, sources and types of material, occupational filing plans, and techniques for counselors and others concerned.

PsyA 5-841. TESTS AND MEASUREMENTS. (3 cr; prereq Educ 5-305 or PsyF 5-811)
Measuring intelligence, achievement, interests, attitudes, and personality traits; using measurement in educational guidance, personnel work, administration, and supervision.

PsyA 8-500. SEMINAR: GUIDANCE. (1 cr per qtr [may be repeated for a maximum of 6 cr]) Bogen, Gum, Tamminen
Integration of graduate study for Master's degree candidates in counseling and school guidance services. Examination of issues and developments in guidance; review of literature and research.

PsyA 8-531. FIELD PRACTICE IN GUIDANCE. (3 cr; prereq 5-211, 5-212 and ‡) Das, Gum, Smaby, Tam
Initial experience in guidance and counseling, observation of students, consultation with teachers and parents, and observation of ongoing guidance programs.

PsyA 8-532. PRACTICUM: INDIVIDUAL COUNSELING. (3 cr; prereq ‡)
Individual assignments in counseling under supervision, using closed circuit TV, videotape or audiotape.

PsyA 8-541. PRACTICUM: GROUP COUNSELING. (3 cr; prereq 8-532 and ‡)
Assignments in group counseling under supervision, using CCTV, videotape, audiotape.

SPA 5-110. NORMAL LANGUAGE DEVELOPMENT. (4 cr, §SpEd 5-250; prereq ‡)
Study of the physical, psychological, and environmental requisites for normal speech and language development. Characteristic phases of language development and implications of language behavior on social and academic adjustment.

SPA 5-210. LANGUAGE DISORDERS IN CHILDREN. (4 cr, §SpEd 5-251; prereq 5-110 or ‡)
Investigation into incidence, etiology, diagnosis, and remediation of language disorders in children.

SPA 5-910. INDEPENDENT STUDY. (1 to 3 cr [may be repeated for a maximum of 6 cr]; prereq sr or grad in speech pathology or special education and △)
Directed study, readings and/or projects of interest to the student in the areas of speech pathology/audiology.

SPA 8-050. CLINICAL INSTRUMENTATION. (1 cr; prereq ‡)
Practice, care and maintenance of electronic and mechanical instruments designed as clinical tools in the habilitation and/or rehabilitation of the speech and/or hearing handicapped.

SPA 8-075. PARENT COUNSELING. (2 cr; prereq ‡)
Basic orientation to parental counseling for the speech pathologist.

SPA 8-105. LANGUAGE AND BEHAVIOR. (3 cr; prereq ‡)
The role and function of language and language systems in human behavior.

SPA 8-175. PROBLEMS: SPEECH PATHOLOGY. (3 cr; prereq ‡)
Speech screening methods, materials, and subsequent establishment of therapy in public school and paramedical settings. Historical background of speech pathology and its parent organization. Identification and discussion of current professional issues.

SPA 8-205. CLINICAL SEMINAR: APHASIA. (3 cr; prereq ‡)
Theoretical and practical study of the adult aphasic. Submission of a satisfactory paper plus a case study.

SPA 8-275. CLINICAL SEMINAR: ARTICULATION DISORDERS. (3 cr; prereq ‡)
Theoretical and practical study of articulatory disturbances. Submission of a satisfactory paper plus a case study.

SPA 8-305. CLINICAL SEMINAR: AURALLY IMPAIRED. (3 cr; prereq ‡)
Theoretical and practical study of aurally impaired individuals. Submission of a satisfactory paper plus a case study.

SPA 8-375. CLINICAL SEMINAR: CEREBRAL PALSY. (3 cr; prereq ‡)
Theoretical and practical study of the cerebral palsied individual. Submission of a satisfactory paper plus a case study.

SPA 8-405. CLINICAL SEMINAR: CLEFT PALATE. (3 cr; prereq ‡)
Theoretical and practical study of the post-operative cleft palate patient. Submission of a satisfactory paper plus a case study.

SPA 8-475. CLINICAL SEMINAR: LANGUAGE DISORDERS. (3 cr; prereq ‡)
Theoretical and practical study of language handicapped children. Submission of a satisfactory paper plus a case study.

SPA 8-505. CLINICAL SEMINAR: STUTTERING. (3 cr; prereq ‡)
Theoretical and practical study of those individuals presenting arrhythmical patterns of speech. Submission of a satisfactory paper plus a case study.

SPA 8-575. CLINICAL SEMINAR: VOICE DISTURBANCES. (3 cr; prereq ‡)
Theoretical and practical study of voice disturbances. Submission of a satisfactory paper plus a case study.

Educational Administration (Specialist Certificate in) (EdAd)

ELEMENTARY, SECONDARY, GENERAL

Professor
Dean A. Crawford
John E. Verrill

Associate Professor
William C. Gemeinhardt
Alvin W. Ollenburger

Assistant Professor
Karl J. Vander Horck, *director of graduate study*

EdAd 5-115. ELEMENTARY SCHOOL ADMINISTRATION. (3 cr; prereq ‡)
Leadership in the elementary school; organizational plans; grouping; pupil progress policies and reports; parent-teacher organizations; improvement of educational programs; special services and other areas of immediate concern to principals.

EdAd 5-116. THE TEACHER AND ADMINISTRATION. (3 cr; prereq tchg exper, or ‡)
Functions of the teacher in school organization; administrative and supervisory relationships; budgetary practices; personnel practices and teacher welfare; homeroom and cocurricular responsibilities; records and reports; public relations; teacher organizations and professional conduct; securing advancement in the profession.

EdAd 5-117. SCHOOLS IN RURAL AREAS. (3 cr; pereq ‡)
Administrative and curricular problems peculiar to rural areas; sociological changes in small towns and farm life; building a school program suited to the culture and needs of people in smaller towns and villages.

EdAd 5-123. ADMINISTERING COMMUNITY EDUCATION. (3 cr; prereq 5-117 or ‡)
Application of fundamental concepts of public school administration to small school systems; particular reference to rural community programs.

EdAd 5-128. WORKSHOP: EDUCATIONAL ADMINISTRATION. (1 to 6 cr; prereq practicing educational administrator or ‡)
Laboratory approach provides opportunities for experienced educators to concentrate their study on common administrative and supervisory problems.

EdAd 5-169. MIDDLE SCHOOL ADMINISTRATION. (3 cr, §5-167; prereq 9 cr in education)
Sources of the Middle School movement; purposes, functions, and limitations; types of organization; administrative problems of curriculum reorganization.

EdAd 8-201/8-202. FOUNDATIONS IN ADMINISTRATION. (3 cr per qtr)
For all students preparing for public school administrative positions. Aspects of administration as they relate to coordination, operation, and organization of elementary and secondary in a local district.

EdAd 8-210. PUBLIC SCHOOL FINANCE. (3 cr.)
Current practices; sources of revenue; types of taxes; theory of taxation; formula used for distribution of school aids; and federal, state, and local support of education.

EdAd 8-217. SEMINAR: ELEMENTARY SCHOOL ADMINISTRATION. (3 cr; prereq 5-115 or ‡)
Problems of administration and organization for instruction in elementary schools, communications and social-system theory, organizational analysis, and change strategies.

EdAd 8-218. SEMINAR: SECONDARY SCHOOL ADMINISTRATION. (3 cr; prereq 8-201, 8-202, 8-264 or ‡)
Problems of administration and organization for instruction in secondary schools, communication and social-system theory, organizational analysis, and change strategies.

EdAd 8-224. SCHOOL LAW. (3 cr)
Constitutional, statutory, and common law bases of school administration; principles growing out of fundamental legal procedures.

EdAd 8-226. SCHOOL PLANT PLANNING. (3 cr)
Planning educational facilities for public and private school systems; emphasis on writing educational specifications.

EdAd 8-227. TEACHER AND EMPLOYEE ADMINISTRATION. (3 cr; prereq 8-201, 8-202)
Selection and placement of school employees, salary schedules, conditions of service, records and reports, and legal aspects.

EdAd 8-235. SEMINAR: EDUCATIONAL ADMINISTRATION. (3 cr; prereq ‡)
Selected topics in school administration, application of theoretical models to problems of decision making, interpersonal relations, and goal attainment. Emphasis on case method and simulation, student analysis of processes, and use of research and writings.

EdAd 8-236. FIELD STUDY: EDUCATIONAL ADMINISTRATION. (0 to 6 cr; prereq ‡)
Required for Specialist Certificate. The 6 cr will be based on a written report covering an approved field study. Students may register for general planning and organization of their study without credit.

EdAd 8-241. INTERNSHIP IN EDUCATIONAL ADMINISTRATION. (1 to 3 cr per qtr [may be repeated for a maximum of 3 cr])
For interns in elementary, secondary, and general administration preparing for Specialist Certificate.

EdAd 8-264. THE SECONDARY SCHOOL PRINCIPALSHIP. (3 cr; prereq 8-201, 8-202)
Factors affecting administration, staff, and student relationships, intraschool relationships, school services.

EdAd 8-265. SECONDARY SCHOOL ADMINISTRATION. (3 cr)
Scheduling, administrative practices affecting learning, the academic program, community relationships, program evaluation.

EdAd 8-270.* PROBLEMS: ELEMENTARY ADMINISTRATION. (3 to 6 cr per qtr [may be repeated for a maximum of 9 cr]; prereq ‡)
Independent study.

EdAd 8-271.* PROBLEMS: SECONDARY ADMINISTRATION. (3 to 6 cr per qtr [may be repeated for a maximum of 9 cr]; prereq ‡)
Independent study.

English (Engl)

Professor

Lewis D. Levang, *head*
Joseph E. Duncan, *director of graduate study*
William M. Crockett
Wendell P. Glick
Robert C. Hart
Robert R. Owens
Albert Tezla

Assistant Professor

Thomas D. Bacig
Edith J. Hols
Klaus P. Jankofsky

Engl 5-111. THE SHORT STORY. (4 cr, §3-110; prereq 1-112) Davis
Writing of the short story with emphasis on structure and techniques learned from critical reading and classroom analysis.

Engl 5-202. INTERPRETATION OF DRAMA. (4 cr, §5-201; prereq 8 cr of literature in this dept; offered when feasible)
Certain technical aspects of reading drama in relation to meaning.

Engl 5-221. SHAKESPEARE. (4 cr, §3-220, §3-221; prereq 8 cr of literature in this dept)
Introductory study, using selected plays from the several periods of Shakespeare's career. Recommended as the first course in Shakespeare.

Engl 5-222. SHAKESPEARE. (4 cr, §5-220; prereq 8 cr of literature in this dept)
Concentrated study of selected plays, with attention to Shakespearean criticism and scholarship. Recommended as second course in Shakespeare.

Engl 5-251. AMERICAN DRAMA. (4 cr, §5-250; prereq 8 cr of literature in this dept) Hart
Critical survey, primarily of period from 1914 to present, with some attention to historical and cultural background; some representative plays of 18th, 19th, and early 20th centuries.

Engl 5-271. MODERN BRITISH DRAMA. (4 cr, §5-270; prereq 8 cr of literature in this dept) Duncan
Historical study of British drama from 1900 to the present: Shaw, Synge, O'Casey, Fry, Osborne, Beckett, Pinter, and others.

Engl 5-303. THE INTERPRETATION OF POETRY. (4 cr, §5-301/5-302) Tezla
Certain technical aspects of poetry in relation to meaning.

Engl 5-311. CHAUCER. (5 cr, §3-310, §5-310) Jankofsky
Introduction to Middle English. Reading and analysis of the works of Chaucer.

Engl 5-331. MILTON. (4 cr, §5-330; prereq 8 cr of literature in this dept) Duncan
Minor poems, *Areopagitica, Paradise Lost,* and *Samson Agonistes.*

Engl 5-411. INTERPRETATION OF THE NOVEL. (4 cr, §5-410; prereq 8 cr of literature in this dept) Owens
Important technical aspects of the novel in relation to meaning.

Engl 5-443, 5-444. ENGLISH NOVEL. (4 cr per qtr, §5-440, §5-441, §5-442; prereq 8 cr of literature in this dept) Owens
Development of the British novel. 5-443: Defoe to Trollope. 5-444: George Eliot to present.

Engl 5-452. AMERICAN NOVEL. (5 cr, §5-450, §5-451; prereq 8 cr of literature in this dept) Hart
History of the American novel in its relations to patterns of American thought.

Engl 5-471. HEMINGWAY AND FAULKNER. (4 cr, §5-470; prereq 8 cr of literature in this dept) Hart
Literary development and analysis of selected works.

Engl 5-523. MEDIEVAL LITERATURE II. (4 cr, §5-510) Jankofsky
General readings in Middle English literature and detailed study of selected works exclusive of Chaucer.

Engl 5-533. 16TH-CENTURY ENGLISH LITERATURE II. (4 cr, §5-530 and 5-531 and 5-532; prereq 8 cr of literature in this dept; offered when feasible) Levang
Readings in the works of the period, excluding Shakespeare's drama.

Engl 5-543. 17TH-CENTURY ENGLISH LITERATURE II. (4 cr, §5-540 and 5-541 and 5-542; prereq 8 cr of literature in this dept) Duncan
Readings in the period, excluding Milton.

Engl 5-553. 18TH-CENTURY ENGLISH LITERATURE II. (4 cr, §5-550 and 5-551 and 5-552; prereq 8 cr of literature in this dept) Owens
English life and letters from 1700 to 1798.

Engl 5-565. ROMANTIC PROSE AND POETRY II. (4 cr, §5-560 and 5-561; prereq 8 cr of literature in this dept) Tezla
English literature, 1790-1830.

Engl 5-566. VICTORIAN PROSE AND POETRY II. (4 cr, §5-562 and 5-563 and 5-564; prereq 8 cr of literature in this dept) Crockett
English literature, 1830-1901.

Engl 5-571. EMERSON, THOREAU, WHITMAN. (4 cr, §5-570; prereq 8 cr of literature in this dept) W Glick
Literary development and analysis of selected works.

Engl 5-572. HAWTHORNE, MELVILLE, TWAIN. (4 cr, §5-573; prereq 8 cr of literature in this dept) W Glick
Literary development and analysis of selected works.

Engl 5-581. MODERN BRITISH POETRY AND CRITICISM. (4 cr, §5-580; prereq 8 cr of literature in this dept) Duncan
British poetry and criticism from 1900 to the present. Yeats, Eliot, Richards, Leavis, Auden, Dylan Thomas, Philip Larkin, John Wain, and others.

Engl 5-590. INDEPENDENT READING. (4 cr [may be repeated for a maximum of 8 cr], §3-590, §8-510; prereq ‡ and △)
Each student chooses readings in conferences with the instructor.

Engl 5-611. LITERARY CRITICISM. (4 cr, §5-610; prereq ‡; offered when feasible)
Reading and analysis of selected critical writings from Aristotle to Arnold.

Engl 5-671. MODERN AMERICAN LITERARY CRITICISM. (4 cr, §5-670; prereq 8 cr of literature in this dept or ‡; offered when feasible) Hart
Readings in the principal schools of modern American criticism, together with some application of their chief critical tenets to selected literary works.

Engl 5-811. INTRODUCTION TO MODERN ENGLISH. (4 cr, §5-810)
Modern theories of English grammar.

Engl 5-821. HISTORY OF THE ENGLISH LANGUAGE. (4 cr, §5-820; prereq 5-811 or ‡)
History of sounds, word stock, and structures of the English language; changes in the language since the Renaissance.

Engl 5-831. SOCIOLINGUISTICS. (4 cr, §5-830; prereq 5-811; offered when feasible)
Communicative behavior in social groups, especially the conventions of dialects and stylistic variation, linguistic interference, and paralinguistic behavior of dominant cultures and subcultures.

Engl 5-910. BIBLIOGRAPHY AND LITERARY RESEARCH. (2 cr; prereq ‡; offered when feasible)
Basic library reference works, scholarly and critical journals, bibliographies of periods and prominent literary figures; exercises and problems in methods and exposition of research.

Engl 5-920. ADVANCED ENGLISH METHODS — SECONDARY. (4 cr, §SeEd 8-211; prereq 3-910 or equiv; offered summer only)
Evaluation of present content and method in the light of research and recent trends in teaching.

Engl 8-530. GRADUATE SEMINAR. (4 cr [may be repeated for cr])

Engl 8-901. TEACHING FRESHMAN COMPOSITION. (1 cr [may be repeated for a max of 6 cr]...tchg assts in English Department are required to attend for 1 cr, and may elect in subsequent qtrs to conduct research and experiments in freshman composition for a maximum of 5 addtl cr; prereq ‡)
Seminar in methods, materials, and objectives of teaching freshman composition.

Engl 8-910. PRACTICUM IN TEACHING COMPOSITION. (4 cr)
Teaching, tutoring and assisting in freshman composition courses, experience in the preparation of materials, micro-teaching and grading student work.

Engl 8-930. PRACTICUM IN TEACHING LITERATURE. (4 cr; prereq 8 cr of literature or ‡)
Teaching in sophomore literature courses; experience in preparation of supplementary materials, consultation with students, and assisting instructors in grading student work.

Geology (Geol)

Professor

Ralph W. Marsden, *head*
John C. Green, *director of graduate study*
Robert L. Heller

Associate Professor

David G. Darby
Donald M. Davidson
James A. Grant
Charles Matsch
Richard W. Ojakangas

Geol 5-010. ADVANCED EARTH SCIENCE FOR TEACHERS. (3 cr; prereq earth science sr or grad, or ‡; 1 hr lect, 4 hrs lab) Matsch
Investigative approach to earth science, integrating the fields of astronomy, weather, climate, oceanography, physical and historical geology, in preparation for secondary school teaching of modern earth science curricula.

Geol 5-020. ENVIRONMENTAL GEOLOGY OF MINNESOTA. (5 cr; prereq 1-110 or 1-019 or ‡; not usable toward Master's degree in geology; offered summer only) Darley, Ojakangas
Rocks, minerals, waters, land forms, geological history and mineral resources—both developed and potential—of Minnesota. Technical, economic, and cultural aspects of the use and preservation of Minnesota's natural resources will be stressed. Laboratory includes a number of local field trips and one 2-day field trip to emphasize the geological history of Minnesota and the significance of geology in land use, development, and environmental problems.

Geol 5-100. FIELD GEOLOGY. (9 cr or ar; prereq 3-100 and 3-312)
Measurement of stratigraphic sections; study of fossils and igneous, sedimentary, and metamorphic rocks. Geological mapping on aerial photographs and topographic maps. Preparation of geologic maps and cross sections. Study of structural and geomorphic features and geologic setting of mineral deposits.

Geol 5-142. SEDIMENTATION AND STRATIGRAPHY. (4 cr; prereq 3-312 or ‡; 3 hrs lect, 2 hrs lab) Darby, Ojakangas
Principles and procedures in the study of sedimentary rocks; mechanics and environments of deposition; stratigraphic nomenclature; history of stratigraphy. Laboratory includes study of analytical techniques for sediments, construction of subsurface maps, and well log and geologic map interpretation.

Geol 5-150. PRECAMBRIAN GEOLOGY. (4 cr; prereq 3-510 and ‡; 3 hrs lect, 1 wk pre-qtr field trip)
Nature, distribution, origin, correlation, and special problems of the Precambrian with emphasis in the Lake Superior Region. Term paper.

Geol 5-180. SEMINAR: PRECAMBRIAN GEOLOGY. (1 to 3 cr [may be repeated for a maximum of 6 cr]; prereq 5-150)

Geol 5-181. SEMINAR: STRATIGRAPHY-SEDIMENTATION. (1 to 2 cr [may be repeated for a maximum of 4 cr]; prereq ‡) Darby, Ojakangas

Geol 5-190. GEOLOGIC PROBLEMS. (1 to 2 cr; prereq ‡)
Individual research in laboratory or field problems.

Geol 5-211. GLACIAL AND QUATERNARY GEOLOGY. (4 cr, §5-210; prereq 1-110 or ‡; 3 hrs lect, 2 hrs field lab) Matsch
Physics of glaciers (glaciology), including their erosional and depositional activities. Survey of geological and biological responses to the changing environment resulting from climate fluctuations during the last three million years of earth history. Field studies on the glacial deposits of Minnesota.

Geol 5-280. SEMINAR: GEOMORPHOLOGY-GLACIAL. (2 cr; prereq 3-200 and 5-211 or ‡) Matsch
Selected topics in geomorphology, glaciology, and the Quaternary geology of North America, with special emphasis given to the quantitative aspects of recent research in these fields.

Geol 5-305. OPTICAL MINERALOGY. (4 cr; prereq 3-312 or ‡; 2 hrs lect, 6 hrs lab) Green
Study and identification of crystalline substances using the polarizing microscope and both thin sections and immersion media; introduction to opaque microscopy.

Geol 5-311. ANALYTICAL TECHNIQUES FOR GEOLOGY. (4 cr; prereq Chem 1-112, Phys 1-031, Math 1-286 or equiv or ‡, 2 hrs lect, 4 hrs lab) Davidson
Basic concepts in modern crystallography. Theory and technique of various analytical procedures including: X-ray, atomic absorption, electron microprobe, electron microscope and mass spectrometric analysis.

Geol 5-320. INTRODUCTION TO THEORETICAL PETROLOGY. (3 cr; prereq Math 1-286, Chem 1-112 or 1-121; 3 hrs lect) Grant
Basic topics in theoretical petrology, in particular phase equilibria as applied to geologic systems.

Geol 5-330. PETROLOGY OF IGNEOUS ROCKS. (4 cr; prereq 3-312, 5-305 and 5-320 and ‡; 2 hrs lect, 4 hrs lab) Green
Survey of important igneous rock types; physical chemistry of magmatic systems; genesis and differentiation of magmas; problems in theoretical igneous petrology; laboratory study of volcanic and plutonic rock associations. Term paper.

Geol 5-340. PETROLOGY OF METAMORPHIC ROCKS. (4 cr; prereq 3-312, 5-305 and 5-320 and ‡; 2 hrs lect, 4 hrs lab) Grant
Metamorphic processes and products including interpretation from theory and experiment; problems in metamorphic petrogenesis; laboratory study with the petrographic microscope and other techniques. Term paper.

Geol 5-350. PETROLOGY OF SEDIMENTARY ROCKS. (4 cr; prereq 3-312, 5-305 or equiv and ‡; 2 hrs lect, 4 hrs lab) Ojakangas
Provenance, associations, and classifications of sedimentary rocks, including sandstones, carbonates, muddy rocks, and others. Microscopic study of thin sections and grain mounts; statistical techniques. Interpretation of rock suites. Term paper.

Geol 5-380. SEMINAR: CRYSTAL CHEMISTRY. (2 cr; prereq Math 1-286, Chem 1-112 and ‡; offered 1972-73 and alt yrs) Davidson
Chemical bonding, atomic structures, crystal growth, crystal chemistry and crystal properties.

Geol 5-400. INTRODUCTORY GEOCHEMISTRY. (3 cr; prereq 1-110, Chem 1-112, Math 1-286 or ‡; offered 1972-73 and alt yrs) Grant
Origin, abundance, and distribution of elements in the solar system, with emphasis on the earth. Fundamentals of phase equilibria and the elementary application of thermodynamics to geologic systems are treated. The fundamentals of isotope geochemistry and its applications to geology are considered.

Geol 5-510. ADVANCED STRUCTURAL ANALYSIS. (4 cr; prereq 3-511, Phys 1-031, Math 1-281, Math 3-501 or ‡) Davidson
Theory of rock deformation, stress-strain theory applications; computerized model and tectonite analysis.

Geol 5-510. ADVANCED STRUCTURAL ANALYSIS. (4 cr; prereq 3-500, Phys 1-006 or Phys 1-019, Math 1-281, Math 3-500, or equiv or ‡) D Davidson
Theory of rock deformation, stress-strain theory applications; computerized model and tectonite analysis. Term paper.

Geol 5-581. SEMINAR: GEOTECTONICS. (2 cr, §5-580; prereq 3-511 or equiv or ‡)
The distribution, origin and geophysical parameters of major earth structures as related to the new global tectonics.

Geol 5-610. ORE DEPOSITS. (4 cr; prereq 3-511, Chem 1-112, Math 1-185 or equiv or ‡; 3 hrs lect, 2 hrs lab) Davidson, Marsden
The distribution, nature, tectonic setting, and origin of ore deposits.

Geol 5-611. GEOLOGY OF IRON ORES. (2 cr; prereq 5-610 or ‡) Marsden
Nature, distribution, and origin of iron ores, stressing Precambrian iron ores. Term paper.

Geol 5-620. INDUSTRIAL MINERALS AND FUELS. (3 cr; prereq 3-511 or ‡) Marsden
Origin, distribution, and nature of industrial mineral deposits, petroleum, and coal.

Geol 5-630. ECONOMIC ASPECTS OF GEOLOGY. (2 cr; prereq 3-600 or ‡)
Political, economic, and environmental factors influencing the mineral industries. Term paper.

Geol 5-700. PALEONTOLOGY. (5 cr, §3-700; prereq 1-110 or ‡; 3 hrs lect, 4 hrs lab) Darby
Invertebrate animals as fossils. The morphology, taxonomy and ecology of important micro and macro invertebrate fossil groups; comparison of living and extinct forms; stratigraphic occurrences; geological time ranges; index fossils of North America.

Geol 8-180. SEMINAR. (1 cr)
Oral and written presentations on topics of current significance to geoscientists. Participation by department staff.

Geol 8-190. GEOLOGIC RESEARCH. (Cr ar; prereq ‡)

History (Hist)

Professor

Ellis N. Livingston, *head, director of graduate study*
Arthur J. Larsen
Maude L. Lindquist
James F. Maclear

Hist 5-001/5-002/5-003. DIRECTED STUDY. (3 cr per qtr; prereq ‡)
A proseminar course.

Hist 5-124, 5-125, 5-126. RENAISSANCE AND REFORMATION. (4 cr per qtr, §5-121 for 5-124, §5-122 for 5-125, §5-123 for 5-126; prereq 1-204, 1-205, 1-206 or ‡; offered 1973-74 and alt yrs) Maclear
5-124: The Renaissance. 5-125: The Northern Renaissance and Reformation to 1530. 5-126: The Reformation after 1530.

Hist 5-225, 5-226, 5-227. RECENT EUROPE. (4 cr per qtr, §5-221, §5-222 for 5-225, §5-222, §5-223 for 5-226, §5-223, §5-224 for 5-227; prereq 1-204, 1-205, 1-206 or ‡) Morris
5-225: Effect of industrialism, liberalism, imperialism, and nationalism on European nation states from 1870 to 1905. 5-226: Background and significance of World War I. 5-227: The interwar years; World War II to present.

Hist 5-376, 5-377. THE AMERICAN SOUTH. (4 cr per qtr, §5-374 for 5-376, §5-375 for 5-377; prereq 1-301, 1-302, 1-303) Fisher
5-376: To 1877. 5-377: To present.

Hist 5-384, 5-385. AMERICAN FOREIGN RELATIONS. (4 cr per qtr, §5-381, §5-382 for 5-384, §5-382, §5-383 for 5-385; prereq 1-301, 1-302, 1-303) Livingston, Storch
5-384: Revolution to 1898. 5-385: 1898 to present.

Hist 5-811/5-812/5-813†. PROSEMINAR: 19TH-CENTURY AMERICA. (3 cr per qtr; prereq ‡) Fischer
5-811: The development of American nationality, 1789-1824. 5-812: Jacksonian democracy and manifest destiny. 5-813: Civil War and Reconstruction, 1860-1880.

Hist 5-821/5-822/5-823†. PROSEMINAR: 20TH-CENTURY AMERICAN HISTORY. (3 cr per qtr; prereq ‡) Livingston
5-821: Late 19th century to 1917. 5-822: From 1917 to 1938. 5-823: From 1938 to the present.

Hist 5-891, 5-892, 5-893. MINNESOTA AND THE NORTHWEST. (4 cr per qtr, §5-391 for 5-891, §5-392 for 5-892, §5-393 for 5-893; prereq 1-301, 1-302, 1-303 or ‡; offered 1973-74 and alt yrs) Lindquist
5-891: Exploration, settlement, and development to 1849. 5-892: Territorial commonwealth and early statehood to 1870. 5-893: Development to present.

Hist 5-894, 5-895, 5-896. THE AMERICAN WEST. (4 cr per qtr, §5-394 for 5-894, §5-395 for 5-895, §5-396 for 5-896; prereq 1-301, 1-302, 1-303 or ‡) Lindquist
5-894: The Old West. 5-895: The Trans-Mississippi West and the Great Plains. 5-896: The Far West.

Hist 8-001. HISTORICAL BIBLIOGRAPHY AND CRITICISM. (3 cr; required of students for the M.A. degree in history who do not present evidence of similar training elsewhere) Storch

Hist 8-891/8-892/8-893†. SEMINAR: MINNESOTA AND THE NORTHWEST. (3 cr per qtr; prereq ‡) Lindquist
8-891: Explorations to 1849. 8-892: Territorial and early statehood to 1873. 8-893: Since 1873.

Physics (Phys)

Professor
Howard G. Hanson, *head*
Thomas F. Jordan, *director of graduate study*
John L. Gergen

Associate Professor
John L. Kroening
Michael Sydor

Phys 5-092. OPTICS LABORATORY. (2 cr; prereq ¶5-119; 4 hrs lab; offered when feasible)
Experiments in interference, diffraction, polarization, optical spectra, photon counting techniques.

Phys 5-093. MODERN PHYSICS LABORATORY. (2 cr; prereq 3-062 and ¶5-101 or ‡; 4 hrs lab ar; offered when feasible)
Experiments in modern physics; microwaves, radioactivity, photoelectric effect, ionization of gases, and optical spectra.

Phys 5-094. ADVANCED LABORATORY. (2 cr; prereq 3-062 or ‡; 4 hrs lab ar)
Experimental problems of special interest to the student. Project may extend over more than 1 qtr. Credit will be given during the quarter in which the project is completed.

Phys 5-101/5-102/5-103. MODERN PHYSICS. (4 cr per qtr; prereq 3-062; 4 hrs lect)
Selected topics in modern physics, including elements of quantum mechanics and applications.

Phys 5-107. THERMAL PHYSICS. (4 cr; prereq ¶5-101; 4 hrs lect)
Elements of statistical physics, thermodynamics.

Phys 5-109. STATISTICAL PHYSICS. (4 cr; prereq 5-107; 4 hrs lect)
Principles of statistical physics applied to equilibrium properties of classical and quantum systems.

Phys 5-119. OPTICS. (4 cr; prereq 3-062 or ‡; 4 hrs lect) Sydor
Fundamentals of physical optics.

Phys 5-120. ELECTRONICS. (4 cr; prereq 3-085, 3 hrs lect, 3 hrs lab; offered when feasible) Casserberg
Electronic devices, amplifiers, special circuits common in research.

Phys 5-126. THEORETICAL MECHANICS. (3 cr; prereq 3-062 and Math 3-380; 3 hrs lect)
Theoretical mechanics, including Lagrangians and Hamiltonians, symmetries and conservation laws, with examples from relativity and electrodynamics, and introducing relevant mathematics.

Phys 5-127. MATHEMATICAL METHODS. (3 cr; prereq 5-126; 3 hrs lect)
Systematic development of mathematical techniques in mechanics and electromagnetic theory.

Phys 5-128. ELECTROMAGNETIC THEORY. (3 cr; prereq 5-127; 3 hrs lect)
Electric and magnetic fields, Maxwell's equations and applications, radiation.

Phys 5-130. INTRODUCTION TO ATMOSPHERIC PHYSICS. (3 cr; prereq 5-128; 3 hrs lect; offered when feasible)
Atmospheric composition and structure; thermodynamics; radiative transfer; atmospheric electricity; chemistry; origin of the earth's atmosphere.

Phys 5-150/5-151. INTRODUCTION TO SOLID STATE PHYSICS. (3 cr per qtr; prereq 5-103 and 5-107; 3 hrs lect; offered when feasible) Sydor
Solid structure, thermal and electronic properties of solids, and solid surfaces.

Phys 5-160. ATOMIC AND MOLECULAR STRUCTURE. (3 cr; prereq 5-103 or ‡; 3 hrs lect; offered when feasible)
Fine and hyperfine structure of atoms and molecules, selection rules and transition probabilities, coupling schemes, and potential curves.

Phys 5-175/5-176. ELECTRODYNAMICS. (3 cr per qtr; prereq 5-128 or ‡; 3 hrs lect) Casserberg, Jordan
Boundary-value problems, Maxwell's equations, covariant formulation of electrodynamics, radiation, relativistic particle motion.

Phys 5-180/5-181/5-182. INTRODUCTORY QUANTUM MECHANICS. (3 cr per qtr; prereq 5-103 and 5-128; 3 hrs lect)
Schrödinger equation, operator formulation, angular momentum, symmetries, perturbation theory, scattering, identical particles, interaction with electromagnetic field.

Phys 5-185. RELATIVISTIC QUANTUM MECHANICS. (3 cr; prereq 5-182; 3 hrs lect; offered when feasible) Casserberg, Jordan
The Poincaré group and relativistic one-particle quantum mechanics, elementary quantum field theory, electromagnetic interactions.

Phys 5-187. PARTICLE PHYSICS. (3 cr; prereq 5-185; 3 hrs lect; offered when feasible) Jordan
Properties of elementary particles, conservation laws and symmetry groups, strong and weak interactions.

Phys 8-199. SEMINAR: SELECTED TOPICS. (Cr ar [may be repeated for cr]; prereq ‡)

Phys 8-200. RESEARCH IN PHYSICS. (Cr ar [may be repeated for cr])

Miscellaneous Fields

Departments in Which There Is Neither a Major Nor a Minor But in Which Graduate Credit May Be Earned

Professor

Walter L. Baeumler (sociology-anthropology)
Lyda C. Belthuis (geography)
John A. Dettmann (business administration)
Leverett P. Hoag (geography)
M. Harry Lease, Jr. (political science)
William R. McEwen (mathematics)
Cecil H. Meyers (economics)
James R. Murphy (music)
A. Neil Pearson (sociology-anthropology)
Robert F. Pierce (speech pathology and audiology)
Richard O. Sielaff (business administration and economics)
Chester A. Sorensen (business administration)
Gerhard E. von Glahn (political science)
Frederick T. Witzig (geography)
Julius F. Wolff, Jr. (political science)

Associate Professor

Pacy Friedman (speech pathology and audiology)
Matti E. Kaups (geography)
James L. Nelson (mathematics)
John H. Ness (speech communication and theatre arts)
David A. Vose (economics)

Assistant Professor

Robert E. Curtis (business administration)
John T. Hatten (speech pathology and audiology)
Jackson R. Huntley (speech communication and theatre arts)
Wayne A. Jesswein (economics)
Jerrold M. Peterson (economics)

HUMANITIES

Fr 5-552. THE 19TH-CENTURY NOVEL. (4 cr, §Fr 5-551; prereq 3-123 and ‡; offered 1973-74 and alt yrs) Jenny

Ger 5-542. GOETHE IN TRANSLATION. (4 cr, §5-541; offered 1972-73 and alt yrs) Viksna
Reading and analysis of Goethe's major works. Poems from early and middle periods, *The Sufferings of Young Werther, Faust* or *Elective Affinities* depending on the student's preparation.

Mu 5-121. PROJECTS IN MUSICIANSHIP SKILLS. (3 cr [may be repeated for a maximum of 6 cr]; prereq 2 yrs music theory and advanced performing ability)
Concentration upon one or more of the following: sight-reading, memorization, accompanying, ensemble playing. Supplementary work in ear training and music analysis provided where necessary.

Mu 5-129. CONDUCTING, ARRANGING, COMPOSITION. (3 cr [may be repeated for a maximum of 9 cr]; prereq 2 yrs music theory and performing ability)
Serious work in any one or more of the above-named fields. Entire class shall constitute a performing ensemble for conducting experience and laboratory trial of student arrangements and compositions. Group assignments and/or individual projects required according to needs and concentrations of students.

Mu 5-161. PREPARATION OF GROUP PERFORMANCE. (3 cr [may be repeated for a maximum of 6 cr]; prereq tchg exper or extensive exper in performing groups)
Concentration upon one or more of the following: rehearsal management and techniques, programming, staging, instrument care and maintenance, and special problems of opera and "musical" preparation. Organization of the class into one or more groups for actual production of a concert or operatic scenes.

Mu 5-169. CHORAL LITERATURE INTERPRETATION. (3 cr; prereq ‡)
Musical and vocal techniques necessary for presentation of great choral compositions from Renaissance to 20th century.

Mu 5-174, 5-175. ADVANCED ORCHESTRATION. (2 cr per qtr; prereq 1-123) Murphy
Murphy
Instruments of the orchestra together with a practical study of art of symphonic scoring.

Mu 5-201. ADVANCED MUSIC HISTORY. (3 cr per qtr [may be repeated for max of 9 cr]; prereq 3-203; 1 class per wk) Gauger
Directed music history study specializing in composer, genre, or period.

Mu 5-211, 5-212/5-213. HONORS SEMINAR. (2 cr per qtr; prereq music major, 3rd qtr jr, adv standing in performance, by invitation)
Individual study in selected areas.

Mu 5-221. PROSEMINAR: MUSIC HISTORY. (3 cr; prereq 1-123 and 3-203 or ‡) Gauger
Specific problems in music history; lectures, discussions, reports, research papers, and student performance; student becomes acquainted with available documentary sources and early instruments.

Mu 5-601. BASIC CONCEPTS IN MUSIC EDUCATION. (3 cr; prereq tchg exper in music or ‡) Downs
Philosophical and psychological foundations of school music.

Mu 5-605. ADVANCED TOPICS IN MUSIC EDUCATION. (3 cr; for exper tchrs and qualified students; prereq ‡) Murphy
Various problems of individual and group instruction, especially at the secondary and collegiate levels.

Mu 5-606. WORKSHOP: (Various titles to be assigned). (1 to 3 cr each offering [no more than 6 cr can be applied to a Master's degree program]; prereq ‡; offered summer only)
Planning and directing general music experiences at the elementary and/or secondary levels using specialized techniques and materials.

Mu 5-650. SUPERVISION OF SCHOOL MUSIC. (3 cr; prereq 3-655, 3-605 or ‡)
Coordination of the music program personnel, and facilities for instruction. Supervisory task and techniques.

Mu 5-656. PRACTICAL OPERATION OF SCHOOL MUSIC. (3 cr; prereq 3-655, 3-605 or ‡)
Development and conduct of appropriate activities in general music, vocal, and instrumental phases.

Mu 8-333. GRADUATE APPLIED MUSIC. (2 cr per qtr [maximum 6]; prereq placement test by music department) A Anderson, Coffman, Downs, Ermey, Ferreira, Gauger, Murphy, Rust, van Appledorn, Williams.
Individual lessons. Minimum of 12 hours of practice per week.

Mu 8-890.* PROBLEMS IN MUSIC EDUCATION. (Cr ar [may be repeated for a maximum of 9 cr]; prereq consent of major adviser) A Anderson, Coffman, Downs, Ermey, Ferreira, Gauger, Murphy, Rust, van Appledorn, Williams
Directed projects in the theoretical and practical problems of teaching music in the schools.

Phil 5-011, 5-012, 5-013, 5-014. HISTORY OF PHILOSOPHY. (4 cr per qtr, §3-011 for 5-011, §3-012 for 5-012, §3-013 for 5-013; prereq 8 cr in philosophy; 5-012 offered 1972-73 and alt yrs; 5-014 offered 1973-74 and alt yrs)
5-011: Ancient Greek philosophy, with emphasis on Plato and Aristotle. 5-012: Medieval and Renaissance philosophy, from Augustine to Descartes. 5-013: From Descartes to Kant. 5-014: From Kant to Nietzsche. Research paper required of graduate students.

Phil 5-200. AESTHETICS. (3 cr, §3-200; offered 1972-73 and alt yrs)
The possibility of a definition of art or of the aesthetic experience examined through a survey of classic aestheticians; attention given to the philosophy of art criticism. Research paper required of graduate students.

Phil 5-540. PHILOSOPHY OF NATURAL SCIENCE. (4 cr, §3-500; prereq 1-005 or ‡; offered 1973-74 and alt yrs)
Basic concepts and presuppositions of science; the problem of induction; theory construction, explanation, prediction. Research paper required of graduate students.

Phil 5-550. PHILOSOPHY OF SOCIAL SCIENCE. (3 cr, §3-550; prereq 1-001, 5-540 or ‡; offered 1972-73 and alt yrs)
Types of explanation in the social sciences; value judgments, concept formation, problems in philosophical psychology. Research paper required of graduate students.

Phil 5-990. INDEPENDENT STUDY. (1 to 4 cr [may be repeated for a maximum of 8 cr], §3-990; prereq jr or ‡)
Tutorial work in problems of special interest to the student, to be arranged with instructor in advance of registration. Students may take Phil 5-990 in conjunction with another philosophy course.

Spch 5-101. HISTORY OF RHETORIC. (3 cr; prereq 1-101; offered 1972-73 and alt yrs)
The development of rhetorical thought as expressed by representative writers.

Spch 5-111. RHETORICAL CRITICISM. (3 cr; prereq 1-101...5-101 recommended; offered 1973-74 and alt yrs)
Problems and methods in the description, critical analysis and evaluation of the theory and practice of rhetoric.

Spch 5-121. STUDIES IN PUBLIC ADDRESS. (3 cr; prereq 1-101...5-101 recommended; offered 1972-73 and alt yrs)
Application of rhetorical theory for the critical analysis of speeches of representative historical figures.

Spch 5-161. SEMINAR: SPEECH. (3 cr [may be repeated for a maximum of 9 cr]; prereq jr and △)
Directed study and preparation of papers on subjects of current interest. Subjects to be announced prior to registration.

Spch 5-171. INDEPENDENT STUDY. (1 to 3 cr [may be repeated for a maximum of 6 cr; undergrads may not take more than 6 cr in both 3-171 and 5-171 combined]; prereq sr and △)
Directed readings and projects of interest to the student in the areas of speech/communication, communication media, theater arts or speech education.

SpTh 5-561. SEMINAR IN THEATER. (3 cr [may be repeated for a maximum of 9 cr]; prereq jr and △; offered 1973-74 and alt yrs)
Directed study and preparation of papers and/or projects on subjects of current interest. Subjects to be announced prior to registration.

SpTh 5-690. THEATER WORKSHOP. (4 cr, §5-691; prereq ♯; offered 1973-74 and alt yrs)
For in-service directors and advanced students preparing themselves to be drama teachers or to enter the theater professionally; participation in all phases of selected plays; ways to improve stage facilities typically available to the high school drama teacher.

SpE 5-861. SEMINAR: SPEECH EDUCATION. (3 cr [may be repeated for a maximum of 9 cr]; prereq jr and △)
Directed study and preparation of papers on subjects of current interest. Subject to be announced prior to registration.

SpE 5-881. SPEECH FOR THE CLASSROOM TEACHER. (3 cr; prereq Spch 1-111, jr; may not count toward B.S. major or minor in speech)
Theory and practice of effective lecturing and the stimulation of productive class discussion. Survey of student speaking activities suitable to the classroom.

SCIENCE AND MATHEMATICS

Math 5-326. LINEAR ALGEBRA. (3 cr, §5-325; prereq 3-320 and 3-670)
Linear transformations and vector spaces including topics from orthogonality, canonical forms, bilinear forms, characteristic values and inner product spaces.

Math 5-385. DIFFERENTIAL EQUATIONS II. (3 cr; prereq 3-699) J Nelson
Uniqueness, comparison, and separation theorems; two-endpoint problems and Green's functions; Lipschitz condition and existence and uniqueness theorems; nonlinear equations, plane autonomous systems, Poincaré phaseplane, stability and Liapunov functions; approximate solutions.

Math 5-521/5-522. COMPUTER PROGRAMMING II AND III. (3 cr per qtr; prereq 3-519) Gergen
Number representations, computer arithmetic, stored computer logic and organization, address modification, looping, branching, machine language and symbolic programming, programming languages. Students use the UMD computer facilities as part of their course work.

Math 5-590. MATHEMATICAL PROBABILITY, STATISTICS I. (3 cr; prereq 3-282 or 3-285 or 3-288) M Miller
Axiomatic development of probability; discrete and continuous univariate and multivariate random variables with their probability distribution; moments and moment generating functions.

Math 5-591. MATHEMATICAL PROBABILITY, STATISTICS II. (3 cr; prereq 5-590) M Miller
Sampling distributions, central limit theorem, principle of maximum likelihood interval estimation and tests of hypotheses.

Math 5-671/5-672. MODERN ALGEBRA II AND III. (3 cr per qtr; prereq 3-670)
Theory of groups, rings, and fields. Selected topics from permutation groups, Sylow theorems, finite Abelian groups, isomorphism theorems, polynomial rings, extension fields, Galois theory, finite fields, modules.

Math 5-701/5-702. ADVANCED CALCULUS I AND II. (3 cr per qtr; prereq 3-699)
Sequences and series; limit superior, limit inferior, and an introduction to summability. Metric spaces; continuous functions on metric spaces, connectedness, completeness, and compactness. Sets of measure zero and the Riemann integral. Sequences and series of functions. Functions of several variables, partial differentiation, implicit functions, and integrals depending on a parameter.

Math 5-730/5-731/5-732. APPLIED MATHEMATICS I-II-III. (3 cr per qtr; prereq 3-699 or ♯)
Laplace transformation, vector analysis, line and surface integrals, inner product and orthogonal sequences, Sturm-Liouville equation, Fourier series, partial differential equations.

Math 5-760. GENERAL TOPOLOGY. (3 cr; prereq 3-699 or ♯)
Introduction to fundamentals of general topology basic to modern analysis. Set theory, Euclidean spaces, metric spaces, topological spaces, continuity, connectedness, compactness, product spaces, axiom of choice, generalized convergence.

Math 5-820. COMPLEX VARIABLES. (3 cr; prereq 3-699; offered when feasible)
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, fundamental theorem of algebra.

Math 5-830. THEORY OF NUMBERS. (3 cr; prereq 3-282 or 3-285 or 3-288; offered when feasible)
Elementary properties of integers; prime and composite numbers, Euclid's algorithm; congruences; the theorems of Fermat and Wilson; primitive roots; indices, Diophantine equations.

Math 5-840. SET THEORY. (3 cr; prereq 3-670 or ♯; offered when feasible)
Logic, sets and set operations on a nonaxiomatic level, Cartesian products, relations, functions, ordinal and cardinal numbers, lattices and axiomatization of set theory including axiom of choice and several axiom systems.

Math 5-970. SPECIAL TOPICS. (1 to 3 cr [may be repeated for a max of 6 cr]; prereq ♯ and △; offered when feasible)
Directed reading and/or research in mathematics.

Sci 5-701. MATHEMATICS FOR HIGH SCHOOL TEACHERS I. (3 cr; prereq △; offered summer only)
Topics from algebra, trigonometry, analytic geometry, and calculus, including theory of equations, binomial theorem, mathematical induction, probability, derivative, anti-derivative, definite integral, fundamental theorem of integral calculus, applications.

Sci 5-702. MATHEMATICS FOR HIGH SCHOOL TEACHERS II. (3 cr; prereq △; offered summer only)
Introduction to modern mathematics. Sets, mappings, mathematical systems, theory of numbers, congruences, vector spaces, and matrices.

SOCIAL SCIENCES

Anth 5-615. CULTURE AND PERSONALITY. (3 cr; prereq 1-604 and Soc 3-170 or Soc 3-700, sr, or ♯; offered when feasible)
The role of culture in forming of personality; problems of individual adjustments to demands of culture. Psychological and socio-psychological approach to culture.

Anth 5-617. SOCIAL ANTHROPOLOGY. (3 cr, §3-617; prereq 1-604 or ♯)
Analysis of institutional patterns of kinship and marriage, economic, political, legal, and magico-religious organization with reference to functional and evolutionary processes, and to anthropological method and theory.

Anth 5-622. APPLIED ANTHROPOLOGY. (3 cr; prereq 1-604, sr or ♯)
Application of anthropology to current problems of government, industry, education, and social welfare planning. Role of anthropology in such administrative activities as technical aid, public health.

Anth 5-624. SPECIAL TOPICS IN ANTHROPOLOGY. (3 cr [may be repeated for cr]; prereq 1-604 or ‡; whenever offered, topic will be announced in *Class Schedule*)
Proseminar on contemporary topics in all branches of anthropology.

BA 5-364. MANAGEMENT ISSUES AND CONCEPTS. (3 cr; prereq sr, 3-304 and ‡)
Past and present contributions to the development of management thought and practice.

BA 5-508. COST ACCOUNTING II. (3 cr; prereq 3-507 or ‡)
Use of cost information in managerial decision making.

BA 5-541. READINGS IN ACCOUNTING LITERATURE. (3 cr; prereq sr, 24 cr in accounting or ‡; offered when feasible)
Discussion and reports on selected topics in practice and theory as found in current accounting literature.

BA 5-542. ADVANCED ACCOUNTING PROBLEMS. (3 cr; prereq sr, accounting major, 3-548 or ‡; offered when feasible)
Study of special problem areas in the field of accounting, with emphasis upon the implication of income, valuation, cost, and taxes on business organizations.

BA 5-717. MARKETING MANAGEMENT. (3 cr; prereq 3-701 or ‡; offered when feasible)
Marketing policy issues. Coordination of advertising, sales development, and other aspects of the total marketing program.

Econ 5-003. CONSUMER ECONOMICS. (4 cr, §5-001; cr not allowed for major or minor in economics for B.A. degree; prereq 1-005 or ‡)
Application of economic principles to major decisions of consumers. Concept of alternative choice. Opportunity cost. How to use income most effectively; use of credit; saving; insurance principles; analysis of advertising as it affects the consumer; sources of consumer information; product testing agencies; analysis of contracts common to consumers; government efforts to protect consumers.

Econ 5-020. CURRENT ECONOMIC ISSUES. (1 to 6 cr [may be repeated for a maximum of 6 cr]; prereq 1-004 and 1-005 or ‡)
Current controversies over economic policy and the problems that underlie them. Special study of selected topics.

Econ 5-032. MATERIALS, METHODS IN ECONOMIC EDUCATION. (4 cr, §SeEd 5-266; prereq ‡)
Analysis, evaluation, and sources of materials; planning and development of materials and methods for elementary and secondary classrooms.

Econ 5-052. ISSUES IN ECONOMIC THOUGHT. (4 cr, §5-021, §5-022, §5-023; prereq 3-011)
The development of selected economic theories.

Econ 5-222. QUANTITATIVE ECONOMICS II. (4 cr, §5-255 or §3-251; prereq 3-101)
The use of mathematical and statistical techniques in economic analysis.

Econ 5-352. ECONOMIC DEVELOPMENT. (4 cr; prereq 3-111 or ‡)
Economic analysis of the various factors leading to the economic development of nations. Consideration of the specific problems faced by underdeveloped nations and their approaches to problem solving. Study of alternate measurements of economic development.

Econ 5-453. INTERNATIONAL ECONOMICS AND FINANCE. (5 cr; prereq 3-111 and 3-112 or ‡)
Classical and modern theory of international trade. Extension, empirical verification, and applications of modern theory. Alternative theories of international trade. Concept and measurement of balance of payments. Methods of balance of payments adjustments. Alternative international monetary systems. Selected current issues.

Econ 5-622. INDUSTRIAL ORGANIZATION. (4 cr; prereq 3-652)
Examination of the theory of industrial organization, its verification from empirical studies, and policy implications.

Econ 5-752. MONETARY ECONOMICS. (4 cr, §5-721; prereq 3-112 and 3-704)
Problems in monetary theory; Federal Reserve control of financial institutions; money market strategy and principal problems in monetary policy including goals, targets and indicators.

Econ 5-821. PUBLIC FINANCE. (3 cr; prereq 3-111, 3-112, 3-803)
Government expenditures, budgeting, fiscal policy, debts, and taxes; special emphasis on economic effects including tax incidence, tax principles, practices, and policies.

Geog 5-116. ANGLO-AMERICA. (5 cr, §5-114, §5-115; prereq 1-303, 1-403 plus 3 cr in geography) Belthuis, Hoag
Topical study and regional presentation of physical and human geographic patterns of United States and Canada.

Geog 5-133. LATIN AMERICA. (5 cr, §3-131, §5-132; prereq 8 cr in geography) Adams
Survey of the cultural and physical diversities of Latin America. Emphasis on physical resources, historical development, population characteristics, and economic activities.

Geog 5-172. WESTERN AND CENTRAL EUROPE. (4 cr, §5-171; prereq 8 cr in geography or ‡) Chamberlin, Witzig
Physical and cultural geography of the countries of western and central Europe considered regionally and by a more detailed discussion of topics related to these countries.

Geog 5-174. MEDITERRANEAN. (3 cr; prereq 8 cr in geography or ‡; offered 1973-74 and alt yrs) Witzig
Physical and cultural geography of lands of Mediterranean Basin and Balkan Peninsula considered regionally and by individual countries.

Geog 5-182. SOVIET UNION. (4 cr, §5-181; prereq 6 cr in geography or ‡) Chamberlin
Character of and bases for the regional diversity of physical resources, population, agriculture, manufacturing, and transportation in the U.S.S.R.

Geog 5-201. GEOGRAPHY OF SOUTHEAST ASIA. (4 cr, §3-213; prereq 4 cr in geography or ‡) Levine
Topical approach to the cultural and physical geography of Malaysia, Singapore, Indonesia, Thailand, Burma, the Philippines, Laos, Vietnam and Cambodia, with emphasis on the problems of land use, transportation, resource development, and spatial and political fragmentation.

Geog 5-211. GEOGRAPHY OF EAST ASIA. (4 cr, §3-211; prereq 4 cr in geography or ‡) Levine
China, Japan, and Korea as a geographic problem; physical, cultural, and political bases of traditional East Asia with analysis of contemporary agriculture, population and its growth, resource, utilization and industrialization, transport, trade and urbanization. Special emphasis on Communist China.

Geog 5-222. AUSTRALIA AND NEW ZEALAND. (4 cr, §5-221; prereq 1-302, 1-402 plus 3 cr in geography) Belthuis
Geographical survey of physical and human resources of Australia and New Zealand.

Geog 5-306. COMPARATIVE CULTURAL GEOGRAPHY. (4 cr, §5-305; prereq 1-303, 1-403 plus 3 cr in geography) Belthuis
Human life in its physical setting using examples mainly from underdeveloped areas from the tropics and subtropics. Will include comparisons of people of different stages of development in similar climates.

Geog 5-573. GEOGRAPHY OF NORDEN. (4 cr, §5-173; prereq 4 cr in geography or ‡) Kaups
Cultural and physical geography of Norden, and introduction to Scandinavian, Finnish, and Icelandic settlements in North America.

Geog 5-701. SETTLEMENT GEOGRAPHY. (4 cr; prereq 8 cr in geography or ‡) Kaups
A cultural geographic approach to study of non-urban settlements; including location, function, and development of settlement types, and theories of settlement. Selected regions of the world.

Pol 5-170. POLITICAL INTEREST INDIVIDUALS AND GROUPS. (4 cr; prereq jr and 5 cr in political science or 12 cr in social sciences or ‡) Grau
The role of interest groups and individuals who lobby government in order to have an impact on public policy. Internal dynamics of groups; strategies of lobbying and its regulation.

Pol 5-320. THE AMERICAN CHIEF EXECUTIVE. (3 cr, §5-307; prereq 1-010 and ‡; offered 1972-73 and alt yrs) Lease
Constitutional powers and political roles of the President and governors; the chief executive and administration; executive relations with legislatures; party and popular leadership; presidential roles in crisis.

Pol 5-330. THE JUDICIAL PROCESS. (4 cr, §5-309; prereq 1-010 or ‡; offered 1973-74 and alt yrs) Lease
Structure of the American judiciary; selection of judges; the process of litigation; influences on judicial decisions; impact of and compliance with decisions.

Pol 5-340. METROPOLITAN GOVERNMENT AND POLITICS. (4 cr, §5-318; prereq 3-030) Olsen
Development of political and governmental problems in metropolitan areas; systems and structures for area-wide local government; emerging trends, potentials, and limitations for metropolitan government in United States and elsewhere; politics of metropolitan reform.

Pol 5-650. AMERICAN POLITICAL THOUGHT. (4 cr, §5-659; prereq 6 cr in political science or 12 cr in social sciences or ‡) Wolff
From colonial times to present; Puritanism, Constitution; Calhoun; social Darwinism; rise of Populist thought; development of legal theory; political thought and American literature.

Pol 5-652. POLITICAL THEORY AND UTOPIA. (4 cr, §5-663; prereq 9 cr in social sciences or ‡) von Glahn
Selected great utopias; planning in ideal states; the problem of authority; radical and conservative utopias and dystopias; utopian literature, chiefly American.

Pol 5-653. CLASSICAL POLITICAL THOUGHT. (4 cr, §5-664, §5-665; prereq 6 cr in political science or 12 cr in social sciences or ‡; offered when feasible) von Glahn
Classical Greek thought; Plato and Aristotle; primitive natural law; Cynics and Stoics; political theory in the Roman state; political thought in the medieval period.

Pol 5-655. EARLY MODERN POLITICAL THOUGHT. (4 cr, §5-665, §5-666; prereq 6 cr in political science or 12 cr in social sciences or ‡; offered when feasible) von Glahn
Renaissance political thought beginning with Machiavelli; idea of sovereignty; Protestant conceptions; English Civil War; Hobbes; Locke; the right to rebel; Montesquieu; Rousseau.

Pol 5-657. RECENT POLITICAL THOUGHT. (4 cr, §5-667; prereq 6 cr in political science or 12 cr in social sciences or ‡) von Glahn
Main currents from French Revolution to present; Marxism and its critics; non-Marxist socialism; syndicalism; anarchism; conservatism; fascism; utopian socialism.

Pol 5-740. AMERICAN POLITICAL PARTIES. (4 cr, §5-737; prereq 1-010) Wolff
Role and functions of the party in American government; party composition and organization; process of nomination and policy formulation; regulation of party organization and activities.

Soc 5-109. SOCIAL CULTURAL CHANGE. (3 cr; prereq ‡)
Factors underlying social change in contemporary societies. Recent researches on social movement reform and revolution, culture contact, impact of rapid technological change. The individual in social structure under conditions of rapid social change.

Soc 5-111. THE FAMILY. (3 cr; prereq ‡)
Evolution of the family: development of family unity or disunity, roles of the several members of the family, methods of investigation of the family.

Soc 5-113. ADVANCED SOCIAL PSYCHOLOGY. (3 cr; prereq ‡)
Analysis of interpersonal behavior within a social context; major theoretical perspectives and current issues including motivation, socialization, group functioning, and behavioral consistency and change.

Soc 5-115. RURAL COMMUNITY ANALYSIS. (3 cr; prereq ‡)
For prospective rural teachers, social workers, and extension workers; emphasis on methods of making field studies of communities.

Soc 5-117. RURAL SOCIAL INSTITUTIONS. (3 cr; prereq ‡)
The structure, function, and change of rural social institutions in a rural environment diffused with contemporary technology and bureaucracy.

Soc 5-119. SOCIOLOGY OF EDUCATION. (3 cr; prereq ‡)
Social structure of the school; the classroom as a social system; analysis of educational roles; impact of social classes on education; school and community power structure.

Soc 5-121. URBAN SOCIOLOGY. (3 cr; prereq ‡)
Cities; urban ecology; urban institutions; and urban way of life.

Soc 5-124. ADVANCED SOCIOLOGICAL THEORY. (3 cr; prereq 3-420 or ‡)
Examination in detail of the work of one social theorist; contemporary theoretical and practical implications of the selected theory.

Soc 5-125, 5-127, 5-129. SPECIAL TOPICS. (3 cr per qtr; prereq ‡; offered when feasible)
A proseminar on contemporary topics in sociology. Specific course content will be announced in *Class Schedule.*

DEPARTMENT ABBREVIATION CODE

Acct — Accounting
AdPy — Psychiatry
AEM — Aerospace Engineering and Mechanics
Afro — Afro-American Studies
AgEc — Agricultural Economics
AgEd — Agricultural Education
AgEn — Agricultural Engineering
AgJo — Information and Agricultural Journalism
Agro — Agronomy and Plant Genetics
Akka — Akkadian
AmIn — American Indian Studies
AmSt — American Studies
Anat — Anatomy
Anes — Anesthesiology
AnSc — Animal Science
Anth — Anthropology
Arab — Arabic
Aram — Aramaic
Arch — Architecture
ArEd — Art Education
Art — Art, Duluth
ArtH — Art History
ArtS — Studio Art
Ast — Astronomy and Astrophysics

BA — Business Administration
Ben — Bengali
BFin — Business Finance
BioC — Biochemistry (Biological)
Biol — Biology
BLaw — Business Law
Bot — Botany
BPhy — Biophysics
BsEd — Business Education

CDis — Communication Disorders
CE — Civil Engineering
Chem — Chemistry
ChEn — Chemical Engineering
Chin — Chinese
ChPy — Child Psychiatry
CICS — Computer, Information, and Control Sciences
CJS — Criminal Justice Studies
Clas — Classics
CLit — Comparative Literature
ClPh — Classical Philology
ClPy — Clinical Psychology
Comp — English Composition
CPsy — Child Psychology
CSPP — Counseling and Student Personnel Psychology

DE — Distributive Education
Dent — Dentistry
Derm — Dermatology
Dsgn — Design

Ecol — Ecology and Behavioral Biology
Econ — Economics
EdAd — Educational Administration
Educ — Education
EE — Electrical Engineering
ElEd — Elementary Education, Duluth
Elem — Elementary Education
Engl — English
Ent — Entomology
EPsy — Educational Psychology

FBio — Forest Biology
ForP — Forest Products
FPCH — Family Practice and Community Health
Fr — French, Duluth
FRD — Forest Resources Development
Fren — French
FS — Foreign Study
FScI — Food Science and Industries
FSoS — Family Social Science
FW — Fisheries and Wildlife

GCB — Genetics and Cell Biology
Geo — Geology and Geophysics
GeoE — Geo-Engineering
Geog — Geography
Geol — Geology, Duluth
Ger — German
Grk — Greek

HE — Home Economics
Heb — Hebrew
HEd — History and Philosophy of Education
HEEd — Home Economics Education
Hist — History
Hlth — School Health Education
HMed — History of Medicine
Hndi — Hindi
Hort — Horticultural Science
Hum — Humanities

IEOR — Industrial Engineering / Operations Research
Ind — Industrial Education
Indc — Indic
Ins — Risk Management and Insurance
IR — Industrial Relations
Ital — Italian

Jour — Journalism and Mass Communication
Jpn — Japanese

LA — Landscape Architecture
LAS — Latin-American Studies
Lat — Latin
Law — Law
Lch — Luchuan
Lib — Library Science
Ling — Linguistics
LMed — Laboratory Medicine

Mar — Marathi
Math — Mathematics
MatS — Metallurgy/Materials Science
MdBc — Biochemistry (Medical)
MdGk — Modern Greek

ME — Mechanical Engineering
Med — Medicine
MedC — Medicinal Chemistry
MedT — Medical Technology
Mgmt — Management
MicB — Microbiology
MidE — Middle East Studies
MinE — Mineral Engineering
MIS — Management Information Systems
Mktg — Marketing
MthE — Mathematics Education
Mu — Music, Duluth
MuEd — Music Education
Mus — Music

Neur — Neurology
NSci — Natural Science
NSu — Neurosurgery
Nurs — Nursing
Nutr — Nutrition

OAM — Operations Analysis and Management
OBio — Oral Biology
Obst — Obstetrics and Gynecology
OPat — Oral Pathology
Opth — Ophthalmology
OR — Operations Research
OrSu — Orthopedic Surgery
Otol — Otolaryngology

PA — Public Affairs
Path — Pathology
PE — Physical Education for Men and Women
Ped — Pediatrics
Pers — Persian
PhAd — Pharmacy Administration
Phar — Pharmacy
Phcg — Pharmacognosy
Phcl — Pharmacology
Phil — Philosophy
Phm — Pharmaceutics
Phsl — Physiology
Phys — Physics
PlPa — Plant Pathology
PlPh — Plant Physiology
Plsh — Polish
PMed — Physical Medicine and Rehabilitation
Pol — Political Science
Port — Portuguese
Prod — Production
Psy — Psychology
PsyA — Psychological Applications, Duluth
PsyF — Psychological Foundations
PubH — Public Health

QA — Quantitative Analysis

Rad — Radiology
RCD — Resource and Community Development
Rec — Recreation and Park Administration
Rhet — Rhetoric
Russ — Russian

Scan — Scandinavian
SchP — School Psychology Training Program
Sci — Science, Duluth
SeEd — Secondary Education
Serb — Serbo-Croatian
Skt — Sanskrit
Slav — Slavic
Soc — Sociology
Soil — Soil Science
SPA — Speech Pathology and Audiology, Duluth
Span — Spanish
Spch — Speech-Communication
SpE — Speech Education, Duluth
SpEd — Special Education
SpTh — Speech-Theater, Duluth
Stat — Statistics
Surg — Surgery
SW — Social Work

TexC — Textiles and Clothing
Th — Theatre Arts
Thai — Thai
Tib — Tibetan
Tran — Transportation and Business Logistics

Urdu — Urdu
Urol — Urology

VAna — Veterinary Anatomy
VM — Veterinary Medicine
VMic — Veterinary Microbiology and Public Health
VObs — Veterinary Obstetrics and Gynecology
VoEd — Vocational Education
VPaP — Veterinary Pathology and Parasitology
VPP — Veterinary Physiology and Pharmacology
VSR — Veterinary Surgery and Radiology

Zool — Zoology

INDEX

Symbols and Explanations

Sequence—A course sequence separated by slashes (5-121/5-122/5-123) must be taken *in the order listed* unless it is specifically stated that a student may enter any quarter.

Prerequisites—When no departmental prefix precedes the number of a course listed as a prerequisite, that prerequisite course is in the same department as the course being described.

A prerequisite reading "5 cr" means 5 credits earned in courses offered by the same department as that offering the course being described.

Symbols—The following symbols are used throughout the course descriptions of all bulletins to denote common and recurring items of information; no page footnotes are used for these symbols.

° Courses through which graduate students may prepare Plan B papers

† Means "to receive credit, all courses listed before dagger must be completed."

‡ Means "students may enter any quarter."

§ Means "no credit given if credit has been received for equivalent course listed after section mark."

¶ Means "concurrent registration in."

♯ Means "consent of instructor."

△ Means "consent of the division, department, or school offering course."

x Means "course is offered more than 1 quarter."

f,w,s,su Following a course number indicate fall, winter, spring, or summer quarters.

Numbering—Courses numbered from 5-000 to 5-998, which are taught by members of the graduate faculty, are open to both graduate and undergraduate students except in the School of Dentistry and a few departments of the Medical School. Those numbered 8-000 or above are for graduate students only. Courses numbered 0-000 to 0-998 are noncredit courses.

University of Minnesota 72 74 Bulletin

APRIL 24, 1972

aw school

UNIVERSITY OF MINNESOTA

Administrative Officers

Malcolm Moos, President

Donald K. Smith, Vice President for Administration

James F. Brinkerhoff, Vice President for Finance, Planning, and Operations

Paul H. Cashman, Vice President for Student Affairs

Lyle A. French, Vice President for the Health Sciences

William G. Shepherd, Vice President for Academic Administration

Stanley J. Wenberg, Vice President for Coordinate Campuses and Educational Relationships

Law School Administration

William B. Lockhart, M.A., LL.B., S.J.D., Dean and Professor of Law

Robert F. Grabb, B.A., LL.B., Associate Dean and Professor of Law

Patricia Lydon, B.A., J.D., Assistant Dean and Assistant Professor of Law

Volume LXXV Number 4 April 24, 1972

UNIVERSITY OF MINNESOTA BULLETIN

Published by the University of Minnesota, Office of Admissions and Records, 105 Morrill Hall, Minneapolis, Minnesota 55455, January through September inclusive. One issue in January, none in February, two issues in March, four issues in April, three issues in May, three issues in June, three issues in July, three issues in August, and one issue in September. Second class postage paid at Minneapolis, Minnesota. Send change of address notices and other communications to Office of Admissions and Records, Minneapolis, Minnesota 55455.

Law School

UNIVERSITY OF MINNESOTA

Law School

GENERAL INFORMATION

The Law School of the University of Minnesota was established in 1888. It is a charter member of the Association of American Law Schools and is on the approved list of the American Bar Association.

The University of Minnesota is located in a large metropolitan center affording easy access to federal, state, and local courts and governmental units. Students may conveniently observe judicial, legislative, and administrative hearings, consult with public officials and judicial personnel, and engage in research in public records of these government units.

The faculty consists of 33 resident, full-time professional law teachers who devote their time to teaching, research, and public service in their respective fields. The procedure courses are taught by men trained and experienced in actual litigation, who now devote full time to their Law School responsibilities. In addition, outstanding practicing lawyers are used for lectures in fields of their specialties and for parts of the Law School's tutorial program. Considerable emphasis is placed on the Law School's tutorial program with small numbers of students working closely with the faculty in seminars, in research, and in courses devoted to legal planning and drafting.

Law School Building

The Law School is housed in Fraser Hall, located between the East River Road (of the Mississippi River) and 15th Avenue S.E., on the Minneapolis Campus of the University. All Law School administrative and faculty offices, student lounges and offices, and library facilities are located in Fraser Hall, except for the Law Review offices which are in an immediately adjacent building. All Law School classes are held in Fraser Hall.

The present physical facilities, although minimally adequate for the current student body, are severely taxed. In fact, in recent years it has been necessary to restrict the size of the entering class because of the lack of space. The State Legislature has recognized the urgent needs of the Law School, however, and has appropriated planning funds for a new building which it is hoped will be completed by 1975. A student-faculty committee has been actively engaged in developing the outlines for what will be one of the most efficient and attractive centers of legal learning in the United States.

LIBRARY FACILITIES

The Law Library

The library of the Law School, containing more than 300,000 volumes and extensive areas for study and research, ranks sixth in size among law school

libraries in the United States and is an outstanding legal research center. It is administered by a director who is a graduate of an American law school as well as a European law school and of an American school of library science. He is assisted by a staff of 10 experienced law librarians.

Because of its exceptionally strong collection of American and British statutes, session laws, law reports, periodicals, treatises, publications of administrative agencies, appeal papers, digests, encyclopedias, and other legal materials, scholarly research in practically any field of Anglo-American law can be carried on in this library. The Rare Book Room contains over 3,000 volumes of early English and American statutes, reports, and treatises. The document collection contains large numbers of British Commonwealth publications and American federal and state government publications, as well as documents of the United Nations and other international organizations.

The Anglo-American collection includes an outstanding collection of legal materials of former British Commonwealth countries such as India and Pakistan. The library also has extensive sections in foreign (especially western European) and international law. A good working collection of literature in law-related social science fields is also available to library patrons.

Law students may use the law library 24 hours a day, 7 days a week, a privilege rarely extended to any entire student body elsewhere. While the primary function of the library is to serve the faculty and students of the Law School, its services are available also to the faculties and students of other departments of the University, to members of the bar, and to all persons who have a real need for legal materials. When needed, special office facilities are provided for visiting lawyers, judges, and scholars from other institutions.

Other Library and Research Facilities

Law students also make use of the general library system of the University which contains over 2,000,000 volumes. The Wilson Library building, which houses the principal collection, is located on the West Bank of the Minneapolis Campus. In addition, students may obtain permission to use the facilities of the Minnesota State Law Library in the Capitol Building in St. Paul, where a vast collection of American legal materials is also available.

PREPARATION FOR LAW STUDY

The Law School does not prescribe any special pre-law college program. Its principal concern is that before entering Law School students have a college education of considerable breadth and, at the same time, one in which the student has dug deeply into advanced courses in areas of special interest to him. Such an education is assured by the major sequence requirement and the cultural distribution plan of most liberal arts colleges. The major sequence insures penetration of one field in considerable depth, while the cultural distri-

bution plan insures a reasonable grounding in such diverse areas as science and mathematics, philosophy and humanities, literature and composition, and the social sciences. It is for this reason that the Law School requires for admission a B.A. degree or its equivalent.

The Law School does not recommend particular areas or departments for pre-law majors. While many law students major in economics, history, or political science, other departmental majors provide good backgrounds for law study and practice. These include such areas as philosophy, the humanities, English, sociology, psychology, mathematics, the physical sciences, anthropology, geography, journalism, speech, classics, and modern languages. The Law School welcomes and encourages a variety of educational backgrounds among its students. It is important that each student's education be as broad as is consistent with the completion of the major requirements. Therefore, a student should ordinarily endeavor to take his electives in areas not too closely related to his major. For example, a student majoring in mathematics or physics would do well to take his advanced electives in such areas as economics, political science, or history.

The Law School attaches special importance to work that will train a student to express himself in the English language forcefully, effectively, and accurately. A lawyer's whole professional career, whatever his specialty, requires hourly communication of ideas through words, oral and written. Success in Law School, as well as in later years of practice, depends in a considerable measure on development of the capacity for effective verbal expression. Therefore, the student should seize every opportunity to take courses that require independent thought and writing. A student should also develop, through courses or activities, his capacities for expressing himself orally.

Students in high school, who intend to qualify for later admission to the Law School, should study in a penetrating manner such courses as history, English, higher mathematics, natural science, and courses dealing with current social problems.

REQUIREMENTS FOR ADMISSION

Academic Program Requirements

Admission to the Law School requires the bachelor of arts degree or its equivalent. The degree of bachelor of science or bachelor of business administration with a well-balanced program will be accepted as the equivalent of the B.A. degree.

The Law School urges that students taking these degrees plan a program with as wide a cultural distribution as possible.

Law School Admission Test

Each applicant for admission is required to take the Law School Admission Test given by the Educational Testing Service of Princeton, New Jersey.

The test is a half-day test designed to measure certain mental capabilities important in the study of law. The test measures academic ability and command of written English. It yields two scores: the LSAT score and the writing ability score.

The test is given in July, October, December, February, and April at selected centers throughout the United States and in some foreign countries. One of these centers is at the University of Minnesota. Normally the test should be taken in October or December of the senior year in college.

Application forms and information bulletins about the test can be obtained from the University of Minnesota Law School, Minneapolis, Minnesota 55455; from the student's college office; or from the Educational Testing Service, Box 944, Princeton, New Jersey 08540.

The completed application form, together with the required fee, must be received in Princeton 3 weeks before the test date. Early inquiry should be made to obtain the exact dates for the tests.

Qualitative Requirements for Admission

Admission is limited to applicants who show reasonable prospects for success in law study and in the profession; however, not all who are qualified by this standard can be admitted. In the past few years the Law School has been able to admit only highly qualified applicants. In order to avoid detriment to the quality of professional training given by the Law School, only the number of qualified applicants within the capacity of the building facilities and academic staff will be admitted. Inability to accept all well-qualified Minnesota residents requires that nonresident admission be limited to outstanding applicants.

The Law School makes a careful study of each application for admission. All relevant factors are taken into consideration. Admissions decisions are not made merely by applying mechanical criteria; however, the experience of the admitting officers is that the applicant's undergraduate record and LSAT score are the best indicators of the likely level of success in law school. The undergraduate record is perhaps most important.

Procedure for Application

Applicants should obtain the application forms directly from the Law School. The LSAT must have been taken and a complete application submitted by March 1 for admission in September. Admission is only granted for the class entering in September. Applications should not be submitted prior to October of the preceding year. A fee of $15 is required from each applicant; this fee is not refundable.

The University of Minnesota Law School participates in the Law School Data Assembly Service (LSDAS) which provides a summary of an applicant's academic work, copies of his college transcripts, and his LSAT score. Each

applicant is required to submit necessary identifying information on the LSAT/ LSDAS registration form and to have his college send a transcript directly to the service. It is preferable if applicants register with the LSDAS and take the LSAT at least 6 weeks before the March 1 application deadline, although February LSAT scores will be considered.

Applicants are to follow the specific application procedures set forth in the Law School brochure entitled *Information to Applicants.*

Registration with Bar Association Officials

A number of states require a student to register with bar admission officials prior to commencement of law studies. A student should ascertain whether this is required in the state where he intends to practice. Such registration is not required in the state of Minnesota.

Advanced Standing

A candidate for graduation must spend the required time in residence, either at this Law School or at some other school which is a member of the Association of American Law Schools. A student coming from such other law school must have the preliminary education required for admission to this school and must spend at least 1 year in attendance at this school before he can qualify for a degree. Advanced standing admissions will be very strictly limited and may not be made at all in any given year. Due to the size of our regularly enrolled student body, we are able to accept only outstanding students who could have been admitted here as first-year students and who have superior law school records.

Additional Admissions Information

For additional information, see the current *Prelaw Handbook*, published annually in October and prepared by the Law School Admission Test Council and the Association of American Law Schools. This book includes material on the law and lawyers, prelaw preparation, applying to law schools, and the study of law, together with individualized information on most American law schools. It may be obtained at college bookstores or ordered from Educational Testing Service, Princeton, New Jersey 08540.

PROGRAM OF INSTRUCTION

Summary of Requirements

The University of Minnesota Law School program leading to the J.D. (Juris Doctor) degree requires 3 academic years of full-time Law School study carried on at prescribed levels of academic achievement.

Purpose and Method

The curriculum of the Law School has three objectives: (1) to provide a thorough and basic training in the law and legal techniques required for successful practice of law and for scholarly work in law; (2) to create an understanding of and appreciation for the role of the lawyer and legal tribunals in the administration of justice; and (3) to prepare the Law School graduates for the lawyer's responsibility to improve the administration of justice and to provide governmental and community leadership. Emphasis is placed on an understanding of the history, principles, and purposes of legal institutions, the operation of these institutions in the modern world, and the development of the skills of legal craftsmanship.

The Law School uses a variety of teaching methods. The basic form of instruction is the case and problem method, which centers around the critical study and discussion of decisions by courts and administrative agencies. The decisions selected for study reflect both the evolution of the law and the efforts to arrive at satisfactory solutions to difficult current problems. Instructors also make use of textual and legislative materials. Decisions, texts, and legislation are supplemented with hypothetical or real problems put to students for consideration and solution.

These decisions and other legal materials give the student a realistic understanding of the history and current state of the law. But the more important purpose for using actual decisions as the basic teaching tool is to pose factual problems out of real life for which the student must seek satisfactory solutions. The primary value of this method of study is the experience gained by the student himself in seeking the best solution for the problem posed, not simply the understanding he acquires concerning the decision actually reached by the court. For the end product sought by the Law School is a lawyer qualified to resolve new and difficult legal problems, thoroughly grounded in his knowledge and understanding of past legal tradition and present law.

Tutorial instruction is used extensively at Minnesota to develop the student's ability to solve problems. In the first year every student is given specific problems to resolve. He engages in independent research and study upon each problem and prepares a legal memorandum, opinion letter, or brief. His analysis and writing are then closely scrutinized by an outstanding lawyer with *Law Review* editorial experience. After a conference, he prepares a second, or even a third draft with the same procedure for scrutiny and discussion.

In 1968, the Law School instituted a continuing tutorial program for all first-year students. Under the direction of several faculty members, selected upperclassmen meet regularly with small groups of first-year students for discussion and assistance in regular course work. Practice tests are given and a one-to-one relationship is developed for the resolution of problems which individual students may meet. The voluntary program, which was designed to give as much help as possible in making the transition from undergraduate school to the vastly different method of instruction in law school, has been enthusiastically received and has more than proved its worth. Minnesota is one of the handful of law schools which offers such a program on a regular basis.

In the second year, the writing program consists of an appellate moot court, with tutorial assistance in the preparation of briefs. The cases are also argued orally.

Small group work continues in the senior year. The student participates in a seminar in which a small group of students examines intensively a special area of interest under a faculty expert in that area. Each senior must prepare a substantial piece of written work aimed at exploring and solving a legal problem, under the guidance of a faculty member. In both the second and third years, elective courses and seminars are offered in planning and in counseling —two of the skills any competent attorney must bring to his profession. Each senior is also given experience in the basic method of resolving controversies; he prepares and tries two cases in the practice court, one to a judge and one to a jury. Members of the judiciary preside at these trials, held in the courtrooms of the Law School.

Courses of Study

The normal course load is 16 hours per week in the first year and 12 to 18 hours per week in the second and third year. Additional work cannot be taken without the dean's approval. Attendance at all classes and all special lectures is required. All courses in the first year are required. A total of 144 credit hours is required for graduation. The schedule for each year is available in the dean's office in the late summer.

Beginning students are admitted only in the fall of the year and are expected to register and attend an orientation period immediately preceding the regular opening of classes.

Relevant course numbers may be found in the *Class Schedule* published each quarter.

FIRST YEAR

(All First-Year Courses Required)

CONSTITUTIONAL LAW (5-007). (6 cr) Auerbach, Lewis, Lockhart, Morrison
Judicial review; distribution of powers under federal system: national powers, state powers, intergovernmental relations; limitations on governmental power: consideration of claims made on behalf of economic and property interests, personal liberties, equality under the law.

CONTRACTS (5-001). (9 cr) Bryden, Kinyon, Sebert
Basic course in law of contract and promissory obligation and legal and equitable remedies for breach; formation of contracts; legal validity and construction; breach; conditions; third-party rights.

LEGAL PROCESS (5-002). (4 cr) Auerbach, Morris, Becker, Wolfram
Introduction to methods and processes of decision making by judicial, legislative, executive, and administrative agencies; illustrated by examining how these agencies have dealt with a problem of wide public concern, the allocation of the burden of industrial accidents.

LEGAL RESEARCH (5-003). (3 cr) Greene, Grabb, and instructors
Books and other tools of the legal profession; preparation of memorandums of law on the basis of facts supplied by practicing attorneys; tutorial instruction in legal analysis and legal writing.

PROCEDURE (5-006). (9 cr) Cooper, Cound, Wolfram
Jurisdiction, pleading, discovery, practice, pretrial motions, trial, judge-jury relationships, directed verdicts, and res judicata.

PROPERTY I (5-004). (9 cr) Cound, Freeman, Schoettle, Stein
Fees, life estates, concurrent tenancies, landlord and tenant, reversions, remainders, uses, executory interests, powers of appointment, class gifts, rule against perpetuities.

TORTS (5-005). (9 cr) Marshall, McCoid, Morris, Robinson
Civil liability for infliction of harm, including intentional infliction of physical harm and defenses, the negligence cause of action, and strict liability; function of tort law; infliction of harm from insult, indignity, and shock, including defamation; misrepresentation and other forms of infliction of economic harm.

SECOND AND THIRD YEAR

ACCOUNTING (5-085). (3 cr) Ar
Bookkeeping techniques; financial statement analysis; recognition of revenue; matching of costs and revenues; inventory and depreciation methods; costs of borrowed capital; accounting for various forms of business association; relationship to legal problems.

ADMIRALTY (5-612). (3 cr) Cound
Admiralty jurisdiction, maritime liens, seamen's and harborworkers' personal injury and death remedies, limitation of liability, marine insurance, ocean bills of lading and charters.

ADMINISTRATIVE LAW (5-606). (4 cr) Auerbach, Robinson, Sebert
Function of administrative agencies in our society; legislative, judicial, and executive control of administrative agencies; interrelations of legislative, judicial, executive, and administrative agencies in development of public policy. Most practitioners are likely to spend more of their time dealing with administrative agencies than litigating in court. The modern practice of law therefore requires a knowledge of the administrative process.

ANTITRUST (5-210). (6 cr) Cooper, Raskind
Basic antitrust concepts of the limitations placed on single firm behavior and market power by the concepts of monopolization and attempted monopolization; horizontal collaboration, as naked cartel and as incident of productive integration; vertical control of distributional systems; mergers. Misuse of legal "monopolies." Price discrimination law.

APPELLATE ADVOCACY (5-055). (3 cr; required writing course for 2nd-year law students except those on *Law Review*) Ar
Practice before appellate courts; preparation by each student of briefs and argument in two appellate moot court cases with tutorial instruction in legal analysis, legal writing, and oral argument.

BANKRUPTCY (5-107). (3 cr) Morris
The administration of debtors' estates when there are not enough assets to satisfy all debts. Primary emphasis on the administration of debtors' estates by the Federal Courts in straight bankruptcy proceedings; but also covers nonbankruptcy compositions, arrangements, assignments for the benefit of creditors, and compositions and arrangements under the Bankruptcy Act.

BUSINESS ASSOCIATIONS (5-051). (3 cr) Koeppen, Marshall, Morris
An introduction to the general law of multiperson unincorporated business organizations—including the partnership, the subpartnership, the limited partnership, the joint venture, the business trust, and the joint stock company; deals primarily with the procedures for forming such organizations and the rights and obligations of participants—as between or among themselves and vis-à-vis nonparticipants.

BUSINESS PLANNING I (5-104). (3 cr) Scallen
Of primary interest to students who plan to advise businessmen at any level—from small businesses to large corporations. The tax, corporate, and securities regulation aspects of problems of organization of corporations, stock dividends, and recapitalization will be considered.

BUSINESS PLANNING II (5-105).(3 cr) Scallen
Builds on Business Planning I. Probes in depth problems encountered in liquidations and reorganizations. A paper is required in lieu of a final examination.

COMMERCIAL PAPER (5-050). (4 cr) Greene, Kinyon, Sebert
Introduction to commercial payment and credit devices, instruments, and commercial bank practices; selected legal problems and principles under the Uniform Commercial Code.

COMPARATIVE LAW (5-607). (4 cr) Greene
The "Code System" approach to solutions of selected legal problems differing from the Anglo-American method, with emphasis on French and German law.

CONFLICTS (5-202). (4 cr) Cound, Wolfram
Jurisdiction of courts to adjudicate; binding effect of judgments rendered in other jurisdictions; choice of the applicable law in a dispute with multistate aspects. Deals with problems that are largely beyond the scope of other courses but implicit in them and that cast a different light upon them. Conflicts problems multiply as interjurisdictional movement and communication increase and traditional solutions have come under increasing stress and change.

CONSTITUTIONAL LAW
See first-year required courses

CONTRACTS
See first-year required courses

COPYRIGHT (5-613). (4 cr) Livermore
Copyright and misappropriation. The principal value of the course is to introduce the student to the concept of property dealing with the protection given to ideas, to mental creations, to things whose value inheres not in possession but in the power to exclude.

CORPORATIONS I (5-053). (3 cr) Koeppen, Marshall, Morris
An introduction to the general law of corporations. Includes formation of corporations; stockholder rights and obligations; powers and obligations of management; voting arrangements; and declaration of dividends. Does not include reorganizations or corporate finance—both of which subjects are reserved for Corporations II.

CORPORATIONS II (5-054). (3 cr) Marshall, Morris
Corporate reorganization and finance. Types of reorganizations which will be considered include: merger, consolidation, sale of assets, recapitalization by amendment, purchase and redemption of shares, and dissolution; also, methods of financing the corporate enterprise, including various capital stock structures, term loans, and bond and debenture offerings.

CREDITORS' REMEDIES (5-109). (3 cr) McClure
State law affecting creditors' remedies is something that virtually every practicing lawyer constantly runs into. Covers such matters as attachment, garnishment execution, supplementary proceedings, creditors' bills, judicial sales, fraudulent conveyance, and exemptions, all matters of almost daily concern to practicing lawyers.

CRIMINAL LAW (5-205). (4 cr) Becker, Cound, Levy, Livermore
Purposes and functions of criminal processes and of the several deprivations imposed by those processes. Requisites for the official designation of acts and persons as "crimes" and "criminals." Justifications for acts otherwise denominated "criminal," with particular emphasis on concepts of criminal responsibility. Nature and limits of the criminal sentencing process.

CRIMINAL PROCEDURE (5-218). (4 cr) Becker, Cound, Livermore, Morrison
Administration of the criminal law, with particular emphasis upon the factual determination of criminal status. The constitutionalization of criminal procedure, and judicial attempts at control of executive behavior. Alternative dispositions available to the prosecution and the criminal defendant, and their consequences. Selected problems in postconviction review.

ENVIRONMENTAL REGULATION (5-215). (3 cr) Bryden
Study of the legal aspects of major environmental problems, with basic introductory materials from other disciplines such as economics, engineering, and biological sciences. Topics will include air and water pollution, management of lakes, parks, open space and scenic easements, drainage of wetlands, governmental organization for environmental protection, multiple-use of federal lands, etc.

ESTATE LAW AND PLANNING I, II, AND III (5-152). (4/3/3 cr) Waterbury
Unit I will deal with the transmission of wealth at death by intestate succession and by will, including marital property rights. Units II and III provide a basic education in the law of trusts and future estates, and a basic education in the federal estate and gift tax law, with some attention to the income taxation of decedents' estates and trusts.

ESTATE PLANNING I (5-151). (5 cr; prereq Taxation I, Trusts and Estates) Stein
Develops student understanding of the process of "planning" a transaction, or, stated another way, choosing between alternative devices for accomplishing client objectives and maximizing client interests. Focusing on the important subject of disposition of property, the course involves a study of arrangements for the devolution of wealth, applying principles of the law of wills, trusts, future interests and federal income, estate, and gift taxation.

EVIDENCE (5-219). (5 cr) Livermore
An examination of the rules governing the admission and exclusion of evidence at trial.

FAMILY LAW (5-604). (4 cr) Becker, Levy
Analysis of the common law and statutory doctrines relating to the creation, functioning, and deterioration of family status; illegitimacy, marriage, juvenile protection, divorce, support.

FEDERAL ESTATE, GIFT, AND FIDUCIARY INCOME TAXATION (5-103). (3 cr) Waterbury
To provide an adequate basic education for the practicing lawyer in Federal Estate and Gift Taxation, and in the Income Taxation of Decedents' Estates and Trusts.

FEDERAL JURISDICTION (5-212). (4 cr) Wolfram
Study of the major problems involved in the cooperative judicial maintenance of a federal system. The respective obligations and freedoms of the federal government and each of the states with respect to in- and out-of-court behavior. Included are problems of inherent limitations on the power of federal courts to adjudicate, Supreme Court review of state court decisions, the subject-matter jurisdiction of the lower federal courts, the power of federal courts to adjudicate with respect to state officials or state interests.

INDEPENDENT RESEARCH (5-608). (3 cr) Staff
Preparation in depth of a major paper on a difficult legal problem.

INSURANCE (5-214). (3 cr) McCoid
The law governing the making of insurance contracts and their construction. Serves the function of focusing the student-lawyer's attention on the broad spectrum of insurance, the issues of coverage and enforcement common to all types of insurance, life, fire and marine, and casualty, and the problems of regulation of the marketing of insurance and the operation of the insurance industry. Prepares the lawyer for advice to his clients as to the nature of insurance protection available to meet their need in a variety of situations.

INTERNATIONAL LAW: PUBLIC (5-602). (4 cr) Morrison
Examines both the legal theories and the current norms of international law. Jurisprudential questions include the definition of law, the sources and impact of international law, and the nature of the international legal process. Substantive questions will include jurisdiction, recognition, sovereign immunity, human rights, state responsibility, law of treaties, the law of international organizations, and the control of the use of force.

INTERNATIONAL COMMERCIAL TRANSACTIONS (5-611). (4 cr) Scallen
An investigation of some basic problems encountered by the United States business which decides to compete in markets outside this country. Consideration will be given applicable United States law affecting decisions on how to constitute the overseas operation, including tax, investment, antitrust, and other considerations. National laws and treaties affecting the availability of foreign markets will be explored emphasizing the exposure of the overseas operation to foreign jurisdiction and the significance of such exposure on planning decisions. Various potential threats to the integrity of the foreign investment will be considered, including expropriation, nationalization. Currency regulations and controls, import licenses and quotas, etc., will show up. Available guarantee or other insurance-type programs against certain types of loss will be included.

LABOR LAW I (5-203). (4 cr) Lewis, Lockhart
Deals with the system of federal laws regulating labor-management relations. The statutory scheme of regulation is a complex one which presents a continuing need for interpretation by the National Labor Relations Board and the federal courts. Also offers an opportunity to study a specific administrative agency as it interprets and applies a detailed code of statutory regulations.

LABOR LAW II (5-204). (3 cr) Lewis, Lockhart
Builds on Labor Law I and is intended for students with a special interest in labor law. Substantial parts are devoted to grievance arbitration and the relationship between the individual and the union. The emerging problems of public employee labor relations will also be considered.

LAND USE PLANNING (5-201). (3 cr) Freeman, Schoettle
Concerned with the public control of land use and development, primarily in metropolitan areas. Problems considered are of increasing importance to lawyers whose practice involves them in the affairs of local governments or in real estate transactions.

LAW AND MEDICINE (5-605). (3 cr) McCoid
Problems of proof of medical facts in legal proceedings; the legal aspects of medical practice; guest lectures by medical personnel in specific areas of medicine of most significance in personal injury and workmen's compensation practice.

LAW REVIEW (5-609). (3 cr each yr)
Basis of selection only. Credit given without grade for satisfactory participation.

LEGAL AID I (5-056). (3 cr; for 2nd-yr law students) Oliphant
Civil problems of indigent citizens who are seeking legal assistance.

LEGAL AID II (5-058). (3 cr; limited to 3rd-yr law students) Oliphant
Program to involve students in the Criminal Justice System; certified to practice under the student practice rule, handle arraignments in Hennepin County Municipal Court, and prepare for at least three full trials.

LEGAL AID III (5-059). (3 cr; limited to 3rd-yr law students) Oliphant
Appellate brief writing clinical seminar in conjunction with the State Public Defender's Office.

LEGAL AID IV (5-060). (3 cr) Oliphant and staff
Civil problems of inmates in state and federal institutions.

LEGAL PROCESS
See first-year required courses

LEGAL RESEARCH
See first-year required courses

LEGISLATION (5-207). (3 cr) McClure
Designed to give a better understanding of the validity and authenticity of statutes Also concerned with matters of internal legislative procedure; of interest mainly to students anticipating a political career or advising business clients who will be concerned about the enactment of legislation affecting their businesses.

LOCAL GOVERNMENT LAW (5-208). (3 cr) Schoettle
Study of the distribution of decision-making power between the state and other units of government. Particular attention will be given to the proper role of the courts in reviewing the decisions of other units of government.

MODERN REAL ESTATE (5-213). (5 cr) Freeman, Graven, Hughes
Background in the major problem areas of current real estate law practice with primary emphasis on the legal handling of contemporary commercial real estate transactions; real estate financing devices such as mortgages and the contract for deed. Is prerequisite to the advanced real estate planning seminar.

POVERTY AND THE LAW: INCOME MAINTENANCE (5-209). (3 cr) Levy
Examination of the following programs: welfare, social security, workmen's compensation, public housing, model cities and community action, equal employment opportunity.

PRACTICE (5-601). (9 cr) Graven, Hughes
Includes evidence material such as direct and circumstantial proof of fact, the hearsay rule and its exceptions, privilege, and expert opinion evidence. Selected trial material is also provided including pretrial, pleading, discovery and motions, trial procedure, opening and closing arguments, jury instructions, jury selection, and postverdict motions. Each student will participate as trial attorney in one court trial and one jury trial. Jury trials include criminal and civil cases.

PROCEDURE
See first-year required courses

PROPERTY I
See first-year required courses

SALES (5-052). (3 cr) Kinyon, McClure, Sebert
The "goods performance" aspects of contracts for the sale of goods under Articles 2, 5, and 7 of the Uniform Commercial Code; the problems involved in the transfer of the goods from seller to buyer including risk of loss from accidental damage or destruction, right of inspection, delivery by carrier, letters of credit, and the remedies for various defaults including breach of warranty and products liability.

SECURED TRANSACTIONS (5-108). (3 cr) Koeppen, McClure, Morris
Some aspects of suretyship law in commercial transactions but primarily concerned with the legal problems of personal property security in retail installment buying and in financing commercial business. Deals mainly with Article 9 of the Uniform Commercial Code and its applications in today's vast areas of buying on credit.

SECURITIES REGULATION I (5-211). (3 cr; prereq Corporations I or consent of instructor) Koeppen
Legal restrictions on the distribution of securities. Primary emphasis is placed on the federal Securities Act, with some comparisons to state blue sky laws. Topics include preparation and processing of the registration statement, restrictions on

offer and sale of securities, exemptions from the restrictions, and civil remedies for violations. Course has value for any student planning a general business practice because it introduces basic securities law concepts such as the definition of a security, secondary offerings; however federal securities law is a specialty in practice, chiefly of large metropolitan law firms.

SECURITIES REGULATION II (5-110). (3 cr; prereq Securities Regulation I) Koeppen
First 6 weeks deal with regulation of trading in securities, primarily with regulation of stock exchanges and broker-dealers under the federal Securities Exchange Act and industry self-regulation. The materials will focus more on trade practices than is usual in a law school course. Remainder of course will be study of investment companies, primarily mutual funds, and their regulation by the Investment Company Act. Course is of limited value unless a metropolitan practice is contemplated.

SOCIAL WELFARE LEGISLATION (5-209). (4 cr) Levy
Governmental programs designed to assure to every member of society the means to obtain without unreasonable effort the material items necessary for a decent minimum standard of living; particular emphasis on the Social Security System; insurance and welfare benefits.

STANDARDS OF THE LEGAL PROFESSION (5-600). (3 cr; required course for 3rd-yr law students) Hughes, Schoettle
Examination of the nature and scope of the work of those trained in the law; their responsibilities to clients, the profession, the administration of justice; and society; includes the content and role of formal standards of professional ethics.

TAXATION I (5-100). (5 cr) Scallen, Raskind
An introduction to the federal income tax as it applies to individuals and business income; coverage includes gross income, exclusions, deductions, capital gains and procedure with some reference to current topics of tax policy and public finance.

TAXATION II (5-101). (3 cr; prereq Taxation I) Raskind
The federal income tax and its application to corporations and their shareholders, including such topics as corporate formation, sale, liquidation, redemptions, distributions, and problems of accumulated earnings, personal holdings, and collapsible corporations.

TRUSTS AND ESTATES (5-150). (5 cr) Stein, Waterbury
A study of the legal concepts concerning the transmission of wealth, including the law of wills, trusts, and future interests; emphasizes the use of the modern will and trust as estate planning devices and the problems of fiduciary administration of trusts and estates. Basic to Estate Law and Planning sequence and a prerequisite for other advanced offerings in this area.

UNFAIR COMPETITION (5-603). (3 cr) Cooper
Judicially developed doctrines to control competitive behavior of aggression, deception, and appropriation; interference with advantageous relations, duty to deal, trademarks, unfair advertising, disparagement, trade secrets, employee competition, and wrongs of imitation.

SEMINAR: AMERICAN INDIAN LAW (5-838). (3 cr; open also to grad students in the social sciences) Auerbach, Hoebel
Will deal with the culture of the American Indians, their primitive law, their current legal statuses and problems, and their future. It will explore the implications of the concept of "modernization" for the American Indians.

SEMINAR: BANKRUPTCY (5-813). (3 cr) Morris
Primarily for those third-year law students contemplating an active bankruptcy practice; for others, the regular course in Creditors' Remedies should be sufficient to meet those needs.

SEMINAR: CONSUMER PROTECTION (5-841). (3 cr) Sebert
Will consider a variety of current problems arising in the context of consumer transactions. Special attention will be paid to the regulation of consumer credit under the Federal Consumer Credit Protection Act and the proposed Uniform Consumer Credit Code (U3C)—e.g., interest rate ceilings, disclosure requirements, third-party freedom from defenses, and proposed limitations on creditor remedies. Also considered will be (a) regulation of deceptive sales practices, and (b) means

of enforcing rights in consumer transactions (e.g., class actions; the role of federal and state administrative agencies, including the proposed administrator for the U3C). Both classwork and a paper will be required.

SEMINAR: CRIMINAL JUSTICE—CORRECTIONS (5-804). (3 cr; open to a limited number of advanced students from related fields) Clendenen
Problems of criminal law administration with particular attention to the field of corrections; includes reports prepared by members on selected topics in the field. Presentations by invited specialists, and an inspection trip to a penal institution.

SEMINAR: DIVORCE COUNSELING (5-806). (4 cr; prereq Family Law) Levy
Students will participate with psychiatrists in interviewing and representing indigent clients seeking divorce and in examination of interviewing techniques and the role of a lawyer in divorce cases.

SEMINAR: ESTATE PLANNING (5-817). (3 cr) Stein
A practical application of the principles of trust, wills, property and tax law; planning and drafting experience; development of estate plans for hypothetical clients of various ages and business situations. Conducted by a partner in a large Minneapolis firm and Professor Stein. Meets in the evenings.

SEMINAR: FREEDOM OF EXPRESSION: SPECIAL PROBLEMS (5-852). (3 cr; prereq Constitutional Law) Freeman
Applicability of the First Amendment's protection of the rights of speech, press, assembly, association, petition in a particular factual setting. In 1971-72, the particular areas covered were rights of prisoners, students, servicemen, and government employees. Subject to discussion with the class, a different special area may be chosen. Paper required.

SEMINAR: GOVERNMENTAL REGULATION OF BANKING (5-830). (3 cr) Koeppen
Problem-solving approach in considering governmental regulation of this country's most vital industry. In lieu of writing a seminar paper, each member of the seminar will have individual responsibility for the research and writing of memoranda on several banking problems of current concern. Insofar as possible the problems studied will be actual problems of the type likely to be faced in practice. Areas from which problems will be drawn are: the power of banks to engage in businesses outside the traditional concept of banking; limitations on access and on competition by nonbanks; capital structure of banks; lending and trust powers; banking's role in federal monetary regulation; branching; mergers; and bank holding companies, including one-bank holding companies.

SEMINAR: INTERNATIONAL LAW, PUBLIC (5-800). (3 cr; prereq public international law course or consent of instructor) Morrison
Examines intensively a selected problem of public international law. The 1971-72 problem for discussion was international protection of human rights.

SEMINAR: JUDICIAL BEHAVIOR (5-837). (3 cr) Morrison
Involves an empirical study of the legal process. Students will examine judicial selection, the organization of the court system, sociological and psychological elements in individual and group decision making, the access and reaction of individuals to legal remedies, and the impact of the courts upon the social system. The seminar will rely heavily upon techniques of social science disciplines. Both classwork and a seminar paper will be involved.

SEMINAR: JURISPRUDENCE (5-843). (3 cr; open to law and philosophy students) Meehl, Sartorius
Focus is on the institutional role and responsibility of a court in deciding cases under a system of judicial adjudication within a democracy.

SEMINAR: THE JUVENILE COURT (5-844). (3 cr) Marshall, Cashman, Clendenen
An examination of legal norms applicable to operation of the juvenile court, with primary emphasis on the court's delinquency jurisdiction. Students will observe selected Minnesota juvenile courts in operation and prepare papers relating their study of applicable legal norms to their empirical observations of the court.

SEMINAR: LABOR LAW: PUBLIC EMPLOYEE RELATIONS (5-820). (3 cr) Lewis
An investigation of problems peculiar to labor relations in the public sphere as distinguished from the private sphere. Includes consideration of fact-finding and compulsory arbitration processes and limitations and the reasons offered therefore on use of the strike and picketing weapons.

SEMINAR: LAW AND AGRICULTURAL ECONOMICS (5-809). (3 cr; open to selected grad students in agricultural economics) McClure and Agricultural Economics staff

Selected topics in areas of concern to both agricultural economics and law.

SEMINAR: LEGAL AND POLITICAL CONCEPTIONS OF EQUALITY (5-812). (3 cr; open to law students and grad students in the social sciences) Auerbach, Krislov

Will examine (a) the evolution of the legal and political concepts of equal protection, state action under the Fourteenth Amendment, and the positive power of Congress to implement the equal protection guarantee; (b) the notion of equality and inequality in a democratic society, bases of justification, including philosophical and empirical findings; (c) the relative responsibility for narrowing inequalities of Society, Nation, and groups with representational (political *and* economic) roles; (d) some concrete problems in education, employment, voting and political representation, economic affairs.

SEMINAR: LEGISLATIVE DRAFTING (5-822). (3 cr) McClure

Selected drafting problems for the Minnesota Legislature and the Minneapolis City Council.

SEMINAR: LEGISLATIVE PRACTICE (5-855). (3 cr) Stein

A new seminar to be offered during academic years in which the Minnesota Legislature is in session. Students in the seminar will research and draft proposed statutes—principally in the housing and other property areas. Efforts will be made to introduce the bills into the legislature, and students will work with the bills through the entire legislative process to possible enactment into law. Designed to develop legislative drafting skills and an understanding of the law-making process.

SEMINAR: MINNESOTA AND FEDERAL CRIMINAL PROCEDURE (5-802). (3 cr; prereq Criminal Law and summer internship) Graven, Oliphant

In-depth study of the problems of state and federal criminal procedures. Student participation will parallel the assignment and handling of a moot court criminal case.

SEMINAR: NATURAL RESOURCES—CONSERVATION AND MANAGEMENT (5-807). (4 cr) Bryden

Intensive work on selected problems concerning environmental protection and resource allocation, such as lakeshore zoning, regulation of the environmental effects of electric power plants, and the operations of the Minnesota Pollution Control Agency.

SEMINAR: NEGOTIATIONS (5-805). (3 cr) Graven

Theory and practice of negotiation. Selected readings and a paper required.

SEMINAR: POLICY PROBLEMS IN THE LAW OF DIVORCE (5-803). (3 cr; limited to 15 students) Levy

Explores the empirical data concerning family stability and divorce in order to try to formulate rational legislative policies concerning the subject. Emphasis placed on social science methodology—statistical and clinical—as well as on the substantive results of what social science data exist.

SEMINAR: PSYCHOLOGICAL RESEARCH, THE LAW AND EDUCATION OF THE DISADVANTAGED (5-808). (3 cr; open to grad students in education and to a limited number of law students) Wood (Education), Schoettle

Will focus on the contribution of psychological research to legal problems arising in connection with the education of the disadvantaged. Particular attention will be given to desegregation, tracking, and ability grouping.

SEMINAR: PSYCHOLOGY, PSYCHIATRY, AND THE LAW (5-846). (3 cr) Livermore, Meehl, Malmquist

A lawyer, psychologist, and psychiatrist consider selected problems of the relation between the behavior sciences and law as a mode of social control. Topics include: rules and empirical facts, utilities and dis-utilities of the criminal sanction, the insanity defense, civil commitment of the mentally ill, law and morals, diagnosis and prediction, the psychologist or psychiatrist as expert witness, psychological determinism and responsibility.

SEMINAR: PUBLIC AFFAIRS (LEGAL PROBLEMS IN MINNESOTA PUBLIC AFFAIRS) (5-811). (3 cr) Graven

Focuses on selected problems of government in the state of Minnesota, such as taxation, metropolitan government, state government reorganization, water resources. Public officials with background in these problems will meet from time to time to provide resource material and a stimulus for discussion. Paper required, with topic to be selected, in consultation with instructor, on some current public affairs problem in Minnesota; paper should be done in consultation with and submitted to the governmental agency or official concerned with the problem.

SEMINAR: REGULATED INDUSTRIES (5-828). (3 cr) Robinson

Principles of economic regulation of public service enterprise—business "affected with a public interest." Focuses on federal regulation, principally the work of the ICC, CAB, and FCC, in regulating transportation and communications.

SEMINAR: REGULATION OF THE MEDICAL PROFESSION (5-829). (3 cr) McCoid

Discussion of a series of problems involving ways in which the medical profession and medical practice are subject to regulation, including but not necessarily limited to: licensing of the practice of medicine or healing arts; control of membership in medical societies; control of membership on hospital staffs or hospital staff privileges; malpractice litigation; regulation of narcotics and drugs; regulation of experimental procedures. Paper required of each student as the basis of seminar discussion.

SEMINAR: REPRESENTATION OF PRISONERS (5-853). (3 cr) Freeman

Specific problems confronting a lawyer who represents a prisoner. Designed to educate students participating in or anticipating participation in the Legal Aid program related to the ongoing prisoner-representation part of the program. Includes areas of computation of sentence, detainers, prison discipline and other aspects of prisoner behavior subject to prison regulations, prisoner access to the courts, procedural problems of habeas corpus with respect to prisoners seeking to challenge their convictions.

SEMINAR: STATE AND LOCAL TAXATION AND FINANCE (5-834). (3 cr) Schoettle

Consideration of legal problems presented by various statutory schemes for financing state and local governments. Acquaints the student with the rudiments of public finance including theories of taxation, the function of the public budget, and PPBS.

SEMINAR: SUPREME COURT (5-839). (3 cr) Lockhart, French, Hale, Snider

An analysis of Supreme Court of the United States as an institution and of its work, including jurisdiction and practice, the decision-making process, with a concentration on cases currently pending or recently decided.

SEMINAR: TAX POLICY (5-854). (3 cr) Raskind

Research on current problems of tax legislation; interpretation of existing statutes and enforcement of the tax laws.

SEMINAR: TEACHING AND LEARNING PROCESS IN LEGAL EDUCATION (5-848). (3 cr; limited to 20 students) McClure, Burris

Study and discussion of *Teaching and Learning: An Introduction to New Methods and Resources in Higher Education*, MacKenzie, Eraut and Jones. Expansion and innovation in higher education, impact of new media and resources, systematic approaches to teaching and learning.

SEMINAR: USES AND LIMITS OF LAW AS AN INSTRUMENT OF SOCIAL CHANGE (5-849). (3 cr; paper required) Auerbach

Theories of the interrelationship between law and social change; the changes in society and the legal system that have occurred during the past 40 years, with special emphasis on changes in particular areas of substantive law and their impact on the social order; a survey of some proposed social changes requiring legal action; proposed changes in (a) U.S. Constitution, (b) Congress, (c) state legislatures, (d) the judicial system, and (e) the legal profession; and the effective limits of law as an instrument of social change.

MISCELLANEOUS INFORMATION

HUMAN RIGHTS

The Board of Regents has committed itself and the University of Minnesota to the policy that there shall be no discrimination in the treatment of persons because of race, creed, color, sex, or national origin. This is a guiding policy in the admission of students in all colleges and in their academic pursuits. It is also to be a governing principle in University-owned and University-approved housing, in food services, student unions, extracurricular activities, and all other student and staff services. This policy must also be adhered to in the employment of students either by the University or by outsiders through the University and in the employment of faculty and civil service staff.

HOUSING

All Law Students

Numerous apartment houses (and rooming houses for single students) are available within walking distance of the Law School. Vacancies in houses, duplexes, apartments, and rooming houses are reported to the University Housing Office, 312-15th Avenue S.E., University of Minnesota, Minneapolis, Minnesota 55455. Normally, it is best to look for off-campus housing in person in the early summer. However, at the time of preparation of this bulletin, there is no shortage of housing near the University.

Married Students

Permanent apartments for married students with one to three children are maintained on the St. Paul Campus of the University. There is convenient bus service to the Minneapolis Campus. The apartments are unfurnished; one bedroom, $88 per month; two bedrooms, $100 per month; all utilities except telephone are included; stoves and refrigerators are provided. Since the waiting list is long, an interested student should get his name on the list as soon as he is admitted to the University. Contact either the University Housing Office, 312-15th Avenue S.E., Minneapolis, Minnesota 55455, or Commonwealth Terrace, 1295 Gibbs Avenue, St. Paul, Minnesota 55108.

Single Students

The best facilities available for single students are in sections of Centennial Hall used for male graduate and professional students or in Comstock Hall for female students. The cost for room and board for the 1971-72 academic year ranged from $1,128 to $1,242. The higher figure is for a "deluxe" single room. Contact the University Housing Office, 312-15th Avenue S.E., University of Minnesota, Minneapolis, Minnesota 55455; or Centennial Hall, University of

Minnesota, Minneapolis, Minnesota 55455; or Comstock Hall, University of Minnesota, Minneapolis, Minnesota 55455.

For male students who prefer to live with law students, the Gamma Eta Gamma law fraternity provides good housing for single students. Contact Gamma Eta Gamma Law Fraternity, 1126 5th Street S.E., Minneapolis, Minnesota 55414.

EXPENSES

Tuition and fees, 1971-72 academic year—residents	$ 711
Tuition and fees, 1971-72 academic year—nonresidents	$1,500

In order to be classified as a resident, the University of Minnesota ordinarily requires bona fide residence for a period of 1 year and evidence of intent to be a permanent resident of Minnesota. The University Office of Admissions and Records makes these determinations. An appeal from such a determination may be taken to a committee.

The Law School has made careful estimates of living and educational expenses for students attending the Law School. The estimated expenses for an unmarried law student who is a resident of Minnesota are $2,990 per year (assuming the student is not living at his parents' home). The estimated expenses for a nonresident are $3,775. Details may be obtained from the dean's office.

Financial Planning

Students are responsible for making adequate financial arrangements to carry them through each year of Law School. The importance of sound financial planning cannot be underestimated. Lack of it accounts for or contributes to as many dropouts as outright scholastic failure, especially during the first year. Some students supplement their income with outside employment, but this is generally discouraged, particularly for first-year students. Excessive outside employment is never permitted. It is well to consider, for planning purposes, that employment in jobs ordinarily open to students is likely to impair academic work and be an unreliable source of continuing income.

As indicated in the loan and scholarship sections of this bulletin, there are several sources of financial assistance for students. Of special interest to second- and third-year students is the loan program of a local bank which will normally provide for their needs up to $1,000 annually. Reliance should not be placed, however, on the availability of loans and scholarships until applications have been approved or definite arrangements made.

In the absence of a definite commitment or arrangement for future years, the fact that a scholarship or loan has been approved for 1 year does not assure that additional funds will thereafter be made available. Normally, such assistance is continued if needed, although in the case of scholarships the student is expected to maintain a specified grade point average in order to qualify for

the following year. The University and the Law School provide emergency loan services, which are liberally administered but may not be available under all circumstances. It is advisable, therefore, for students whose financial resources are marginal to arrange with an individual or bank in their home town for extension of credit in the event their financial plans are disrupted.

Part-time Employment

Employment opportunities in Minneapolis and St. Paul are substantial. However, the faculty is gravely concerned over the effect outside work has on the student's performance in Law School. It is strongly recommended that the student engage in *no* outside work. All students engaged in outside employment are required to submit a statement concerning the number of hours of work and to counsel with one of the deans. If individual circumstances require a substantial amount of employment, arrangements must be made through the dean's office to reduce the amount of Law School work accordingly.

Fraternity or residence hall counseling provides room and board plus a small amount of cash for the academic year. Nonresidents are also given the benefit of paying resident tuition rates. The time required for counseling duties is substantial. For more information, contact: Director of Residence Counseling Program, 201 Eddy Hall, University of Minnesota, Minneapolis, Minnesota 55455.

FINANCIAL AIDS

Scholarships

Almost all Law School scholarships require a showing of academic merit and of financial need. Scholarships are available to first-year students as well as to advanced students. The stipends may vary with the financial need, but usually cover the cost of tuition and books for both residents and nonresidents. A special program is also available to aid disadvantaged and minority group students.

Further details on the scholarship program may be found in the Law School brochure entitled *Financial Aid Information for First Year Students.* Entering students must apply by March 1. A scholarship applicant does not apply for a particular scholarship listed below. The University of Minnesota Law School participates in the Law School Financial Aid Service. It is not necessary to submit an application form separate from that provided by the service. Please write to the Law School Financial Aid Service, Educational Testing Service, Princeton, New Jersey 08540, for the LSFAS application form and, in filling it out, indicate the University of Minnesota Law School as a recipient.

Law Firm Scholarships—Annual scholarships are supported by each of the following law firms and individual lawyers:

Bellman, Samuel H.
Best, Flanagan, Lewis, Simonet & Bellows
Briggs & Morgan
Haverstock, Gray, Plant, Mooty & Anderson
Doherty, Rumble & Butler
Dorsey, Marquart, Windhorst, West & Halladay
Faegre & Benson
Friedell, Share & Solomon
Gislason, Reim, Alsop & Dosland
Hvass, Weisman, King & Allen
Johnson & Thompson
Kueppers, Strong & Kueppers
Larson, Sheldon S.
Leonard, Street & Deinard
Lindquist & Vennum
Maun, Hazel, Green, Hayes, Simon & Aretz
Meagher, Geer, Markham & Anderson
Moore, Costello & Hart
Nelson & Oyen
O'Connor, Green, Thomas, Walters & Kelly
O'Leary, Trenti, Berger & Carey
Oppenheimer, Hodgson, Brown, Wolff & Leach
Roberts, Arthur
Robins, Davis & Lyons
Slater, Lee H.
Stacker, Silverstein, Burke & Radsom
Stark, Clarence A.
Spellacy & Lano
Stringer, Donnelly & Sharood
Sullivan & Cromwell
Thomas, King, Swenson & Collatz
Van Valkenburg, Moss & Flaherty

In addition to the foregoing law firm scholarships, generous gifts from individuals, corporations, and other organizations have provided the following scholarship funds. Some are endowed, while others are supported by annual gifts, and some by both endowment and current gifts.

Walter D. Boutell Memorial Scholarship—A bequest of $15,000 by the late Walter D. Boutell to assist needy students who have shown exceptional industry and ability in their work.

Cargill Foundation Scholarship—An annual gift of $1,650 from the Cargill Foundation of Minneapolis to provide one first-year, one second-year, and one third-year scholarship to students of ability and need.

Wilbur H. Cherry Memorial Scholarship Fund—A fund of some $60,000 initiated by the Minnesota Law Alumni Association and built through the generosity of alumni and friends in memory of the late Professor Wilbur H. Cherry for scholarships to needy and promising students of the Law School.

Class of 1924 Scholarship Fund—A growing endowment fund established by the Class of 1924 in memory of its departed members to be expended for scholarships at the dean's discretion.

Melvin S. Cohen Law Scholarship Fund—An endowment gift of $10,000 from Melvin S. Cohen, National Presto Industries, Inc., to provide a scholarship for a student of need and promise of future good citizenship.

Roger L. and Agnes C. Dell Fund—A fund of $10,000 contributed for scholarships and loans to assist students; preference is to be given to students from the 7th Judicial District of Minnesota.

Homer B. Dibell Law Scholarship Fund—A gift of $10,000 to endow a scholarship in memory of the Honorable Homer B. Dibell, a Minneapolis Supreme Court Justice and member of the Law School faculty.

James E. Dorsey Scholarship Fund—A fund of about $9,000 created by friends, associates, and family of James E. Dorsey to be used for scholarships as determined by the faculty.

Dow Chemical Fund—$500 contribution for Patent Law Scholarship awarded to a Law School student selected by Dow Chemical Company.

Fairchild Foundation Scholarship Fund—A $25,000 contribution for scholarships, loans, and assistance to law students who are members of minority groups.

Henry J. Fletcher Memorial Aid Fund—See section on Loan Funds. The income from this fund may be used for scholarship assistance to deserving and needy students.

General Mills Law Scholarship—An annual gift of $700 for a promising law student with financial need.

Curtis Lloyd Jensen Scholarship—A fund of $10,000 bequeathed by Verna Blanche Jensen in memory of her brother, Curtis Lloyd Jensen, LL.B. '35, the income to be used for scholarships for Law School students of high character, all-around promise, and need.

Sidney J. Kaplan Legal Scholarship Endowment Fund—A growing endowment fund of over $10,000 created in memory of Sidney J. Kaplan of Minneapolis by associates, friends, and family to provide annual scholarships on the basis of aptitude for outstanding performance in legal studies, and not on the basis of need.

Law Faculty Scholarship Fund—A fund of $19,000 donated by members of the Law School faculty for scholarships in the Law School, augmented by current faculty gifts.

Law Student Wives' Association Scholarship Fund—An annual scholarship for two married law students.

3-M Company Law Scholarship Fund—An annual gift of $1,000 to provide funds for two $500 scholarships to be awarded by the faculty on the basis of scholastic ability and need.

William B. Lockhart Scholarship—A $25,000 endowment from Charles M. Dale, '17, given to perpetuate the name of Dean William B. Lockhart, the income from which is to be used for scholarships for deserving students who have successfully completed the first semester of Law School.

Malakoff Foundation Fund—A $250 contribution given in memory of J. J. Mallon for scholarships for minority students.

Thomas McCabe Memorial Scholarship Fund—A $350 contribution from the law firm of Van Evera, Mundt, Koskinen, Clure & Andrews to be used for scholarships.

Robert C. McClure and Bruno H. Greene Law Scholarship Fund—An endowment of $25,000 made possible through the generosity of Mrs. Polly Annenberg Levee and James A. Levee, 1969, to provide scholarship assistance to deserving students. The recipient is to be selected by Professors McClure and Greene of the Law School faculty for whom the fund was named.

Simon Meshbesher Memorial Scholarship Fund—An endowment of $10,000 contributed by friends of the late Simon Meshbesher, the income from which is to provide an annual scholarship for a worthy and needy law student.

Minneapolis Legal Secretaries Association Fund—A $400 gift for scholarships for third-year women students.

Minnesota Mutual Life Insurance Company Law Scholarship—An annual $600 scholarship for a promising student with financial need.

Minnesota State Bar Foundation Law Scholarships—This foundation, affiliated with the Minnesota State Bar Association, provides several substantial scholarships yearly for needy and outstanding law students who are residents of Minnesota.

Minnesota State Bar Foundation Scholarship Fund—A $1,300 contribution to be awarded as scholarship aid to minority students.

Edmund M. Morgan Scholarship Fund—An endowment of $25,000, the gift of Charles M. Dale of Portsmouth, New Hampshire, to honor Edmund M. Morgan. The income is to be used for scholarships for students of promise in financial need.

Weed Munro Scholarship—A bequest of $1,000 and a residuary fund, after the death of life beneficiaries, to establish a Weed Munro Scholarship in the Law School.

Ronald J. Nemer Scholarship Fund—A growing fund created by classmates and friends in memory of Ronald J. Nemer to provide scholarship aid for promising law students.

Northern States Power Company Law Scholarship—An annual $550 scholarship for a promising student with financial need.

F. H. Peavey & Company Law Scholarship—An annual scholarship for an outstanding student with financial need.

Harvey T. Reid Scholarship Fund—An award made possible through the generosity of Harvey T. Reid of Fort Lauderdale, Florida.

Harold J. Richardson Law Scholarship Fund—An endowment of $13,000 established by Mrs. Harold J. Richardson in memory of her husband, the income to be used for scholarships for deserving students.

A. W. Spellacy Memorial Scholarship Fund—A growing fund established by the law firm of Spellacy, Spellacy & Lano of Grand Rapids in memory of A. W. Spellacy.

Royal A. Stone Memorial Fund—An endowment fund, the gift of the late Olive Whiting Stone, of approximately 2 million dollars, the income to assist deserving students in the Law School to complete their education.

Melvin C. Steen Scholarship Fund—An endowment fund in excess of $10,000 contributed by Melvin C. Steen of New York City, the income to provide an annual scholarship of not less than $500.

Sullivan and Cromwell Scholarship Fund—An endowment fund in excess of $10,000 contributed by Norris Darrell of New York City, the income to provide an annual scholarship of not less than $500.

Walter J. Trogner Scholarship Fund—An endowment fund of over $300,000, the gift of the late Walter J. Trogner, a Law School graduate of the class of 1911 and Minneapolis attorney, providing scholarships up to $2,500 for exceptionally promising students.

William Reynolds Vance Scholarship Fund—A fund of over $25,000 donated by Charles M. Dale, '17, to perpetuate the name and honor the memory of the late Dean William Reynolds Vance and to be used for scholarships for students who have completed at least 1 semester in the Law School and have demonstrated ability, character, and need.

Charles B. Wartenbe Scholarship—A $500 scholarship from funds provided by Mrs. Virginia Dixon Wartenbe in memory of her husband, a graduate of the class of 1905.

Judge Betty W. Washburn Scholarship Fund—An endowment fund of $10,000 established by Mrs. Anton Hulman, Sr., in memory of Judge Betty W. Washburn of Minneapolis to provide annual scholarships for promising law students.

Elmer L. Williams Loan Fund—A $5,000 contribution from Elmer L. Williams, '16, for the purpose of assisting financially needy law students.

Loans

As a general rule, students should base their financial planning on Federally Guaranteed Bank Loans. Students who are unable to obtain these loans from their own banks should write the Law School for information on special arrangements which have been made to assist them in obtaining the loans locally. First-year students with demonstrable need will be considered for an additional loan of up to $750 from Law School-University trust funds, and emergency loans may also be available. Second- and third-year students may reasonably expect to borrow $2,500 annually through a combination of Guar-

anteed Bank Loans and First National Bank of Minneapolis-Law Alumni Loans, and second- and third-year students with demonstrable need will be considered for an additional loan of $500 from Law School-University trust funds.

As loan programs are subject to change, first-year students should write the Law School for current, detailed information as soon as they are accepted.

Guaranteed Bank Loans—These loans are made by private banks and guaranteed by the federal government. Law students may borrow as much as $1,500 per year. A student from a family with an adjusted income of less than $15,000 a year pays no interest while in school; thereafter he pays approximately 3 percent. A student from a family with an adjusted income higher than $15,000 a year pays 6 percent. Additional information on these loans and application forms may be obtained from the Law School or the University Office of Student Financial Aid. As these loans are made by a bank or other financial institutions, it is advisable for a prospective borrower to consult his own bank to determine whether it participates in the program.

First National Bank of Minneapolis Loans—The Law School has an arrangement with the First National Bank of Minneapolis to provide loans at low interest and liberal repayment terms for second- and third-year law students. Guarantee funds for the plan are provided by the Law Alumni Association and contributors to loan guarantee funds. Students have up to 4 years to make repayment after the bar examination.

Federal Cartridge Foundation Guarantee Loan Fund—Gifts to make financial aid in the form of loans available to law students; to be used to furnish security for loans or as direct loans to students.

Henry J. Fletcher Memorial Aid Fund—Approximately $40,000 given by Charles L. Horn, LL.B. '12, and others, to perpetuate the memory of the late Professor Henry J. Fletcher and to assist students attending Law School.

Bernard M. Heinzen Guarantee Loan Fund—A gift in memory of Bernard M. Heinzen of the class of 1928 to make financial aid in the form of loans available to law students; to be used to furnish security for loans or as direct loans to students.

Frank B. Kellogg Loan Fund—A bequest by the late Frank B. Kellogg; now valued at over $39,000.

Albert P. Krost Loan Fund—A fund of $10,000 to be loaned to worthy law students; established by the bequest of Clara B. Krost in memory of her husband, Albert P. Krost.

Law Alumni Loan Fund—Approximately $45,000 donated by alumni and friends of the Law School. Loans are without interest until graduation or termination of law studies.

Gustavus Loevinger Memorial Aid Fund—Gifts of $4,000 from friends and relatives of the late Judge Gustavus Loevinger.

Vernon W. Olson, Jr., Memorial Loan Fund—Over $1,000 in gifts by family and friends in memory of Vernon W. Olson, Jr., '52; to provide interest-free loans for deserving members of the *Minnesota Law Review*.

Robins, Davis & Lyons Guarantee Loan Fund—Gifts to make financial aid in the form of loans available to law students; to be used to furnish security for loans or as direct loans to students.

Wheeler, Fredrikson & Larson Loan Fund—A growing fund to provide loans interest free until graduation.

Wheeler, Fredrikson & Larson Guarantee Loan Fund—A gift to make financial aid in the form of loans available to law students; to be used to furnish security for loans or as direct loans to students.

STUDENT ACTIVITIES AND HONORS

Minnesota Law Review

The *Minnesota Law Review*, established in 1917, is a legal periodical of the Law School. It publishes leading articles by experts in their fields, as well as notes and comments on recent developments of the law prepared by an editorial board consisting of students who are elected on the basis of their high scholastic achievements. Successful service on the *Law Review* is the highest honor recognized by the Law School. It is an experience in research, legal analysis, and writing of unexcelled value in the development of professional and technical skills.

Students on Faculty Committees

Law students take an active part in the general governance of the Law School. Students serve on faculty committees which deal with matters of student concern. The student members are selected by the Law School Council and take an active part in such aspects of the school as curriculum development, clinical programs, admissions, scholarships, and teaching evaluation. The program provides a ready avenue for student opinion and opens the way for student evaluation of and assistance in the continuing development and improvement of the school.

Law School Council

The Law School Council consists of representatives from each class. The council, as representative of the student body, plays an important role in the administration of the Law School. It supervises the functioning of the honor system under which examinations in the school are written. It serves as an important medium for the exchange of views and suggestions between staff and students with respect to questions arising in the course of Law School operations, and supervises the operation of the Henry Rottschaefer Student-Faculty Lounge. It provides student representation on certain faculty committees. It arranges for special lectures and Law School convocations. It has charge of social functions involving the school as a whole, such as the activities of Law Day, student-faculty picnic, the annual Law School dance, and the student-faculty coffee hours.

The council, as representative of the student body, is a member of the Law Student Division of the American Bar Association.

Each student may apply for individual membership in the Law Student Division of the American Bar Association. An individual membership entitles the student to a subscription to the *Student Lawyer Journal*, and an opportunity to receive the A.B.A. *Journal* at reduced rates. The individual membership also entitles the student to a pamphlet publication service which provides information on a variety of topics related to the legal profession including placement information.

Legal Aid Clinical Programs

The University of Minnesota Law School operates one of the largest and finest clinical legal aid programs in the United States. Over 280 students per year participate in a wide range of projects which are closely supervised from the central clinic office located a few blocks from the main law building. The clinic is staffed by six full-time attorneys, nine student directors, and the Associate Clinical Professor of Law. Seminars are taught in conjunction with the student field work.

During his second year, a law student may work in Legal Aid I. He will receive 3 academic credits for his efforts (pass/fail). As a participant he will be engaged in handling the civil problems of indigent citizens who are seeking legal assistance. The student interviews a potential client, accepts the client if he is financially eligible, and prepares a memorandum on the law. The memo is approved by a member of the State Bar before any advice is given. A seminar is taught in conjunction with the field work by various members of the Law School faculty.

Second- and third-year students may also participate in the federal and state prison project. In this program, assistance is rendered to inmates at the various state prisons or at the Federal Correctional Institution at Sandstone, Minnesota. Related seminars are taught by the Law School faculty during the course of a student's work in this program.

Seniors may participate in Legal Aid II, a program designed to directly involve sudents in the Criminal Justice System. Seniors are certified to practice under the Student Practice Rule, handle arraignments in Hennepin County Municipal Court, and prepare for at least three full trials. A student's work is supervised by a member of the Law School faculty and a lawyer from the Hennepin County Public Defender for Misdemeanors Office. Three academic credits are given for the successful completion of this program.

Seniors may also take an appellate brief writing clinical seminar which is run in conjunction with the State Public Defender's Office. Students handle the preparation of live criminal appellate briefs for argument in the State Supreme Court. Three academic credits may be received for successfully completing this program.

Students in the Legal Aid programs are working with experienced attorneys from the Hennepin County Public Defender's staff and attorneys participating in a three-state prison consortium. Close supervision is provided over all work done by a student in the program by both the Law School faculty and members of the practicing Bar.

Order of the Coif

The Law School has a chapter of the Order of the Coif, a national honorary society of law students. Election to this society is made by the faculty at the close of the senior year from the 10 percent of the graduating class highest in scholarship.

Degrees with Honors

Honor students receive their degrees *cum laude, magna cum laude,* and *summa cum laude* in accordance with standards established by the faculty.

Other Honors

Each year recognition is given to students with A averages and to those with B averages by placing them on the Dean's List. Recognition is also given to the student in each class who makes the greatest improvement in his academic work over the preceding year.

Associate Membership, Minnesota State Bar Association

A student in his senior year may become an associate member of the Minnesota State Bar Association upon payment of $1 dues. This entitles him to all the privileges of full membership except the right to vote. He may attend meetings and receives copies of *Bench and Bar,* an association publication. Lectures by leading practitioners are sponsored by a committee of the association on topics of special interest to those about to enter the legal profession. Some committees of the association are open to student membership. Membership is voluntary but is favored by the Law School.

PLACEMENT

The Law School maintains a placement office for the benefit of its students and graduates. The assistant dean in charge of placement and the placement secretary render assistance to law students seeking part-time or summer employment. The primary work of the office is concerned with placement of first- and second-year students in summer internships and locating seniors and graduates in permanent positions. Law firms, corporations, and government agencies from all over the United States come to the Law School to interview students. The placement service strives to provide guidance to students, graduates, and employers on placement matters.

SPECIAL PROGRAMS

Summer Internship Programs

As a supplement to the efforts of the Placement Office to secure summer jobs for students during their law school careers, two special summer internship programs have been developed. First, for the past 2 years the Hennepin County Bar Foundation has sponsored a number of very successful internships for disadvantaged students. The students have worked in various local public agencies dealing with both civil and criminal law problems.

In addition, in 1972 the Minnesota Public Law Internship program was created to provide 15 summer jobs for outstanding first-year students. The students were placed in numerous public interest law projects in areas such

as consumer protection, pollution control, penal reform, court reorganization, and school desegregation and financing. It is hoped that funds will be available to continue and perhaps expand such programs, which provide students with valuable experience as well as significant financial assistance.

Graduate Study in Law

The Law School has no regular program for graduate study in law but occasionally, for an outstanding student, arranges a special program of academic work, research, and writing under the supervision of a member of the faculty leading to the degree of master of laws. Normally, however, students are advised to apply to one of the several law schools that offer regular graduate programs.

Combined Degrees and Graduate Courses Outside the Law School

The law faculty encourages law students to take a limited number of graduate level courses in other divisions of the University. These courses may also be used for graduate credit, if the student is properly registered in the Graduate School. Similarly, several graduate departments are willing to give graduate degree credit for Law School courses completed by the student while the Law School is also giving credit for these courses. The net effect of these arrangements is to reduce the total time for completion of both degrees by about 2 academic quarters.

The Law School's program is thus an effort to coordinate two separate programs, the professional course and the graduate course, rather than a "joint program" which attempts to fully integrate them. However, there is one specifically defined joint degree program leading to a juris doctor and a master of public administration which is described below.

A student who wishes to apply for admission in such a program should seek advice from the Law School and the Graduate School. A *Graduate School Bulletin* may be obtained by writing the Graduate School, 316 Johnston Hall, University of Minnesota, Minneapolis, Minnesota 55455.

Joint Law-Public Affairs Program

The Law School cooperates with the School of Public Affairs in providing the opportunity for students to receive both the doctor of laws and the master of public administration degrees in 4 years of full-time study. The School of Public Affairs was formed recently, but is the successor to the Public Administration Center which has been part of the University for a generation. Its creation grew out of a conviction that the study of public affairs, designed to prepare students for policy-making leadership and policy analyst positions in the public sector, ought to include the analysis, formulation, implementation, and evaluation of public policy, as well as its administration.

Normally, students in the joint program spend their second or third academic year in the School of Public Affairs. A core of courses (18 credit-hours) in public affairs is required of all degree candidates in that school. Students in the joint program also take an additional 18 credit-hours in a "policy concentration" in public affairs or another department. The public affairs program and policy concentration include material from mathematics, statistics, economics, and political science, as well as the less structured experiences of public life. It may also include internship experience. Prospective candidates for the joint program must be admitted to both schools. Further information can be obtained from Director of Graduate Studies, School of Public Affairs, Social Sciences Building, University of Minnesota, Minneapolis, Minnesota 55455.

Graduate Studies for Foreign-Trained Lawyers

The Law School and the Graduate School of the University of Minnesota have approved a program leading to the degree of master of arts in American legal institutions. The program calls for meeting the requirements of Plan B under the rules of the Graduate School with concentration in a field of law. Inquiries about this program should be addressed to the Graduate School, University of Minnesota, Minneapolis, Minnesota 55455.

The program of work leading to this degree is designed to familiarize the foreign student who has studied law in his own country with American legal institutions. Only foreign graduate law students, therefore, may be awarded this degree.

The program of work will be selected to suit the particular needs of each foreign student. Normally, at least 3 quarters of graduate study is required with concentration in the field of law. Courses accounting for 21-27 quarter credits must be taken in the Law School. The required 18 quarter-credits outside the field of concentration may be taken in other departments of the University. Within the limits indicated, the number of quarter credits to be taken in the Law School and the courses to be taken outside the Law School will be agreed upon by the student and the appropriate Law School committee. The courses to be taken outside the Law School will be selected to enable the foreign student to put his studies in the Law School in their proper social, economic, political, and cultural framework.

The Law School does not provide financial assistance to foreign students. Information about assistance given by the University may be obtained from the Office of the Adviser to Foreign Students.

Training Project in Delinquency Control

The Law School jointly sponsors with the Department of Sociology and the School of Social Work a program for the training of personnel working in the field of juvenile delinquency. A member of the Law School faculty gives a course, Law and the Legal System for Correctional and Social Workers (Soc 5-103). The seminar on criminal law is open to graduate students in the School

of Social Work and the Department of Sociology upon approval of the seminar instructors and of the dean of the Law School.

Those interested in pursuing the undergraduate program should consult the Department of Sociology.

CHAIRS IN LAW FOR DISTINGUISHED PROFESSORS

The Law Alumni Association of the Law School undertook, in late 1967, a fund-raising campaign to establish and maintain several chairs in law for distinguished law professors. The program has been an unqualified success, and each year since its inception several of the country's outstanding legal scholars have joined the faculty and brought new strength to the Law School. In 1971-72, the chairs were filled by Professor Robert E. Keeton of the Harvard University Law School, an expert in the field of insurance, and Professor David W. Louisell, outstanding in the field of procedure and evidence.

UNIVERSITY CALENDAR

The annual University calendar will be found in the *General Information Bulletin* which may be obtained from the Office of Admissions and Records, University of Minnesota, Minneapolis, Minnesota 55455. The Law School calendar is available as part of the registration material each fall.

LAW SCHOOL FACULTY

Carl A. Auerbach, B.A., LL.B., Professor of Law

Jerome M. Bach, B.S., M.D., Associate Professor of Psychiatry and Adjunct Professor of Law

Loftus Becker, B.A., LL.B., Assistant Professor of Law

Titus P. Bellville, B.S., M.D., Associate Professor of Psychiatry and Adjunct Professor of Law

David P. Bryden, B.A., LL.B., Professor of Law

Richard J. Clendenen, B.A., M.S.W., Professor of Criminal Law Administration

John J. Cound, B.A., LL.B., Professor of Law

Barry C. Feld, J.D., Ph.D., Associate Professor of Law and Sociology

Alan D. Freeman, B.A., LL.B., Associate Professor of Law

Melvin B. Goldberg, A.B., LL.M., J.D., Associate Professor of Law

David L. Graven, B.A., J.D., Professor of Law

Bruno H. Greene, B.S., J.U.D., LL.B., Professor of Law and Director of the Law Library

James L. Hetland, Jr., B.S.L., J.D., Professor of Law

Joyce A. Hughes, B.A., J.D., Associate Professor of Law

C. Paul Jones, LL.M., Adjunct Professor of Law

Wm. Douglas Kilbourn, B.A., LL.B., M.B.A., Professor of Law

Stanley V. Kinyon, B.A., J.D., Professor of Law

Bart Koeppen, B.A., LL.B., Professor of Law

Samuel Krislov, Ph.D., Professor of Political Science and Adjunct Professor of Law

Robert J. Levy, B.A., LL.B., Professor of Law

Thomas P. Lewis, B.A., LL.B., S.J.D., Professor of Law

Joseph M. Livermore, B.A., LL.B., Professor of Law

Carl P. Malmquist, M.D., Associate Professor of Child Development and Adjunct Professor of Law

Donald G. Marshall, B.A., LL.B., Professor of Law

Robert C. McClure, B.S.L., LL.B., Professor of Law

Allan H. McCoid, B.S., LL.B., Professor of Law

Paul E. Meehl, Ph.D., Regents' Professor of Psychology and Adjunct Professor of Law

C. Robert Morris, B.A., LL.B., Professor of Law

Fred L. Morrison, Ph.D., J.D., M.A. (Oxon.), Professor of Law

Robert Oliphant, B.A., J.D., Associate Professor

Leo J. Raskind, LL.B., Ph.D., Professor of Law

Glen O. Robinson, B.A., LL.B., Professor of Law

Stephen B. Scallen, B.A., J.D., Professor of Law

Ferdinand P. Schoettle, B.A., LL.B., Professor of Law
John A. Sebert, B.A., J.D., Associate Professor of Law
Robert A. Stein, B.S.L., J.D., Professor of Law
Thomas L. Waterbury, B.A., J.D., LL.M., Professor of Law
Charles W. Wolfram, B.A., LL.B., Professor of Law

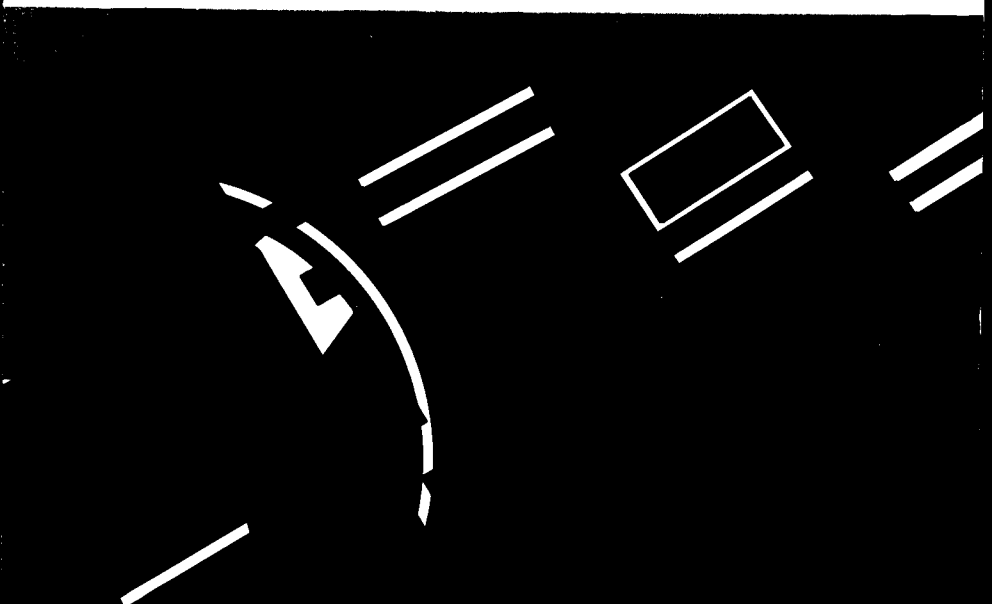
Part-time Faculty

Douglas K. Amdahl, B.B.A., LL.B., Instructor in Practice
David T. Bennett, B.A., J.D., Instructor in Appellate Advocacy
Philip F. Boelter, B.S.I.E., J.D., Instructor in Appellate Advocacy
Richard A. Bowman, B.A., LL.B., Instructor in Appellate Advocacy
Irving R. Brand, B.S.L., LL.B., Instructor in Practice
John M. Broeker, B.A., LL.B., Instructor in Appellate Advocacy
James W. Fahlgren, B.A., LL.B., Instructor in Appellate Advocacy
George W. Flynn, B.A., J.D., Instructor in Appellate Advocacy
John French, B.A., LL.B., Adjunct Professor of Law
Robert B. Gillespie, B.A., LL.B., Instructor in Practice
James Hale, B.A., LL.B., Adjunct Professor of Law
Robert A. Heiberg, B.A., LL.B., Instructor in Appellate Advocacy
Robert L. Helland, B.A., LL.B., Adjunct Professor of Law
James S. Holmes, B.A., J.D., Instructor in Appellate Advocacy
William A. Johnstone, B.A., J.D., Instructor in Legal Writing
Gary H. Levinson, B.A., J.D., Instructor in Appellate Advocacy
Thomas G. MacIntosh, B.S.C., J.D., Instructor in Appellate Advocacy
Milton D. Mason, B.A., LL.B., Instructor in Practice
William J. Miller, B.A., J.D., Instructor in Legal Writing
O. Russell Olson, B.A., LL.B., Instructor in Practice
Harris Ravine, B.A., J.D., Instructor in Legal Writing
Fredric T. Rosenblatt, B.A., J.D., Instructor in Appellate Advocacy
Noah S. Rosenbloom, B.A., LL.B., Instructor in Practice
Jerry W. Snider, B.A., J.D., Adjunct Professor of Law
Mark N. Stageberg, B.A., J.D., Instructor in Legal Writing
Jan D. Stuurmans, B.A., J.D., Instructor in Appellate Advocacy
Reynolds B. Thomas, B.A., J.D., Instructor in Appellate Advocacy
Michael Trucano, B.A., J.D., Instructor in Appellate Advocacy
Laurance R. Waldoch, B.A., J.D., Instructor in Appellate Advocacy
Robert M. Wattson, B.A., J.D., Instructor in Appellate Advocacy

University of Minnesota 72/74 Bulletin

AUGUST 29, 1972

library school



UNIVERSITY OF MINNESOTA

Volume LXXV | Number 18 | August 29, 1972

UNIVERSITY OF MINNESOTA BULLETIN

Published by the University of Minnesota, Office of Admissions and Records, 105 Morrill Hall, Minneapolis, Minnesota 55455, monthly January and September, semi-monthly March and June, tri-monthly May and July and four times in April and August. Second class postage paid at Minneapolis, Minnesota. Send change of address notices and other communications to Office of Admissions and Records, Minneapolis, Minnesota 55455.

Library School

UNIVERSITY OF MINNESOTA

The Library School has a three-fold purpose: to provide education of high quality for prospective and present members of the library profession; to conduct research and studies to advance knowledge in librarianship; and to promote the application of new ideas and knowledge to libraries and library problems. Established in 1928, the Library School is a department of the College of Liberal Arts of the University of Minnesota and is a graduate professional school. It is a member of the Association of American Library Schools and its program is accredited by the American Library Association.

The Library School provides programs of study in library science at the master's, specialist, and doctoral levels. In accordance with the standards of the American Library Association, the master's program is offered as the basic minimum preparation for a professional degree at the career-entrance level. The specialist and doctoral programs are designed to offer the opportunity for advanced study and specialization for the increasingly complex demands facing library and information sciences today.

Students may prepare for careers in various types of libraries: in college, university, and research libraries; in public libraries at the municipal, county, and regional levels; in school libraries and instructional materials centers; in special libraries and information agencies connected with business, government, industry, science, and technology, and in professional schools. In addition, there are several main types of library functions for which students may prepare depending on individual interest. These include reference work and readers' advisory service; technical services involving the selection and acquisition of materials and the organization of these materials, both print and nonprint, for use; administration and organization of libraries.

The profession needs men and women with a broad background of knowledge in the arts and sciences which will enable them to feel at home in the world of ideas. Librarians must be well balanced emotionally and intellectually, constantly acquiring new knowledge through reading and study to meet the multidisciplinary nature of librarianship. Interest in service to people, the ability to work well with others, initiative and flexibility to meet the changing demands of librarianship are all important personal qualities required of the professional librarian.

Prospective students who have questions not answered in this bulletin should write to: Director, Library School, 3 Walter Library, University of Minnesota, Minneapolis, Minnesota 55455.

Library School

GENERAL INFORMATION

Human Rights — The Board of Regents has committed itself and the University of Minnesota to the policy that there shall be no discrimination in the treatment of persons because of race, creed, color, sex, or national origin. This is a guiding policy in the admission of students in all colleges and in their academic pursuits. It is also to be a governing principle in University-owned and University-approved housing, in food services, student unions, extracurricular activities, and all other student and staff services. This policy must also be adhered to in the employment of students either by the University or by outsiders through the University and in the employment of faculty and civil service staff.

Evening Courses — Certain courses are offered in the late afternoon and evening. No more than 12 credits earned in evening classes in Continuing Education and Extension may be applied to an advanced degree program under the regulations of the Graduate School. Students intending to pursue graduate work in extension should be familiar with the instructions in the *Graduate School Bulletin* and the *Evening Classes Bulletin.* For more information concerning evening study, telephone or write the Library School office, 3 Walter Library, University of Minnesota, Minneapolis, Minnesota 55455 (telephone 373-3100).

Correspondence Courses — The Library School, in accordance with the standards of the American Library Association, offers no correspondence courses, nor does it accept for credit toward a degree courses taken by correspondence at other universities.

Summer Session — The Library School offers a selection of courses in two 5-week terms for which resident credit is given. Depending upon the courses offered, the Master's degree can be earned in 4 or more summers; however, it is strongly recommended that at least 1 quarter be spent in residence during the regular academic year. The degree must be completed in 7 years.

Summer students are strongly advised to apply for admission to the Graduate School by February 15 for entrance in the first term of the Summer Session.

Qualifying Examinations — Students who have completed basic and general introductory courses in reference, cataloging and classification, and selection of library materials in library science programs not accredited by the American Library Association may take qualifying examinations in these subjects. They will be excused from taking these courses at Minnesota if they demonstrate their mastery of these subjects by performance on a qualifying examination taken at least 1 week before the beginning of their first term in the Library School. Students who have been admitted to the Graduate School should make an appointment to discuss the examinations with the assistant to the director of the Library School. Graduate students may try a qualifying examination for any given course only once.

Proficiency in a Foreign Language — Students are urged to include study of one foreign language in their undergraduate programs in order to obtain good reading ability in it. Although the Library School does not require that students pass a foreign language proficiency examination for the Master's degree, a reading knowledge of a foreign language is considered essential for most librarians. Students are reminded that prospective employers look for ability in a foreign language for certain types of positions.

Placement Service — The Library School provides information for its graduate students about vacancies of which it has been notified by employers. The Library School cannot, however, guarantee positions. Graduates will have greater flexibility in pursuit of employment if they are free to relocate.

Foreign Students — Persons from other countries must meet the same admission requirements as United States citizens. In addition, applicants whose native language is not English must demonstrate an acceptable level of proficiency on the Test of English as a Foreign Language (TOEFL). Students from non-English-speaking countries normally are permitted to carry no more than 9 credits in their first 2 quarters of residence; they must expect to need 21 to 24 months of study for completion of the M.A. degree.

The Advisory System — Each graduate student is assigned to a faculty adviser. The advisory system of the Library School is designed to help the student understand the rules and regulations of the Graduate School and the Library School and to plan an individual program of study based on his personal interests and career orientation.

Facilities — Classrooms, faculty and administrative offices, and the library science collection of 8,000 volumes are located in Walter Library on the East Bank of the Minneapolis Campus. The Wilson Library on the West Bank, containing the humanities and social sciences collections, is the central headquarters for the University Library system which has holdings of more than 3,000,000 volumes. There are more than 20 additional subject libraries on the Minneapolis Campus and several special collections such as the James Ford Bell Collection of materials related to the history of exploration and trade before 1800, the Ames Library of South Asia, the Kerlan Collection of Children's Literature and Book Illustration, the Hess Collection of Dime Novels, Immigrant Archives, and the University Archives.

Library methods and practices may be observed, not only in the University libraries, but also in the public, school, and special libraries of the metropolitan area of Minneapolis-St. Paul. Students also have the opportunity to observe newer methods of organizing and disseminating information in the Library School information retrieval laboratory.

Fellowships — The Irene Fraser Jackson Memorial Fellowship and the H. W. Wilson Memorial Fellowship, each of $1,000, are available annually together with a limited number of awards of lesser value. Recipients of these fellowships are required to pay tuition. Inquiry should be addressed to the Library School before February 15 for information on other fellowships which may be available in 1973-1975.

All available awards are made on a competitive basis; applicants must meet the admission requirements of the Graduate School of the University of Minnesota, including a Bachelor's degree and a grade point average of B plus. Fellowships are open only to United States citizens.

Inquiries concerning all fellowships and requests for application forms should be addressed to the Library School, 3 Walter Library, University of Minnesota, Minneapolis, Minnesota 55455. It is advisable to submit fellowship applications by February 15 for the academic year beginning in the following September.

Prospective students are reminded that there are many outside sources from which qualified library school students may receive financial aid. The booklet *Financial Assistance for Library Education* describes many of these sources of aid and is available from the Office for Recruitment, American Library Association, 50 East Huron Street, Chicago, Illinois 60611, for 50 cents.

Assistantships — Through the cooperation of the University Library, students who have completed basic courses in library science are eligible to apply for a graduate library assistantship. Appointees work 20 hours per week in the University Library, at a salary of $3,348 for 12 months, and study half-time, carrying no more than 9 credits in a quarter. A student holding such an appointment benefits by gaining practical experience while he is studying for the library profession. The typical graduate library assistant should be able to earn his degree in 18 to 21 months. Applications for an assistantship may be made at any time during the year.

Student Employment — The University maintains a Student Employment Service, 30 Wulling Hall, which helps students find employment to meet a part of their expenses. Some vacancies for library science students in the metropolitan area of Minneapolis-St. Paul are also reported to the Library School office.

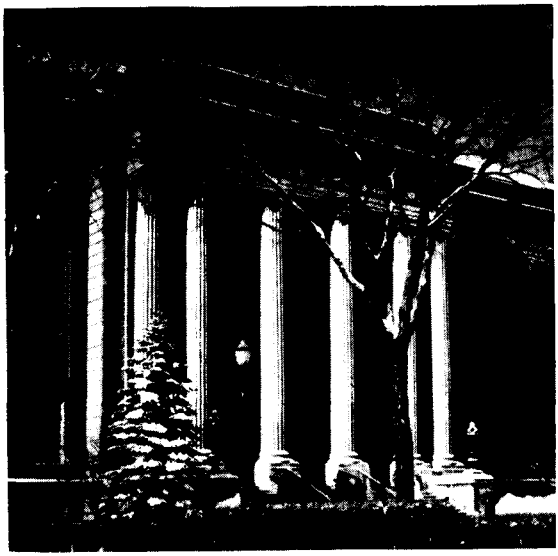
Tuition and Fees (1972-1973) — A credential examination fee of $15 is required of all applicants for admission to the Graduate School. During the academic year, full-time graduate students pay a tuition fee of $200 a quarter if they are residents of Minnesota, $505 a quarter if nonresidents; the student services fee is $42 per quarter. Foreign students are required to pay an additional health fee of $5 per quarter. All fees are subject to change without notice.

Students attending in the Summer Session, whether resident or nonresident, pay a credit hour fee of $12.50 per credit; the student services fee is $20.50 per term.

Housing Facilities — Most out-of-town students live in the University-maintained residence halls, in private rooming houses, or in apartments. Information concerning housing facilities may be obtained from: Director of University Housing, 312 - 15th Avenue S.E., University of Minnesota, Minneapolis, Minnesota 55455.

Food Services and Restaurants — Several restaurants and food services are available in Coffman Memorial Union close to Walter Library. Largest is the cafeteria, on the ground floor. There is also a soda fountain, a lunch counter, and a commuters' lunchroom for students who bring lunches from home. Shevlin Hall, also in the vicinity of Walter Library, has a cafeteria and lunchroom for students. On the West Bank where Wilson Library is located, cafeteria and vending service is provided in Anderson and Blegen Halls. There are also several privately operated restaurants near the campus.

Additional Information — The prospective student should consult the current University of Minnesota's *Graduate School Bulletin,* and the *General Information Bulletin* for further details regarding University services and facilities, rules and regulations, and general student activities.



Walter Library

PROGRAMS

Undergraduate Program

Although the Library School does not offer an undergraduate degree, it does provide three courses at the undergraduate level for juniors and seniors in the College of Liberal Arts and the College of Education. Lib 5-101, 5-221, and 5-401 are available as electives, particularly for those students who wish to determine vocational interest in the field. Lib 5-221 has a general educational value. No special admission procedure is required. However, an adviser in the Library School office, 3 Walter Library, is available to interview undergraduates and advise them on opportunities for a career in librarianship.

The Master of Arts Degree

The program for the M.A. degree offers the basic preparation for careers in all types of libraries — academic, public school, and special — by providing a foundation of general professional knowledge and an introduction to an area of special interest. Each student is assigned to a faculty adviser who will help him to plan an individual program of study designed according to the student's ability, background, and career goals. Considerable flexibility is permitted in the designing of most programs.

ADMISSION REQUIREMENTS

1. A Bachelor's degree from a recognized college or university. The major part of the undergraduate program should be devoted to academic rather than professional or vocational study. It is not necessary to have taken any previous course work in library science; the prerequisite for librarianship is a broad liberal arts education in the humanities, social sciences, and sciences with a strong concentration in at least one subject field or in an interdepartmental program. Occasionally students without the proper liberal arts background may be admitted with the requirement of taking additional liberal arts course work.
2. Evidence of high academic achievement. The undergraduate academic record is of primary importance as an indication of the applicant's ability to undertake graduate study. Undergraduates who plan to apply to the graduate Library School are advised to present on *A-D* as much work as possible in academic subject areas.
3. A satisfactory score on the Miller Analogies Test.
4. The approval of both the Graduate School and the Library School.

For seniors in their last year of undergraduate study, and for all college graduates planning a career as a librarian, the first step is to apply for admission to the Graduate School. Application materials may be obtained from the Graduate School, 322 Johnston Hall, University of Minnesota, Minneapolis, Minnesota 55455.

New students are admitted in June (first term of the Summer Session), and September (fall quarter). Since the Library School cannot accommodate all quali-

fied applicants within the limits of its resources and facilities, it is strongly recommended that application for either of these admission dates be made by February 15.

DEGREE REQUIREMENTS

Course Credits

The Graduate School offers the Master's degree under two plans: Plan A, including a thesis, and Plan B, which substitutes additional course work and at least one research paper for the thesis. The Library School strongly recommends Plan B for most students, but Plan A is permitted in the case of students with special backgrounds and interests.

1. *Plan A* — A typical program of study includes 57 quarter credits of graduate study, consisting of 30 credits in library science course work, 9 credits in a related field, and a thesis which counts for 18 credits.
2. *Plan B* — A typical program of study includes 54 quarter credits of graduate study, consisting of 42 credits in library science course work, 9 in a related field, and a research paper, of the quality but not the scope of a thesis, which counts for 3 credits. Students may wish to extend the research requirement to 6 or 9 credits and in this case the 42 credits in library science course work will be modified to 39 or 36 credits.

The three foundation courses, Lib 5-101, 5-221, and 5-401, are required of most students. A student who has completed similar courses in a library science program accredited by the American Library Association or who has passed qualifying examinations in these fields is required to take fewer library science courses and more courses in related fields than do students with no previous study in library science. In each individual program, the number of credits in related fields will depend upon the student's previous study.

Grades

Graduate students are required to earn a 3.00 average in all library science courses taken at the University of Minnesota. The Graduate School requires an overall grade point average in *all* courses of 2.80 or above (A = 4.00).

Transfer of Credits

With the approval of the adviser and the director of the Library School, a limited number of graduate credits from other universities may be applied to a student's program, provided that this does not modify the Graduate School's requirement of a minimum of 36 graduate credits taken in residence at the University of Minnesota. A student must have been fully admitted to the graduate school of the institution concerned for such graduate credits to be applicable. Students' programs may include graduate courses in library science taken in other library science programs accredited by the American Library Association and graduate courses in related fields taken at other universities if these credits have not been used toward another degree. No transfers of graduate credits from other institutions will modify the minimum requirement of 1 academic year in residence for the earning of a graduate degree.

Final Examination

A final oral examination is required which will examine the student's understanding of his studies both in library science and the related field.

Period of Study

A full-time student should be able to complete all the requirements for the Master's degree within a calendar year. Twelve hours of credit is the normal full-course load which may be taken in each academic quarter, and 6 hours the normal full-course load in each term of the Summer Session. Students may not register for more than 15 credits in a quarter or more than 9 credits in a summer term. The program, including course credits transferred from another institution, must be completed within 7 years after admission to the Graduate School.

Specialist Certificate in Library Science

The Library School offers a sixth-year program for post-Master's students with experience as professional librarians seeking advanced study as library specialists or teachers of library science. The total resources of the Graduate School are available to any student admitted for post-M.A. study, and a wide variety of specialist programs is possible.

ADMISSION REQUIREMENTS

1. High academic performance in undergraduate and graduate study to date, including previous course work in library science.
2. A satisfactory score on the Miller Analogies Test.
3. A fifth-year degree in library science and at least 2 years of successful experience in a library or as a teacher of library science.
4. The approval of both the Graduate School and the Library School.

CURRICULAR AND OTHER REQUIREMENTS

Programs will be planned according to the background and special interests of each student and will draw on the graduate offerings of the entire University as well as of the Library School. A student is not required to take most of his work in the Library School though he may do so if this is appropriate to his needs and if he avoids duplication of courses taken previously.

A minimum of 45 credits of graduate study beyond the fifth-year degree must be offered of which at least 30 credits will be taken in residence at the University of Minnesota. A research paper and final oral examination will be required; there is no foreign language requirement.

A student who is preparing to teach is encouraged to choose one library science course which he will audit in his first term, studying the literature of the course, and planning his own presentation of the subject. Whenever possible, the Library School will offer the student the opportunity to gain practical experience by teaching at least one class.

Further information about the Specialist Certificate in Library Science is available from the Library School, 3 Walter Library, University of Minnesota, Minneapolis, Minnesota 55455.

Doctor of Philosophy Degree

The doctor of philosophy degree is a research degree; its purposes are to provide an advanced education leading to specialization for service and leadership in the field of librarianship, and to promote independent research resulting in a substantial contribution to knowledge.

ADMISSION REQUIREMENTS

1. High academic performance in undergraduate and graduate study to date, including previous course work in library science.
2. A satisfactory score on the Miller Analogies Test.
3. A fifth-year degree earned in a library science program accredited by the American Library Association and at least 2 years of successful professional experience.
4. A statement of professional interests, outlining the applicant's career goals and general proposed program of study.
5. Satisfactory letters of recommendation from three persons such as professors and librarians qualified to attest to the applicant's competence to undertake and benefit from doctoral study.
6. An interview with the doctoral committee of the faculty of the Library School or its representative.

Applications for admission to the Ph.D. program are reviewed by the doctoral committee of the faculty of the Library School which attempts to assess the ability of the candidate to pursue successfully the doctoral program and to complete it within a reasonable period of time. The committee also considers the capacity of the school to accept candidates in the light of faculty commitments.

Application materials may be obtained from the Graduate School, 322 Johnston Hall, University of Minnesota, Minneapolis, Minnesota 55455. Supporting documents such as the statement of professional interests and letters of recommendation should be addressed to: Director of Graduate Studies, Library School, 3 Walter Library, University of Minnesota, Minneapolis, Minnesota 55455.

Students are encouraged to begin their studies in fall quarter. Applications for admission should be received in the Graduate School by March 1 for fall quarter admission to the doctoral program.

Further information about the doctoral program is available from the Library School, 3 Walter Library, University of Minnesota, Minneapolis, Minnesota 55455.

DEGREE REQUIREMENTS

The degree of doctor of philosophy with a major in library science will be awarded by the Graduate School of the University of Minnesota upon comple-

tion of the general Graduate School requirements for the degree, as stated in the *Graduate School Bulletin,* and the following specific requirements of the Library School.

Course Credits

In keeping with the philosophy of the Graduate School that a doctoral program should have breadth as well as depth, and that the entire resources of the graduate faculties of the University shall be available to all doctoral students as they plan their programs, the Library School has set no minimum or maximum credit hour requirements in library science or in related fields of study. The student is encouraged to consider the total courses and services offered by the Graduate School as he and his adviser design his individual program of course work, independent study, and research. Half or more of the course work may be in subjects other than library science. Courses in disciplines other than library science are selected to strengthen the candidate's competence by the addition of study in fields related to his major interest and area of specialization. This work is taken either as a minor or as a supporting field of study and constitutes not less than one-sixth of the program proposed for the degree as required by the Graduate School.

In order to demonstrate competency as a scholar, the student must take courses of study independently to acquire the skills of scholarship necessary to pursue research successfully. These skills may require study in foreign languages, mathematics, statistics, computer programming, historiography, or social science research techniques. The number and type of skills required of the individual student are specified after the topic and nature of the research project have been determined. One or more of the following may be necessary for a particular program and research investigation:

1. Demonstration of competency in two foreign languages.
2. Demonstration of a higher level of proficiency in a single foreign language.
3. Demonstration of competency in one language and one or more special research techniques or collateral fields of knowledge.
4. Demonstration of competency in one or more special research techniques or collateral fields of knowledge.

Program Planning

Since the doctoral degree emphasizes research, the planning of the student's program is closely related to the area of specialization in library science that will include the topic for the thesis investigation. Under the direction of his adviser, the student is required to choose an area of specialization for preliminary exploration in search of a thesis topic in his first quarter of registration.

When the area for research investigation has been determined, the student notifies the director of graduate studies so that a research committee can be appointed. The research committee determines the selection of research skills and competencies needed to handle the research project and advises the student on the total program of study and the courses to be submitted to the Graduate School for approval. At the end of 1 academic year of advanced study, the stu-

dent will be expected to demonstrate to his research committee that he has the ability to identify and analyze research problems and to carry on an investigation resulting in a doctoral thesis.

Written and Preliminary Oral Examinations

Normally the written examination is held after 3 or 4 quarters of full-time study beyond the Master's degree. The student is examined on his knowledge of the field of library science, the chosen area of specialization, and the related field(s) and his ability to integrate his knowledge and apply it to problems related to librarianship and other disciplines. The preliminary oral examination may be held at any time after the written examination.

Thesis and Final Oral Examination

In addition to the requirements described above, the doctoral candidate must prepare a thesis of scholarly character which represents a contribution to knowledge. The final oral examination shall be a defense of the doctoral thesis.

Doctoral Degree in Subject Area Other than Library Science

A librarian with a Master's degree in library science who prefers a doctoral program in another subject field may apply for admission in the appropriate department and with the approval of the Library School may offer a minor in library science. The purpose of such a program is to enable a librarian to prepare himself as a subject specialist.

Continuing Education

A graduate of the Library School or of another library school may request permission to take courses for the purpose of continuing professional study without applying the work toward an advanced degree. The student is urged to discuss his study plans with the assistant to the director who will advise him on the appropriate admission procedures.

Biomedical Librarian Program

The purpose of this program is to prepare librarians and information specialists capable of handling the expanding activities of health science libraries. The program is organized within the general framework of the M.A. degree with a major in library science. In addition to the basic courses in librarianship, students will take those courses of particular relevance to the special requirements of the biomedical library field. Students who complete Lib 8-132, Health Sciences Libraries, will be eligible for certification by the Medical Library Association after completion of the Master's degree.

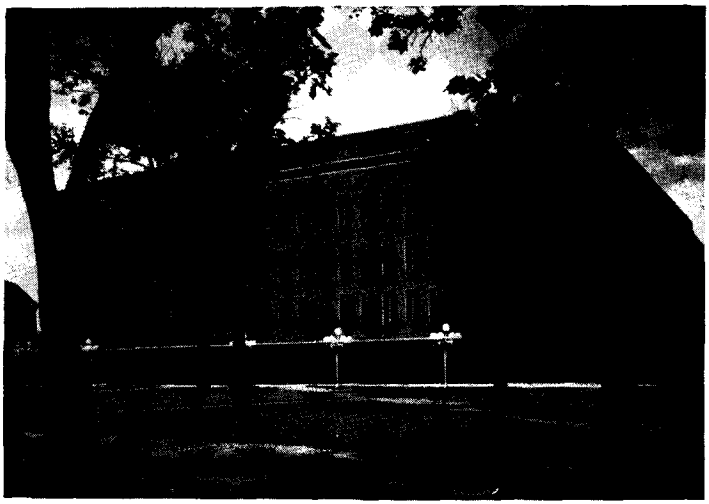
School Library Certification

The Library School offers two programs which enable students to meet state requirements for school library certification in Minnesota.

Persons who hold a teaching certificate should apply for admission to the Master's degree program; on completion of 25 credits of specified course work, the student may apply for minimum certification as a school librarian. The credits completed at the time of certification may be applied to the Master's grade.

A special program is also available for graduates of liberal arts colleges who lack teaching certificates and desire careers in school librarianship. The 60-credit program includes courses both in library science and education and leads to a Master's degree with a major in library science and to recommendation by the College of Education for certification as a school librarian.

Further information about both programs and application procedures may be obtained from the Library School office, 3 Walter Library, University of Minnesota, Minneapolis, Minnesota 55455. Information is also available from the Library School on the development of a program which will enable students to meet state requirements for media generalist certification in Minnesota.



Wilson Library

DESCRIPTION OF COURSES

Note — ‡ means "consent of instructor is required."

Courses in each area carrying numbers in the 5-000 series are open to juniors, seniors, and graduate students; credit toward the M.A. degree is granted if the student is officially admitted to the Graduate School. Courses numbered in the 8-000 series are open only to students who have been officially admitted to the Graduate School or to students who already hold a fifth-year degree in library science.

Courses marked ** are basic introductory courses required of all M.A. candidates unless they have demonstrated their mastery of these subjects by performance on qualifying examinations.

LIBRARY SCHOOL (Lib)

I. Foundation Courses

The following three foundation courses are prerequisite to all other courses in library science.

5-101. ** **INTRODUCTION TO LIBRARIES AND LIBRARIANSHIP.** (5 cr) McClaskey
Librarianship as a profession; development of libraries as social agencies; principles of library administration and management.

5-221. ** **RECORDS OF KNOWLEDGE.** (4 cr) Rohde
History and development of the records of knowledge in relation to the communication problems of society; principles of selection and dissemination to meet library clientele information needs.

5-401. ** **ORGANIZATION OF INFORMATION I.** (4 cr) Brekhus, Simonton
Introduction to methods and problems involved in the description, subject organization, and retrieval of records of knowledge and information in bibliographies, library catalogs, and machine-based systems.

II. Library in Society

5-102. MEDIA CENTER ADMINISTRATION. (3 cr; prereq 5-101, 5-221, 5-401) Olson
Organization and administration at the school building level of the library as the single agency that encompasses all forms of instructional materials; philosophy and objectives of service; administration and organization plans, procedures, and relationships.

8-001. HISTORY OF LIBRARIES AND LIBRARIANSHIP. (4 cr; prereq 5-101, 5-221, 5-401) Shove
Library development from ancient times to the present with emphasis on library service in the United States in the 19th and 20th centuries.

8-003. PUBLISHERS AND PUBLISHING. (4 cr; prereq 5-101, 5-221, 5-401) Shove
History of publishing in the United States with emphasis on the 19th and 20th centuries. Economics and organization, copyright, influence of machines, important publishers and booksellers, censorship, book production and distribution.

8-005. COMMUNICATION MEDIA, INTELLECTUAL FREEDOM, AND LIBRARIES. (4 cr; prereq 5-101, 5-221, 5-401) Berninghausen
Potentialities, limitations, and proper use of the various media of communication in relation to the responsibilities of librarians; intellectual freedom in the library.

8-103. PUBLIC LIBRARIES. (4 cr; prereq 5-101, 5-221, 5-401) McClaskey
Development of public library services with emphasis on the growth of cooperative library systems and interrelationships with all types of libraries; social change and problem solving as related to research, literature, organization, administration, and legal factors.

8-111. ACADEMIC LIBRARIES. (3 cr; prereq 5-101, 5-221, 5-401) McDiarmid, Stanford
The academic community; library services, organization, and staffing problems in college and university libraries.

8-131. SPECIAL LIBRARIES. (3 cr; prereq 5-101, 5-221, 5-401) Peck
Development and administration of libraries devoted to serving a special clientele, defined either in terms of a subject field or an organization.

8-132. HEALTH SCIENCES LIBRARIES. (5 cr; prereq 5-101, 5-221, 5-401) McClaskey
Organization and administration of libraries devoted to serving the health sciences community; current trends, including modern techniques of health sciences, communication, and the development of cooperative library systems; introduction to the literature of medicine and related fields.

III. Clientele, Materials, and Services

5-204. PRINT MATERIALS IN LIBRARIES. (3 cr; prereq 5-101, 5-221, 5-401) Olson
Selection, evaluation, and use of books, periodicals, and other printed sources of information and recreation for youth in school and public libraries; reading patterns of children and adolescents, and implications for selection of printed materials to meet the requirements, purposes, and abilities of different age groups.

5-205. MATERIALS RELATED TO THE CURRICULUM. (3 cr; prereq 5-101, 5-221, 5-401, 5-204) Olson
Survey of elementary and secondary school curricula with emphasis on a multimedia approach to teaching and optimum use of school libraries by teachers; consideration of teacher and librarian relations; exploration in depth of materials in at least one curriculum area.

5-301. READING, LISTENING, AND VIEWING GUIDANCE FOR YOUTH IN LIBRARIES. (3 cr; prereq 5-101, 5-221, 5-401) Olson
Philosophy and objectives of library service in schools and children's departments; guidance techniques; planning library programs. Review of relevant research related to reading, viewing, and listening, and survey of professional literature from various fields pertinent to understanding children and adolescents.

8-222. REFERENCE AND INFORMATION SERVICES. (4 cr; prereq 5-101, 5-221, 5-401) King
Information sources and services to meet clientele needs; user-librarian-information interface; research, evaluation, and planning for future services.

8-223. GENERAL BIBLIOGRAPHY. (4 cr; prereq 5-101, 5-221, 5-401) Shove
Major national and trade bibliographies of the world, with emphasis on those of the United States, Great Britain, France, Germany, and Russia; their use in selection and acquisition of print and nonprint materials, and in the preparation of bibliographies.

8-224. SUBJECT BIBLIOGRAPHY. (4 cr; prereq 5-101, 5-221, 5-401) Kromer, Stanford
An overview of the world of learning and the various disciplines as they have developed in the United States, and study of the bibliographic apparatus in relation to the structure of the disciplines.

8-227. LEGAL LITERATURE AND RESEARCH. (3 cr; prereq 5-101, 5-221, 5-401) Greene
Legal research methods and materials for law libraries.

8-230. SEMINAR: SUBJECT BIBLIOGRAPHY. (3 cr; prereq 8-223 or 8-224) Kromer, Stanford
Intensive study of the bibliographical apparatus of the social sciences, humanities, sciences with concentration in any one of these fields; investigation of designated problems relating to the bibliography of all three fields.

8-233. HISTORY OF CHILDREN'S LITERATURE. (4 cr; prereq 5-101, 5-221, 5-401) McClaskey
Introduction to the history and study of children's literature in relation to social history with special reference to current application for library services.

8-241. HISTORY OF BOOKS AND PRINTING. (4 cr; prereq 5-101, 5-221, 5-401) Shove
Bookmaking in its various forms from earliest times to the present. Development of the alphabet and the manuscript book; invention and spread of printing; design of the modern book with emphasis on aesthetic and technical aspects.

8-304. ADULT SERVICES. (5 cr; prereq 5-101, 5-221, 5-401) Amundson, Rohde
Nature of the adult clientele; selection of library materials and the development of library services to meet changing adult needs and interests.

IV. Organization of Information

8-402. ORGANIZATION OF INFORMATION II. (4 cr; prereq 5-101, 5-221, 5-401) Brekhus, Simonton
Advanced study of methods and problems involved in the description, subject organization, and retrieval of records of knowledge and information in bibliographies, library catalogs, and machine-based systems.

8-403. DESCRIPTIVE BIBLIOGRAPHY. (3 cr; prereq 5-101, 5-221, 5-401) Parker
Problems in bibliographical research, especially those encountered in acquisition, cataloging, and description of antiquarian books.

8-411. LIBRARY MECHANIZATION AND SYSTEMS ANALYSIS. (4 cr; prereq 5-101, 5-221, 5-401) Brekhus
Systems analysis as applied to library operations; data representation and coding systems; application of technological developments such as microforms and computers to library operations.

V. Librarianship and Library Research

8-501. SEMINAR: LIBRARY EDUCATION. (3 cr; prereq ‡) Berninghausen

8-701. RESEARCH METHODS IN LIBRARIANSHIP. (3 cr; prereq 5-101, 5-221, 5-401) McDiarmid, Stanford
Purposes and principles of research with emphasis upon the distinctive characteristics of library science problems; critical examination of research studies; preparation of tentative research proposals.

8-950. LIBRARY PROBLEMS. (Cr ar; prereq ‡) Stanford
Intensive study of selected problems in library science. Offered as needed for advanced Master's, specialist, and doctoral students.

8-970. INDEPENDENT STUDY IN LIBRARY SCIENCE. (Cr ar; prereq ‡) Staff

8-990. LIBRARY RESEARCH. (Cr ar; prereq ‡) Staff
Graduate students under Plan B are required to register for at least 3 credits in library research with the approval of the professor who will guide the research paper.

Index