History of Science and Technology (HSci)

Professor: Alan E. Shapiro, director; Arthur L. Norberg, director of graduate studies; Ronald N. Giere; Sally Gregory Kohlstedt; Edwin T. Layton; Robert W. Seidel; Roger H. Stuewer

Associate Professor: John Beatty; John M. Eyler

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

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

Curriculum—The program emphasizes conceptual developments within science and technology, as well as interactions between science, technology, and society.

Prerequisites for Admission—The prerequisite is a bachelor’s degree with a minimum grade average of B. Students should be capable of interdisciplinary study. Depending on background and career objectives, additional preparatory studies may be necessary in either the science-technology area or in the humanities and social sciences.

Special Application Requirements—Three letters of recommendation are required.

Master’s Degree Requirements—Programs vary with the student’s needs and background, but typically include at least six foundation courses from at least three of the following “areas”: history of physics, history of biology, history of technology, and social and institutional history of science and technology. An oral final examination is required.

Doctoral Degree Requirements—The Ph.D. program is intended for those planning professional careers in teaching, research, or other activities requiring a high degree of scholarly competence. Individual curricula vary, but a typical program includes at least six “area” courses (see Master’s Degree Requirements). Ph.D. candidates must also take at least three courses in ancient to early modern history of science or technology, and at least three courses in modern to contemporary history of science or technology.

Language Requirements—Candidates for the M.A. degree must demonstrate reading proficiency in one foreign language, normally French or German. Candidates for the Ph.D. degree must demonstrate reading proficiency in two foreign languages, normally French and German.

Minor Requirements for Students Majoring in Other Fields—Requirements are arranged on an individual basis. See also the description of the freestanding minor program in studies of science and technology.

For Further Information and Applications—Including the publication A Guide to Graduate Study in the History of Science and Technology, which supplies more detailed information about requirements, contact the Program in History of Science and Technology, University of Minnesota, 342e Tate Laboratory of Physics, 116 Church Street S.E., Minneapolis, MN 55455 (612/624-7069).

HSci 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

HSci 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

HSci 8888. Thesis Credits: Doctoral. (36 cr required)

HSci 5011. Theories of Color: Newton to Helmholtz. (4 cr; offered when feasible) Shapiro

HSci 5050. Special Topics in History of Science. (4 cr; prereq #) Contact faculty member or program office for information on specific topics.

HSci 5060. Special Topics in History of Technology. (4 cr; prereq #) Contact faculty member or program office for information on specific topics.

HSci 5111. Physical Sciences in Antiquity. (4 cr; offered when feasible) Shapiro

HSci 5113. Natural Philosophy in the Scientific Revolution. (4 cr) Shapiro

Emergence of modern science in 17th century. Development of scientific method (nature of scientific explanation, experiment, quantitative approach) and new conceptual basis for physical world (space, matter, force). Bacon, Galileo, Descartes, Boyle, and Newton, among others.

HSci 5201, 5202. History of Biology. (4 cr per qtr; §3201, §3202) Beatty

Scientific, philosophical, and social factors in development of biology; changing styles of biological reasoning and changing relationships between biological and physical sciences. 5201: Biology from antiquity through early modern period. 5202: Biology in 19th and 20th centuries.
HSCI 5242. The Darwinian Revolution. (4 cr; prereq Biol 1009 or 1101 or #) Beatty
Pre-Darwinian conceptions of nature; development and reception of Darwin’s theory of evolution by natural selection; broader context of Darwinian Revolution, including religious thought, political theory, and views about proper scientific methodology.

History of computing developments in the last century with equal attention to factors affecting evolution of hardware and software, growth of the industry and its relation to other business areas, and changing relationships resulting from new data gathering and use of machinery.

HSCI 5331. Technology and American Culture. (4 cr, §3331) Norberg
Historical survey of development of American technology in its cultural and intellectual context, from colonial period to present. Transfer of technology to America; establishment of infrastructure promoting economic growth; relationship among government, corporate, and academic influences; social response to technological developments.

HSCI 5332. Science and American Culture. (4 cr, §3332) Kohlstedt
Historical survey of development of American science. Transfer of science to America; development of indigenous traditions for pursuit of science; establishment of infrastructure for education and research; response of public to scientific development; relationship among government, corporate, and academic scientists.

HSCI 5401. Engineering Ethics in Historical Perspective. (4 cr, §3401) Historical survey of engineering ethics in America. Successful and unsuccessful strategies for dealing with ethical issues compared primarily by using recent case studies, such as the space shuttle Challenger.

HSCI 5511. History of Scientific Methodology. (4 cr; offered when feasible) Beatty

HSCI 5825. The Nuclear Age. (4 cr)
Origin, development, and social impact of nuclear physics from beginning of 20th century through post-World War II era. Experimental discoveries; theoretical models of nucleus; refugees from Nazism and Fascism; construction and use of atomic bomb; Oppenheimer and McCarthyism.

HSCI 5924. History of 19th-Century Physics. (4 cr, §Phys 5924; prereq general physics or #) Stuewer
Conceptual developments in physics (Young, Fresnel, Oersted, Ampère, Faraday, MacCullagh, Maxwell, Hertz, Lorentz, Lavoisier, Rumford, Dalton, Mayer, Joule, Helmholtz, Carnot, Clausius, Kelvin, Boltzmann, Mach, others). Relationships of these developments to social, philosophical, and theological influences.

HSCI 5925. History of 20th-Century Physics. (4 cr, §Phys 5925; prereq general physics or #) Stuewer
Conceptual developments in relativity (Michelson, Lorentz, Poincaré, Einstein, others), quantum mechanics (Planck, Einstein, Rutherford, Bohr, Sommerfeld, Ehrenfest, Pauli, Millikan, Compton, Heisenberg, de Broglie, Schrödinger, Born, others), and nuclear physics (Chadwick, Gamow, Fermi, others). Relationships of these developments to social, philosophical, and theological influences.

HSCI 5935. History of Nuclear Physics. (4 cr; prereq general physics or #; offered when feasible) Stuewer

HSCI 5970. Directed Studies. (1-15 cr; prereq #)

HSCI 5990. Directed Research. (1-15 cr; prereq #)

HSCI 8111. Historiography of Science and Technology. (4 cr; prereq HSCI grad student or #) Analysis of scholarship in history of science and technology. Major approaches and controversies.

HSCI 8121. Foundations for Research in Ancient Science. (4 cr; prereq HSCI grad major or minor or #)
Development of natural and mathematical science in ancient Near East and Classical Greece.

HSCI 8122. Foundations for Research in the Scientific Revolution. (4 cr; prereq HSCI grad major or minor or #)
Copernican revolution; mechanical philosophy; development of experimental science; Newtonian synthesis.

HSCI 8420. Social and Cultural Studies of Science. (4 cr, §CSDS 8910, §SST 8420)
Seminar focuses on theoretical and methodological differences among practitioners of social and cultural studies of science; selected responses from historians and philosophers of science.

HSCI 8900. Seminar: History of Early Physical Sciences. (4 cr; prereq #) Shapiro

HSCI 8910. Seminar: History of Modern Physical Sciences. (4 cr; prereq #) Stuewer

HSCI 8920. Seminar: History of Biological Sciences. (4 cr; prereq #) Beatty

HSCI 8930. Seminar: History of Technology. (4 cr; prereq #) Layton, Norberg

HSCI 8940. Seminar: History of Science and Technology in America. (4 cr; prereq #) Kohlstedt, Norberg, Seidel

HSCI 8941. Women in Science: Historical Perspectives. (4 cr) Kohlstedt
Analysis of women’s roles in development of science and technology; emphasis on their initiative, their participation in scientific institutions, and attitudes toward women as scientists within scientific inquiry.

HSCI 8950. Seminar: Science and Technology in Cultural Settings. (4 cr; prereq HSCI grad student or #)
HSci 8970. Directed Studies. (1-5 cr per qtr [max 15 cr]; prereq #)
HSci 8990. Directed Research. (1-5 cr per qtr [max 15 cr]; prereq #)

Horticulture (Hort)

Professor: Gary M. Gardner, head; James J. Luby, director of graduate studies; Peter D. Ascher; Mark L. Brenner; John V. Carter; David W. Davis (emeritus); Wesley P. Hackett; Florian I. Lauer (emeritus); Pen (Paul) H. Li; Albert H. Markhart III; Joan Nassauer; Harold M. Pellett; David G. Pitt; Carl J. Rosen; Joseph R. Sowokinos; Bert T. Swanson (emeritus); Donald B. White; David K. Wildung
Associate Professor: Deborah L. Brown; John E. Erwin; Vincent A. Fritz; Anne M. Hanchek; Emily E. Hoover; Peter J. Olin; Alan G. Smith; Mark S. Strefeler
Assistant Professor: Susan M. Galatowitsch; Mary H. Meyer; Cindy B. Tong

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

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

Curriculum—Students normally emphasize either a subdiscipline of horticulture (floriculture, fruits, nursery management, potatoes, turf, or vegetables); a biological discipline related to horticulture (genetics, plant breeding, plant physiology, landscape ecology, or restoration ecology); or landscape horticulture. The Department of Horticultural Science administers this program, which is closely aligned with the interdepartmental programs of plant breeding and plant biological sciences (see the appropriate headings in this bulletin). All three majors are offered in the Department of Horticultural Science.

Prerequisites for Admission—Applicants are expected to have successfully completed college-level courses in horticulture, biology, chemistry, physics, and mathematics.

Special Application Requirements—Three letters of recommendation submitted on the department’s form from persons familiar with the applicant’s scholarship potential, a statement of background and career goals, a listing of completed prerequisite courses submitted on the department’s form, scores from the General Test of the Graduate Record Examination, and a complete set of transcripts in addition to that required by the Graduate School are required. Students may enter the program any quarter. Because fellowship nominations and departmental research assistant awards are made in early February, students with outstanding academic records should apply by December 15 preceding the year they wish to enter.

Master’s Degree Requirements—The minimum coursework requirement is 28 credits for Plan A (plus 16 thesis credits) and 44 credits for Plan B. A complete statement of degree program requirements may be obtained from the director of graduate studies. There are few specific course requirements, because each program is planned to meet the individual interests and needs of the student. Students are required to present a research planning seminar (8066) and a final seminar (8042). The final examination is oral.

Doctoral Degree Requirements—Programs are flexible, tailored to the student’s background and professional interests. With approval from the advisory committee, courses in related fields may be used as part of the major work. One quarter of teaching in conjunction with a supervised teaching course (8000) is required of all students. Students are expected to participate in and present at least one seminar (8042) and one research planning discussion (8066) and to earn 2 credits in such discussion courses as 8060, 8062, 8063, and 8065.

Minor Requirements for Students Majoring in Other Fields—Nine credits are required for a master’s minor in horticulture; 18 credits for a doctoral minor.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Horticultural Science, University of Minnesota, 305 Alderman Hall, 1970 Folwell Avenue, St. Paul, MN 55108 (612/624-4242; fax 612/624-4941; e-mail kuype001@tc.umn.edu; http://www.soils.umn.edu:8003).

Hort 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)
Hort 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)
Hort 8888. Thesis Credits: Doctoral. (36 cr required)
Hort 5001f. Harvest to Market of Horticultural Crops. (3 cr; prereq PBio 3131) Li, Tong
Physiological processes of horticultural crops after harvest as related to maturity, time to harvest, quality, ripening, senescence, handling, storage, and marketing. Interdisciplinary approaches to problem solving and decision making in postharvest management.

Hort 5015s. Restoration and Reclamation Ecology. (4 cr; prereq 1 plant biol or botany course, 1 ecol course) Galatowitsch
Ecological and physiological concepts as basis for revegetation of grasslands, wetlands, forests, and other landscapes. Methods for plant materials selection, stand establishment, evaluating revegetation success. Overview of federally and state-administered restoration and reclamation programs. Weekend and evening trips to examine several restoration and reclamation sites in Minnesota.

Hort 5020. Topics in Plant Science for Teachers. (1-4 cr; prereq 1 plant science or educ course; not for credit in Hort grad program; University College only)
Intensive workshop on inquiry-based science instruction for elementary and secondary school educators; skills and activities for teaching plant science. Managing classroom/schoolyard plant growth.

Hort 5026f. Landscape Management. (4 cr; prereq completion of business enrichment requirements and 75 percent of cr requirement in landscape, nursery, turf sequence) Pedersen
Integrates environmental horticulture industry disciplines and commodities; superimposes appropriate business management principles. Scientific methods and technical applications incorporated through problem solving and case studies.

Hort 5030. Landscape Design of Residential and Small Commercial Sites. (3 cr, §3030; prereq 1021, 1022, LA 1301 or #)
Fundamentals of landscape design theory, including organization of space, complementary shapes and forms, site analysis, and relationship of structure, texture, and seasonal interest in the landscape; further study of plans and environmental requirements as they influence design.

Hort 5031f. Temperate Fruit Production. (4 cr; prereq 3001; PBio 3131 recommended; offered odd yrs) Hoover
Principles of fruit production, emphasizing temperate fruit crops. Integrated management of fruit cropping systems, including site selection, cultural and management practices, taxonomic classifications, physiological and environmental control of plant development. Intensive use of writing.

Hort 5034s. Commercial Vegetable Agriculture. (5 cr; prereq 3002 or Agro 1010, Soil 3125)
Crop cultural and product handling and use systems in various world regions. History and evolution of species and product development. Seed and stand establishment; propagation; pest management. Applied physiology and genetics of fruit, bulb, tuber initiation; sink development, maturation, and quality. Lectures, labs, and field trips.

Hort 5040w. Advanced Plant Growth Regulation. (4 cr; prereq sr with 15 cr plant sciences incl 3 cr plant physiology; offered even yrs)

Hort 5041. Landscape Design and Implementation. (4 cr, §3040; prereq 3030 or 5030)
Builds on techniques in Hort 5030. Architectural and graphic techniques and design concepts in relation to horticultural plant performance and maintenance. Implementation of students' designs encompasses grading, site manipulation, and plant installation.

Hort 5042f.* Turfgrass Science. (5 cr; prereq 3001, 3072, PIPA 3002) White
For advanced students in turf with career objectives in professional turf management. All phases of the turf industry considered. Emphasis on the ecology, physiology, and theory of turf population dynamics and on specialized management situations such as golf course, commercial sod production, and fine turf athletic settings.

Hort 5046f. Nursery Management I. (4 cr, 5046-5047-5048†; prereq 1021, 1036) Swanson
Introduction, history, organization, and scope of the nursery industry. General nursery business administration, production schedules and cultural management for seedbeds and field grown stock. Lab includes field trips and greenhouse and field training in nursery operations. Field trips.

Hort 5047w. Nursery Scheduling and Enterprise Development. (2 cr, 5046-5047-5048†; prereq 5046) Swanson
Development of specific crop schedules, using current technical and economic data for efficient production. Development of total nursery enterprise designed for workable and profitable business establishment.

Hort 5048s. Nursery Management and Production II. (4 cr, 5046-5047-5048†; prereq 5047) Swanson
Pest management and governmental regulations concerning the nursery industry. Container growing operations and marketing of all products. Specific topic research and nursery operation development by the student. Lab includes field trips and greenhouse and field training in nursery operations. Field trips required.

Hort 5054s. Commercial Floricultral Production Practices. (4 cr; prereq 1036, 3002, PBio 3131) Erwin
Principles of commercial bedding plant production systems. Emphasis on major bedding plant crops and their cultural practices. Lectures, labs, field trips.
Hort 5055f. Commercial Floriculture Production Systems. (5 cr; prereq 1036, 3002, PBio 3131 or #) Strefeler

Hort 5091.* Directed Studies. (2-6 cr; prereq 8 cr upper div hort course, ∆)
Written or oral report based on library, lab, or field research.

Hort 5999. Special Workshop in Horticulture. (1-4 cr; prereq #)
Offered in locations off the Twin Cities campus. Consult Class Schedule or department for current topics.

Hort 8000. Supervised Teaching Experience in Horticulture. (2 cr, §Agro 8000, §Soil 8000; prereq #) Hoover
Students are provided classroom or extension teaching experience in Departments of Agronomy and Plant Genetics or Horticultural Science or Soil, Water, and Climate and participate in teaching topic discussions to strengthen skills and develop personal teaching philosophy.

Hort 8007f,w,s. Extension Horticulture Practicum. (1-5 cr; prereq 12 grad cr)
Selected activities that may include development of an extension fact sheet, assistance in Horticulture Clinic, or preparation of a workshop or short course.

Hort 8022w. Breeding Asexually Propagated Crops. (3 cr; prereq Agro 5020; offered alt yrs)
Methods applied to improving asexually propagated plants. Apomixis, polyploidy, chimeras, mutations, and interspecific hybridization.

Hort 8023f.* Evolution of Crop Plants. (4 cr; prereq 13 grad-level credits) Ascher
Origin, distribution, and evolution of cultivated plants; implication of evolutionary processes on crop breeding for needs of people today.

Hort 8041w. Discussions in Administrative Organization. (1 cr) Gardner
Organization and administration in agricultural experiment stations; project development and research outlines.

Hort 8042f,w,s.* Horticultural Seminar. (1 cr)
Reports and discussions of problems and investigational work.

Hort 8045w.* Plant Response to Environmental Stress. (3 cr; prereq 3 cr 5xxx biochem, 3 cr 5xxx plant physiology; offered alt yrs) Carter
Examined from molecular to organismal levels.

Hort 8051f,w,s,u.* Advanced Problems in Horticultural Crop Breeding. (3-9 cr; prereq #)
Written report based on library, lab, or field research.

Hort 8052f,w,s,* Advanced Problems in Physiology of Horticultural Crops. (3-9 cr; prereq #)
Written report based on library, lab, or field research.

Hort 8060f,w,s. Discussions in Potato Research. (1 cr)
Covers all aspects of potato genetics, breeding, and physiology. Emphasis on current research and literature.

Hort 8062f,w,s.* Discussions in Plant Hardiness. (1 cr; prereq # Li, Carter)
Broad subject area of plant hardiness. Temperature and drought stress.

Hort 8063f.* Seminar; Discussions in Horticultural Plant Breeding. (1 cr; prereq # Luby)
The application of plant breeding theory and techniques to selected horticultural crops. Structured to encourage student leadership and direction.

Hort 8065w,s,* Discussions in Postharvest Physiology. (1 cr; prereq # Li, Tong)
Physical requirements and physiological basis of storage techniques used in maintaining quality in horticultural products. Topics include historical evolution of postharvest physiology, biochemical and physical changes occurring during storage and senescence of horticultural products.

Hort 8066. Discussions in Horticulture Research. (1 cr) Smith
Emphasis on research being conducted by graduate students in the department.

Hort 8090. Graduate Horticultural Research. (1-18 cr; prereq ∆)
Directed studies.

Other Courses of Interest
Agro 5020. Introduction to Plant Breeding
Agro 8200. Plant Breeding Principles and Methods I
Agro 8210. Plant Breeding Principles and Methods II
PBio 5183. Water, Minerals, and Translocation

Hospital Pharmacy

Professor: Daniel Canafax; James C. Cloyd; Charles E. Halstenson; John C. Rotschafer; Darwin E. Zaske
Associate Professor: Ronald S. Hadsall, director of graduate studies; Paul W. Abramowitz; Robert J. Cipolle; Courtney V. Fletcher; Nina M. Graves; David R. Guay; Henry Mann; Mary E. O’Connell; Linda M. Strand
Assistant Professor: Charles E. Daniels; Ricci M. Giese; Thomas S. Rector
Clinical Assistant Professor: Christine M. Jolowsky; Thomas E. Scott
Adjunct Instructor: Delores M. Ryan

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

Degree Offered—M.S. (Plan A and Plan B).
Curriculum—The program is designed for qualified pharmacists who wish to prepare for careers in pharmacy management, practice, and drug therapy research in organized healthcare settings. Research focuses on the delivery of pharmacy services and the use of therapeutic agents in humans.

Prerequisites for Admission—A degree from a college of pharmacy and an exceptional scholastic record are required. Evidence of personal capability and fitness for work in the healthcare field is essential.

Special Application Requirements—Submission of a résumé and special supplemental application form plus completion of a personal interview are required.

Degree Requirements—For Plan A, a minimum of 20 quarter credits in the major field, a minimum of 8 quarter credits in one or more related fields outside the major, and 16 thesis credits. Students are encouraged to select a minor. The final examination is oral.

For Plan B, a minimum of 44 credits of coursework in computer science, healthcare delivery, hospital administration, hospital pharmacy administration, management seminar, research, statistics, and other subjects. One Plan B project and two Plan B papers are required. Minor fields vary. The final examination is oral.

Language Requirements—None.

For Further Information and Applications—Contact Graduate Studies in Hospital Pharmacy, University of Minnesota, 7-115 Weaver-Densford Hall, 308 Harvard Street S.E., Minneapolis, MN 55455 (612/624-2973; fax 612/625-9931).

SAPh 8777. Thesis Credits: Master's. (16 cr required; Plan A only)

Social and Administrative Pharmacy (SAPh)

SAPh 8100. Seminar. (1 cr per qtr)

SAPh 8200. Research Problems. (Cr ar)

SAPh 8210, 8220. Experimental Pharmacotherapeutics I, II. (3 cr per qtr; offered alt yrs) Canafax, O'Connell

Theory of advanced methodologies, applications, and evaluation techniques used to determine safety, efficacy, and toxicity of drug therapies. 8210: Advanced theory: approaches, problems, and applications in pharmacotherapeutic problem solving. 8220: Advanced techniques: therapeutic end points and newly developing methodologies.

SAPh 8301. Clinical Therapeutics. (3 cr per qtr; offered alt yrs)

Clinical lectures on diagnosis and treatment of common diseases.

SAPh 8400. Special Clinical Problems. (Cr ar)

Medication errors, drug distribution systems, patterns of drug use, cost-benefit analysis of prescribed medication according to diagnosis, age, dosage form, effectiveness, side effects, incidence of adverse effects, or drug use and misuse.

SAPh 8700. Hospital Administration. (2 cr; offered alt yrs) Abramowitz

History, classification, organization, and functions of hospital departments in relation to the pharmacy service.

SAPh 8701. Hospital Pharmacy Administration I. (3 cr; offered alt yrs)

SAPh 8702. Hospital Pharmacy Survey. (1 cr; prereq 8701; offered alt yrs) Broekemeier

SAPh 8703. Hospital Pharmacy Administration II. (3 cr; offered alt yrs)

Continuation of 8701.

Human Factors/Ergonomics (HumF)

Professor: Michael Wade (kinesiology), director of graduate studies; Arthur G. Erdman (mechanical engineering); Laël C. Gatewood (laboratory medicine and pathology); Denise Guerin (design, housing, and apparel); Tarald O. Kvalseth (mechanical engineering); Gordon E. Legge (psychology); Donald Vesley (environmental and occupational health)

Associate Professor: Peter Hancock (kinesiology); Ruth Kanfer (psychology); Don R. Riley (mechanical engineering)

Assistant Professor: Joseph A. Konstan (computer science); Karen LaBat (design, housing, and apparel); Shashi Shekhar (computer science)

Senior Research Fellow: John C. Carmody (Minnesota Building Research Center)

Course of Study—Minor in human factors/ergonomics, applicable to doctoral programs only.

Curriculum—Human factors/ergonomics, an interdisciplinary area of study, focuses on the interaction between people and technology. It emphasizes a bio-behavioral approach to human performance in the context of the human-machine interactions. Human factors/ergonomics has its roots in psychology, kinesiology, cognitive science, engineering, operations research, and physiology. More recently, computer science and software engineering have become significant elements in human factors/ergonomics.
Prerequisites for Admission—Admission to the human factors/ergonomics graduate minor is contingent upon prior admission to a doctoral degree-granting program within the Graduate School. Admission to the minor is limited and only by permission of the director of graduate studies in the human factors/ergonomics minor.

Minor Requirements—The minimum number of graduate credits for the minor is 21. Individual student programs are developed in consultation with the major adviser and the director of graduate studies in the minor. Students with sufficient background or previous course experience equivalent to one or more courses within the curriculum may apply for waiver of the appropriate requirements and replace waived courses with additional electives. The core of the minor curriculum consists of three required courses: a lecture course on the foundations of human factors/ergonomics (Kin 5xxx), a proseminar in human factors/ergonomics (HumF 8xxx), and a seminar in application of human factors/ergonomics (HumF 8xxx). Students select their remaining courses from a list of electives.

Language Requirements—None specific to the minor program.

For Further Information and Applications—Contact the Doctoral Minor Program in Human Factors/Ergonomics, Human Factors Research Laboratory, School of Kinesiology and Leisure Studies, College of Education and Human Development, University of Minnesota, 141 Mariucci Arena, 1901 Fourth Street S.E., Minneapolis, MN 55455 (612/625-5300).

**Kin 5001. Foundations of Human Factors/Ergonomics.** (4 cr; prereq admission to HumF minor or #; 3 lect, 1 rec-lab hrs per wk) Historical, conceptual, empirical, methodological, and practical foundations; interrelationships and interdependence between human performance and design factors in performance environment.

**HumF 8001. Proseminar in Human Factors/Ergonomics.** (1 cr per qtr [3 cr required for HumF minor]; prereq admission to HumF minor) Survey of major topics, including theoretical influences, methods, and samples of current research.

**HumF 8002. Topics in Human Factors.** (2-4 cr [3 or 4 cr requires participation in supervised research project]; prereq admission to HumF minor or #) Lectures and in-depth discussion.

Immunology

See Microbiology, Immunology, and Molecular Pathobiology.

Industrial Engineering

See Mechanical Engineering.

Industrial Relations (IR)

Professor: James G. Scoville, director of graduate studies; Dennis A. Ahlburg; Richard D. Arvey; Avner Ben-Ner; Hyman Berman; Mario F. Bognanno; Richard J. Butler; John P. Campbell; Rene V. Dawis; Marvin D. Dunnette; John A. Fossum; Morris M. Kleiner; Jeylan T. Mortimer; John Remington; Paul R. Sackett; George Seltzer (emeritus); Andrew F. Whitman; Mahmood A. Zaidi

Associate Professor: Ross E. Azevedo; Michael P. Keane; Brian P. McCall

Assistant Professor: John W. Budd; Yijiang Wang

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

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

Curriculum—Subfields are collective bargaining; compensation and reward theory and administration; economics of human resources; organization theory and administration; and staffing, training, and development.

Prerequisites for Admission—Entering students are expected to have completed, or to complete during their first quarter, introductory courses in micro- and macroeconomics, and psychology.

Special Application Requirements—Three letters of recommendation evaluating the applicant’s scholarship, a complete set of transcripts (in addition to that required by the Graduate School), and Graduate Record Examination scores are required. Applicants whose native language is not English are required to score at least 550 on the Test of English as a Foreign Language (TOEFL). Entry in both the day and evening M.A. programs is in fall or spring quarter only. Priority application deadline is December 15 for fall quarter. Applications received after this deadline are considered on a space-available basis. Entry in the Ph.D. program is usually in the fall; application deadlines are those established by the Graduate School. The financial aid application deadline is December 15.
Master’s Degree Requirements—The M.A. degree is offered in day and evening programs. For Plan A, a minimum of twelve courses (48 credits), 16 thesis credits, and a thesis are required. Major coursework includes 8001, 8002, 8011, one course from at least three areas in industrial relations, and three additional industrial relations courses. The related field must consist of a minimum of two courses in an approved field or fields of study related to industrial relations. Commonly selected fields are business administration, economics, psychology, sociology, or statistics. The twelfth course may be in industrial relations or a related field.

For Plan B a minimum of sixteen courses (64 credits) and three Plan B papers are required. Major coursework includes 8001, 8002, 8003, 8004, 8005, 8006, 8007, 8011, 8012, and four additional industrial relations courses. A minimum of 12 graduate credits must be earned in related fields, at least 8 credits of which are usually in a single field. Commonly selected fields are business administration, economics, psychology, sociology, or statistics. A Plan B paper must be written in conjunction with 8011 and 8012. The third paper can be written in conjunction with any other course appearing on the approved program.

Students with limited or no business administration background may take a core of specified M.B.A. courses consisting of a minimum of 12 credits.

A final oral examination is required under both plans after all coursework and Plan B papers are accepted or the thesis draft approved by the adviser.

Doctoral Degree Requirements—In addition to coursework and study in industrial relations, students are expected to have a solid preparation in one or more of the six designated related social or behavioral science disciplines (anthropology, economics, history, political science, psychology, sociology). Students must successfully complete examinations in research methodology and two of the five industrial relations subfields.

Ph.D. programs should be composed of a major and a research program. The research program must include a minimum of 24 credits in research methods and techniques.

The graduate faculty in industrial relations may require higher performance standards than those specified in the General Information section of this bulletin.

Language Requirements—None.

Minor Requirements for Students Majoring in Other Fields—Industrial relations may be selected as a minor or as part of a supporting program for the Ph.D. by students majoring in education, hospital and healthcare administration, or the social and behavioral sciences. The minor must consist of at least 28 credits, including five courses in at least four subfields, plus a Ph.D. seminar. Industrial relations can also be offered as a related field in business administration. Students must complete a minimum of 28 credits. For specific minor and related field requirements, consult the director of graduate studies.

For Further Information and Applications—Contact the Industrial Relations Center, University of Minnesota, 537 Management and Economics Building, 271 19th Avenue South, Minneapolis, MN 55455 (612/624-5810; fax 612/624-8360; e-mail efrench@csom.umn.edu).

IR 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

IR 8777. Thesis Credits: Master's. (16 cr required; Plan A only)

IR 8888. Thesis Credits: Doctoral. (36 cr required)

IR 5000. Topics in Personnel and Industrial Relations. (1-8 cr)

IR 5002. Systems of Conflict and Dispute Resolution. (4 cr) Azevedo

IR 5006. Labor Policy. (3 cr, §PA 5430) Budd, Kleiner

IR 5990. Independent Study in Personnel and Industrial Relations. (1-8 cr; prereq Sch Mgmt or Grad Sch Mgmt approval)
IR 8000. Graduate Topics in Industrial Relations. (Cr ar; prereq 8002, IR MA student or Sch Mgmt approval) Selected topics.

IR 8001. Introduction to Quantitative Methods and Techniques for Industrial Relations. (4 cr; prereq IR grad student or ∆) Ahlburg, Budd, Keane, McCall, Wang
Industrial relations problems. Application of descriptive and inferential statistics, including probability, hypothesis testing, confidence intervals, analysis of variance, and bivariate linear regression and correlation. Introduction to computer software and hardware for problem solutions and exercises.

IR 8002. An Introduction to Industrial Relations. (4 cr, §3002; prereq Econ 1101, Econ 1102, Psy 1001, IR MA student or ∆) Azevedo, Fossum, Scoville, staff

IR 8003. Staffing, Training and Development. (4 cr; prereq 8002 or #, IR grad major or ∆; IR grad major must register A-F) Arvey, Sackett, Wanberg
Introduction to staffing processes (recruitment, selection, promotion, demotion, transfer, dismissal, layoff, retirement), training development theory and techniques as mechanisms for influencing individual and organizational outcomes, such as performance, satisfaction, and climate.

IR 8004. Design and Management of Organizations for a Changing World. (4 cr; prereq 8002 or #, IR grad major or ∆; IR grad major must register A-F) Arvey, Ben-Ner, Wang
Introduction to micro through macro organizational issues at individual, dyadic, group, organizational, and environmental levels; their implications for organizational design, control, coordination, and development.

IR 8005. Compensation and Reward Theory and Programs. (4 cr; prereq 8002 or #, IR grad major or ∆; IR grad major must register A-F) Azevedo, Butler, Fossum
Introduction to compensation and reward programs in employing organizations. Concepts, models, and theories of organizational and employee behavior in design and implementation of pay programs. Job evaluation, salary surveys, pay structures, salary increase programs, variable compensation, benefit programs, executive compensation, skill-based pay, and laws and regulations.

IR 8006. Introduction to Labor Market Analysis. (4 cr; prereq 8002 or #, IR grad major or ∆; IR grad major must register A-F) Ahlburg, Azevedo, Bognanno, Budd, Keane, McCall, Zaidi
Labor supply and demand analysis, its international dimensions; determination of wages, employment and unemployment; accumulation of human capital and investment in education and training; government regulation in areas of discrimination and workplace safety; role of unions in wage determination.

IR 8007. Collective Bargaining: Private and Public Sectors. (4 cr; prereq 8002 or #, IR grad major or ∆; IR grad major must register A-F) Bognanno, Budd, Remington

IR 8011. Intermediate Quantitative Methods and Techniques for Industrial Relations. (4 cr; prereq 8001, IR grad student or ∆) Ahlburg, Budd, Keane, McCall
Theory and applications of alternative quantitative methods and techniques in formulation and analysis of various industrial relations problems and practices. Cases, problem sets, and computer exercises.

IR 8012. Industrial Relations Systems. (4 cr; prereq completion of the core course sequence in IR or #, IR grad major or ∆; IR grad major must register A-F) Arvey, Fossum, Sackett, Scoville, Seltzer
Integration of industrial relations subfields. Application of elements of industrial relations to human resource management issues in public and private sectors. Course project involves evaluation of industrial relations practices in chosen organization.

IR 8013. Staffing and Selection: Strategic and Operational Concerns. (4 cr; prereq 8003 or #, IR grad major or ∆; IR grad major must register A-F) Arvey, Sackett, Wanberg
Theory and practice related to staffing decisions (recruitment, selection, promotion, demotion, transfer, dismissal, layoff, retirement) in organizations. Legal environment in which staffing decisions are made. Staffing from strategic and operational perspectives.

IR 8014. Organizational Structure and Environmental Systems. (4 cr; prereq 8004 or #, IR grad major or ∆; IR grad major must register A-F) Arvey, Ben-Ner, Wang
Impact of environmental systems on organization design and dynamics of organizational redesign. Employing organizations in terms of general and specific environmental conditions: technological, legal, political, economic, demographic, ecological, and cultural.

IR 8015. Compensation Theory and Applications. (4 cr; prereq 8005 or #, IR grad major or ∆; IR grad major must register A-F) Azevedo, Fossum
Effects of economy and demography of employees on employers and pay programs; effects of changes in hiring, development, and use of employees on design of pay program components. Cost-benefit analysis of compensation program components on organizational outcomes. Integration of compensation programs in human resource management.
IR 8016. Human Resource Planning. (4 cr, §8036; prereq 8006 or #, IR grad major or Δ; IR grad major must register A-F) Azevedo, Zaidi
Theoretical and empirical models of planning for human resource use. Micro-economic analysis; Delphi processes; Markov, Career-Path, and Transition models; and programming approaches. Focus on quantitative analysis of movement of workers through organization.

IR 8017. Labor Movements in a Changing World. (4 cr; prereq 8007 or #, IR grad major or Δ; IR grad major must register A-F) Bognanno, Budd, Remington
Labor movement philosophies. Critical evaluation of labor movement growth and adjustment to environmental change. Domestic and international perspectives of labor movement innovations.

IR 8022. International Human Resource Management. (4 cr; prereq 8002 or MBA 8015 or # or Δ; IR grad major must register A-F) Bognanno, Scoville, Zaidi
Introduction. Legal, institutional, and market aspects of work arrangement, and their impact on multinational and transnational corporations operating in foreign countries.

IR 8023. Employee Training: Creating a Learning Organization. (4 cr; prereq 8003 or #, IR grad major or Δ; IR grad major must register A-F) Arvey, Sackett, Wanberg
Theory, research, and practice related to design and implementation of employee training programs. Instructional design, training techniques, transfer of training, and program evaluation and costing. Role of employees, unions, and firm policies and practices in training process.

IR 8024. Organization Design and Change. (4 cr; prereq 8004 or #, IR grad major or Δ; IR grad major must register A-F) Arvey, Ben-Ner, Wang
Principles of organizational and task design in relation to internal organizational operations. Resource dependency, power, conflict, and political behavior in organizations. Information structures, centralization, and decentralization.

IR 8025. Employer-Sponsored Employment Benefits Programs. (4 cr; prereq 8005 or #, IR grad major or Δ; IR grad major must register A-F) Azevedo, Butler
Design and administration of nonmandatory compensation benefit programs: health insurance and wellness programs; pensions, salary reduction, and deferred compensation programs; pay for time not worked; other insurance plans. Analysis of risks related to work force demography and employee behaviors. Compliance with legal requirements. Cafeteria benefit plans.

IR 8026. Human Resources and Firm Performance. (4 cr, §8046; prereq 8006 or #, IR grad major or Δ; IR grad major must register A-F) Kleiner
Role that human resource policies and practices play in firm productivity, profitability, and market value.

IR 8027. Dispute Resolution Practices: Mediation, Fact Finding, and Arbitration. (4 cr; prereq 8007 or #, IR grad major or Δ; IR grad major must register A-F) Bognanno, Budd, Remington
Private and public sector impasse/dispute resolution for contract negotiation and administration. Methods and practices used in grievance resolution, mediation, fact finding, and arbitration. Newly emerging approaches.

IR 8032. Comparative and International Labor Movements. (4 cr; prereq 8002 or #, IR grad major or Δ; IR grad major must register A-F) Scoville
Emergence, evolution, structures, functions, and challenges ahead of labor movement in developed countries. Industrial relations systems in comparative perspective. International labor organizations. Prospects and problems of labor in developing countries.

IR 8033. Employee Development: Creating a Competitive Advantage. (4 cr; prereq 8003 or #, IR grad major or Δ; IR grad major must register A-F) Theory, research, and practice. Career development and planning, employee and management development techniques, and organizational and employee concerns related to mobility, job stress, balancing work and family, obsolescence and plateauing, and cross-cultural assignments.

IR 8034. Motivation and Work Behavior in Contemporary Organizations. (4 cr, §8035; prereq 8004 or #, IR grad major or Δ; IR grad major must register A-F)
Major topics of microlevel organizational behavior with more intensity and depth than typically found in survey course. Accountability, organization citizenship behaviors, forms of organizational attachment, motivation and issues of equity and justice.

IR 8037. Labor-Management Negotiations. (4 cr; prereq 8007 or #, IR grad major or Δ; IR grad major must register A-F) Bognanno, Budd

IR 8042. Human Resource Information Systems. (4 cr; prereq IR core or #, IR grad major or Δ; IR grad major must register A-F)
Analysis of use of human resource information systems as related to industrial relations. Hardware and database fundamentals, software applications, security issues, vendor evaluation, system and software development and design issues, and strategies for gaining user acceptance.

IR 8045. Public Policy and Employee Benefits. (4 cr; prereq 8005 or #, IR grad major or Δ; IR grad major must register A-F) Butler
IR 8106. Topics in Micro Labor Market Analysis. (4 cr; prereq 8006 or #; IR PhD major or Δ; IR grad major must register A-F) Ahlburg, Bognanno, Keane, McColl, Zaidi

May include micro aspects of unemployment, implicit-contracts and efficiency wages, investment in human capital, occupational choice, job search, job matching and turnover, migration, labor force participation, and government program evaluation.

IR 8116. Topics in Macro Labor Market Analysis. (4 cr; prereq 8006 or #; IR PhD major or Δ) Ahlburg, Keane, Zaidi

May include theories of unemployment based on sectoral shocks, theories of wage rigidity, efficiency wage theories, interindustry wage structure, role of labor market in resource allocation, and effects of government intervention in labor market.

IR 8800. Advanced Quantitative Research Methods. (4 cr; prereq IR core or #; IR PhD major or Δ; IR grad major must register A-F) Ahlburg, Budd, Keane, McColl

General linear model and its assumptions and violations; simultaneous equations; pooling cross-section and time series; limited and qualitative dependent variable models; sample selection models; hazard models. Emphasis on application to industrial relations and management.

IR 8801. Seminar: Industrial Relations Research Methodology. (4 cr; prereq IR PhD major or Δ) Ahlburg, Bognanno, Keane, McColl, Sackett

Research methodology appropriate to study of industrial relations: application in research projects.

IR 8802. Seminar: Industrial Relations Systems. (4 cr; prereq IR core or #; IR PhD major or Δ) Scoville, Zaidi

Industrial relations thought and research. Investigating, integrating, and synthesizing more traditional related disciplines, theories, and research into interdisciplinary body of knowledge concerned with human resource problems and employment relationships.

IR 8803. Seminar: Staffing, Training, and Development. (4 cr; prereq 8003 or #; IR PhD major or Δ) Arvey, Sackett

Staffing and training concepts, problems, and research.

IR 8804. Seminar: Organization Theory. (4 cr; prereq 8004 or #; IR PhD major or Δ) Arvey, Ben-Ner, Wang

Organization theories, application in industrial relations research and practice.

IR 8805. Seminar: Compensation and Reward. (4 cr; prereq 8005 or #; IR PhD major or Δ) Azevedo, Fossum

Issues of employee compensation and reward: analysis of relevant theoretical models; formulation of research into compensation and reward issues.

IR 8806. Seminar: Analysis of Current Labor Market Theory and Empirical Research. (4 cr; prereq 8006 or #; IR PhD major or Δ) Ahlburg, Bognanno, Keane, McColl, Zaidi

Functions and operations of labor markets, theory, and research.

IR 8807. Seminar: Collective Bargaining and Labor Relations. (4 cr; prereq 8007 or #; IR PhD major or Δ) Bognanno, Budd

Analysis of contemporary theoretical and empirical research.

IR 8990. Independent Study in Industrial Relations. (Cr ar; prereq #; IR grad major must register A-F only)

Individual readings and/or research projects especially useful to student’s objectives and program.

Interdisciplinary Archaeological Studies (InAr)

Regents’ Professor: George R. Rapp, Jr. (Archaeometry Laboratory), associate director of graduate studies; Rutherford Aris (chemical engineering and materials science)

Professor: Guy E. Gibbon (anthropology), director of graduate studies; Frederick M. Asher (art history); Arthur C. Aufderheide1 (laboratory medicine and pathology); Subir K. Banerjee (geology and geophysics); Frederick A. Cooper (Classical and Near Eastern studies); Edward J. Cushing (ecology, evolution, and behavior); Stephen Gudeman (anthropology); Jackson P. Hershbell (Classical and Near Eastern studies); Calvin B. Kendall (English); Eva C. Keuls (Classical and Near Eastern studies); Sheila M. McNally (Classical and Near Eastern studies); Michael F. Metcalf (history); Thomas S. Noonan (history); Robert J. Poor (art history); Timothy G. Rous1 (sociology-anthropology); William B. Schwabacher (chemistry); Alan E. Shapiro (history of science); Theofanis G. Stavrou (history); Ellen J. Stekert (English); Peter S. Wells (anthropology)

Adjunct Professor: Orrin C. Shane

Associate Professor: Gerald W. Johnson (civil engineering); William W. Malandra (Classical and Near Eastern studies); Howard D. Mooers1 (geology); Jonathan Paradise (Classical and Near Eastern studies); Daniel D. Reisman (Classical and Near Eastern studies); Philip H. Sellew (Classical and Near Eastern studies); Janet D. Spector (anthropology)

Adjunct Associate Professor: Scott F. Anfinson; Clark A. Dobbs; Dale R. Henning; Gordon R. Peters1; Nancy C. Wilkie

Assistant Professor: Catherine E. B. Asher (art history); Eve B. Cole1 (philosophy); Oliver P. Nicholson (Classical and Near Eastern studies)

Adjunct Assistant Professor: Susan C. Mulholland1 (Archeometry Laboratory)

Lecturer: Bettina Arnold (anthropology); John R. Bower1 (sociology-anthropology); William K. Miller1 (Archeometry Laboratory)

Other: John M. Weeks (University Libraries)

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

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

**Curriculum**—The program in interdisciplinary archaeological studies offers opportunities to create individualized degree programs in which a focus in archaeology is integrated with aspects of one or more other fields. Students define their own interests and, in consultation with their adviser, design a program suited to their individual needs. The potential combination of fields integrated with archaeology is limited only by faculty expertise and interest. Graduate work toward the master’s degrees can be pursued on the Twin Cities campus or Duluth campus or both. The focus of coursework for the Ph.D. is on the Twin Cities campus.

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

**Special Application Requirements**—Graduate Record Examination scores are required. The program normally begins in fall quarter, but enrollment beginning in winter or spring quarter is possible in special circumstances. The application deadline for consideration for Graduate School fellowships is December 15.

**Degree Requirements**—The program does not offer set tracks of study. However, students at the master’s level are expected to take a series of three core seminars, which include combinations of method and theory in archaeology, archaeologic science, and an interdisciplinary topics seminar. New doctoral-level students are expected to take an interdisciplinary topics seminar and core seminars they have not taken earlier in one form or another. Except for these basic requirements, each student creates her/his own interdisciplinary program in consultation with program advisers. All programs of study are subject to review by the program steering committee. The final examination for both master’s degrees is oral.

**Language Requirements**—All students are expected to acquire competence in the research tools necessary for their graduate and future professional work. Often these are foreign languages and/or quantitative or experimental skills. The language and/or technique requirement is set by the student’s advising committee.

**For Further Information and Applications**—Contact Interdisciplinary Archaeological Studies, University of Minnesota, 215 Ford Hall, 224 Church Street S.E., Minneapolis, MN 55455 (612/625-1062).

**InAr 8666. Doctoral Pre-Thesis Credits.** (max 18 cr per qtr; doctoral student who has not passed oral prelims)

**InAr 8777. Thesis Credits: Master’s.** (16 cr required; Plan A only)

**InAr 8888. Thesis Credits: Doctoral.** (36 cr required)

**InAr 5100. Topics in Interdisciplinary Archaeological Studies.** (4 cr; prereq enrollment in program or #)

**InAr 8001. Method and Theory in Archaeology.** (4 cr, §AnSt 8001; prereq grad major or #)

**InAr 8002. Advanced Theory in Archaeology.** (4 cr, §AnSt 8002; prereq grad major or #)

**InAr 8100. Interdisciplinary Seminar.** (4 cr, §AnSt 8100; prereq grad major or #)

**InAr 8200. Directed Readings.** (Cr ar, §AnSt 8200; prereq ∆)

**InAr 8300. Directed Research.** (Cr ar, §AnSt 8300; prereq ∆)

**International Education**

*Professor:* Ayers Bagley; William M. Bart; John J. Cogan; L. Sunny Hansen; Frances Lawrenz; Gary N. McLean; Josef A. Mestenhauser; Dianne L. Monson; Edgar A. Persons; S. Jay Samuels; Robert D. Tennyson

*Associate Professor:* R. Michael Paige, director of graduate studies; Patricia Avery; James M. Brown; V. Lois Erickson; Kerry J. Freedman; March L. Krotee; Robert E. Orton; Jane E. Plihal

*Other:* Kay A. Thomas

**Course of Study**—Minor in international education, applicable to master’s (M.A. only) and doctoral programs.
Curriculum—The freestanding, interdisciplinary graduate minor in international education is for students enrolled in any M.A. or Ph.D. degree program who wish to enter careers in research, consulting, administration, and teaching in an international context. The minor offers a coordinated set of courses from the Departments of Curriculum and Instruction, Educational Policy and Administration, Educational Psychology, and Work, Community, and Family Education; the School of Kinesiology and Leisure Studies; and the Institute of Child Development.

Prerequisites for Admission—Admission to the international education minor is contingent upon prior admission to the Graduate School and to an M.A. or Ph.D. program at the University of Minnesota. Admission to the minor program is limited and only by permission of the International Education Committee and the director of graduate studies. Students interested in this option are welcome to consult with the director of graduate studies.

Minor Requirements—The minimum number of graduate-level quarter credits for the minor is 10 credits at the master’s level and 18 credits at the doctoral level. A student’s program is developed in consultation with the major adviser, the director of graduate studies of the home department, and the director of graduate studies for international education. Three course areas are addressed in the minor: foundations and critical issues; research (doctoral only); and area-specific coursework. It is understood that some courses may not have specific international content but nevertheless produce competencies and skills deemed essential to students intending to work in an international context. The minor is not available to students completing a Graduate School degree in educational policy and administration with a concentration in comparative and international development education.

Language Requirements—None specific to the minor program.

For Further Information and Applications—Contact the Director of Graduate Studies, International Education Minor, Comparative and International Development Education, Educational Policy and Administration,
Interpersonal Relationships Research (IRel)

**Professor:** W. Andrew Collins (child development), director of graduate studies; Ellen Berscheid (psychology); Larry L. Cummings (management); Harold D. Grotevant (family social science); Willard W. Hartup (child development); Dean Hewes (speech-communication); Robert Leik (sociology); James Maddock (family social science); Geoffrey Maruyama (educational psychology); David Olson (family social science); A. Marilyn Sime (nursing); Mark L. Snyder (psychology); Alan Sroufe (child development)

**Assistant Professor:** Patricia Frazier (psychology); Becky L. Omdahl (speech-communication)

**Course of Study**—Minor in interpersonal relationships research, applicable to doctoral programs only.

**Curriculum**—Interpersonal relationships research is an interdisciplinary field concerned with behavioral interaction patterns between two persons and the impact of these interactions. Its roots lie in psychology, sociology, family studies, communication, and nursing. The curriculum provides students with broad theoretical and methodological foundations for research on interpersonal relationships.

**Prerequisites for Admission**—Admission to the interpersonal relationships research graduate minor is contingent upon prior admission to the Graduate School and to a doctoral program in a degree-granting department. Admission to the minor program is limited and only by permission of the director of graduate studies in interpersonal relationships research.

**Minor Requirements**—Students seeking to complete the interpersonal relationships research minor at the Ph.D. level are required to take the following core courses: Psy 5204, IRel 8001 (a three-quarter proseminar), and IRel 8010. The minor requires a minimum of 21 credits. Additional credits beyond the required courses must be selected from a designated course list that includes approximately 40 courses offered by many disciplines. Credits from courses in the student’s major department, however, do not count toward the minor.

**Language Requirements**—None specific to the minor program.

**For Further Information and Applications**—Contact the Doctoral Minor Program in Interpersonal Relationships Research, Institute of Child Development, University of Minnesota, 104 Child Development, 51 East River Road, Minneapolis, MN 55455 (612/624-2396; fax 612/624-6373; e-mail mcdon007@tc.umn.edu).

**IRel 8001. Proseminar in Interpersonal Relationships Research.** (1 cr per qtr [max 3 cr]; prereq admission to IRel minor)
Survey of major topics, including theoretical assumptions, methods, and samples of current research.

**IRel 8010. Seminar: Statistical and Methodological Issues in Research on Dyadic Relationships.** (3 cr; prereq admission to IRel minor, #)
Survey of topics in design and analysis of research on behavior in two-person interactions.

**IRel 8360. Seminar: Topics in Interpersonal Relationships Research.** (1-4 cr; prereq admission to the IRel minor or #)

**Italian**
See French and Italian.

**Japanese**
See East Asian Languages, Literatures, and Linguistics.

**Journalism**
See Mass Communication.
**Kinesiology and Leisure Studies**

**Kinesiology**

*Professor*: Michael G. Wade, director; Fred S. Apple (laboratory medicine and pathology); Richard S. Crow (epidemiology); Richard P. DiFabio (physical medicine and rehabilitation); Arthur G. Erdman (mechanical engineering); David W. Johnson (educational psychology); Roger T. Johnson (curriculum and instruction); Arthur S. Leon; Herbert L. Pick (child development); Lela J. Stoner; Albert Yonas (child development)

*Associate Professor*: Allen W. Burton, director of graduate studies; Bruce D. Anderson; Peter A. Hancock; Mary Jo Kane; March L. Krotee; Robert C. Serfass; Diane M. Wiese-Bjornstal

*Adjunct Associate Professor*: Virgil G. Mathiowetz

*Lecturer*: Nancy L. Greer; James V. Mastro

*Research Associate*: Thomas W. Kernozek; Stirling P. Stackhouse; Ava J. Walker

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

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

**Curriculum**—Emphases in the master’s and doctoral programs are biodynamics (exercise physiology and biomechanics), motor behavior (motor development, motor learning/control, human factors, adapted physical education), and psychological and sociocultural dimensions of sport.

**Prerequisites for Admission**—Although prospective students generally have an undergraduate degree in the field, others with a baccalaureate degree may be admitted who have related preparation and a significant background and interest in the scientific study of physical activity. Admitted students may be required to complete background preparation.

**Special Application Requirements**—A completed kinesiology application form, scores from the Graduate Record Examination General Test (verbal and quantitative) or Miller Analogies Test, three letters of recommendation evaluating the applicant’s scholarship, and submission of a scholarly paper are required.

**Master’s Degree Requirements**—Course requirements include Kin 5980, 8980, 8981 (Plan B only), EPsy 5260, and evidence of effective professional communication. For Plan A the minimum course credit requirement is 28 credits (excluding 16 thesis credits); for Plan B it is 44 credits. The final examination is oral for both Plan A and Plan B students.

**Doctoral Degree Requirements**—Programs are individually designed with one area of emphasis in association with a minor or supporting field of study. Preliminary written and oral examinations are based on Kin 5170, Kin 5980, and program coursework. Other coursework requirements for all Ph.D. students include a minimum of nine credits in statistics and six credits of graduate seminar.

**Language Requirements**—None.

For Further Information and Applications—Contact the School of Kinesiology and Leisure Studies, University of Minnesota, 111 Cooke Hall, 1900 University Avenue S.E., Minneapolis, MN 55455 (612/624-5017).

**Kin 8666. Doctoral Pre-Thesis Credits.** (max 18 cr per qtr; doctoral student who has not passed oral prelims)

**Kin 8777. Thesis Credits: Master’s.** (16 cr required; Plan A only)

**Kin 8888. Thesis Credits: Doctoral.** (36 cr required)

*Note*—Kinesiology course listings immediately follow the recreation, park, and leisure studies program description below.

**Recreation, Park, and Leisure Studies**

*Professor*: Leo H. McAvoy; John E. Rynders (educational psychology); Stuart J. Schleien; Michael G. Wade

*Associate Professor*: Bruce D. Anderson; Mary Jo Kane; John H. Schultz; Carla E. S. Tabourne; Diane M. Wiese-Bjornstal

*Assistant Professor*: Dorothy H. Anderson (forest resources); Stephan P. Carlson (4-H youth development)

*Research Associate*: David W. Lime (forest resources)

*Other*: Linda A. Heyne

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

**Degrees Offered**—M.A. (Plan A and Plan B); and Ph.D. in education (emphasis in recreation, park, and leisure studies).

1 Also holds graduate faculty appointment in education.
Curriculum—Emphases in the master’s program are parks and recreation administration, therapeutic recreation, outdoor education/recreation, and sport management. The doctoral degree with the major in education offers preparation for an academic career in the emphases above. For a general description of the major in education, see the Education section of this bulletin.

Prerequisites for Admission—Although prospective students generally have an undergraduate degree in the field, others with related backgrounds may be admitted. Admitted students may be required to complete appropriate undergraduate and graduate courses.

Special Application Requirements—A completed RPLS application form and scores from either the Miller Analogies Test or the Graduate Record Examination (verbal and quantitative) are required. Students are admitted each quarter.

Master’s Degree Requirements—Requirements include 5980, 8980, and 8981 (Plan B only). For Plan A the minimum course credit requirement is 28 credits (excluding 16 thesis credits); for Plan B it is 44 credits. A final oral examination is required for both plans.

Doctoral Degree Requirements—The program consists of the following: a common core of at least 18 credits in the historical, scientific, and philosophical foundations of recreation, park, and leisure studies and of higher education; an emphasis area of at least 32 credits; thesis development of at least 52 credits (including 36 thesis credits); and a supporting program or minor of at least 21 credits. Three Ph.D. seminar courses must be included in these degree requirements. Foundation requirements are examined in association with the written preliminary examination.

Language Requirement—None.

For Further Information and Applications—Contact the School of Kinesiology and Leisure Studies, University of Minnesota, 111 Cooke Hall, 1900 University Avenue S.E., Minneapolis, MN 55455 (612/624-5017).

Rec 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

Educ 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

Educ 8888. Thesis Credits: Doctoral. (36 cr required)

Section 3. Recreation, Park, and Leisure Studies

Note—Recreation, park, and leisure studies course listings immediately follow the kinesiology course listings below.

Kinesiology (Kin)

Kin 5100. Developmental/Adapted Physical Education. (3 cr; PEL) Burton, Mastro
Physical education for students with disabilities, emphasizing administration, curriculum, assessment, history, legal mandates, and resources.

Kin 5101. Physical Activities for Persons With Disabilities. (3 cr; PEL) Burton
Adaptation of physical activities for persons with disabilities, emphasizing application of current movement science research.

Kin 5102. Practicum: Developmental/Adapted Physical Education. (1-6 cr [max 6 cr]; prereq 5100; S-N only; PEL) Burton
Observation of and participation in physical education instruction for students with disabilities; includes seminar component for discussion of current issues in development/adapted physical education and exchange of ideas and problems.

Kin 5106. Adapted Aquatics. (2 cr; prereq current American Red Cross Water Safety Instructor certification or equiv YMCA certification to receive Adapted Aquatic Instructor certification or no prereq if no certification desired)
Approaches to teaching aquatics, aquatic programming options, accommodations, and adaptations for persons with disabilities; organization and administration, resources, assessments, and individualized education plans.

Kin 5111. Sport Facilities. (3 cr, §Rec 5111; prereq kin or rec major or #) Anderson
Planning of areas and facilities for athletics, physical education, and sport; emphasizing current trends and problems.

Kin 5120. Advanced Biomechanics. (4 cr; prereq biomechanics, 3111 or #; PEL)
Principles of mechanics applied to human movement and analysis of motor skills; application to individual projects.

Kin 5121. Contributions of Basic Science to Kinesiology. (3 cr) Hancock
Recent research in related physical sciences; applications in selected areas.

Kin 5122. Applied Exercise Physiology. (3 cr; prereq 3386 or equiv or #; PEL) Serfass
Application of concepts in human physiology to exercise physiology, sports training, and physical activities, with particular reference to respiratory and cardiovascular systems.

Rec 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

Educ 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

Educ 8888. Thesis Credits: Doctoral. (36 cr required)

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Kin 5120. Advanced Biomechanics. (4 cr; prereq biomechanics, 3111 or #; PEL)
Principles of mechanics applied to human movement and analysis of motor skills; application to individual projects.

Kin 5121. Contributions of Basic Science to Kinesiology. (3 cr) Hancock
Recent research in related physical sciences; applications in selected areas.

Kin 5122. Applied Exercise Physiology. (3 cr; prereq 3386 or equiv or #; PEL) Serfass
Application of concepts in human physiology to exercise physiology, sports training, and physical activities, with particular reference to respiratory and cardiovascular systems.

Rec 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

Educ 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

Educ 8888. Thesis Credits: Doctoral. (36 cr required)

Section 3. Recreation, Park, and Leisure Studies

Note—Recreation, park, and leisure studies course listings immediately follow the kinesiology course listings below.

Kinesiology (Kin)

Kin 5100. Developmental/Adapted Physical Education. (3 cr; PEL) Burton, Mastro
Physical education for students with disabilities, emphasizing administration, curriculum, assessment, history, legal mandates, and resources.

Kin 5101. Physical Activities for Persons With Disabilities. (3 cr; PEL) Burton
Adaptation of physical activities for persons with disabilities, emphasizing application of current movement science research.

Kin 5102. Practicum: Developmental/Adapted Physical Education. (1-6 cr [max 6 cr]; prereq 5100; S-N only; PEL) Burton
Observation of and participation in physical education instruction for students with disabilities; includes seminar component for discussion of current issues in development/adapted physical education and exchange of ideas and problems.

Kin 5106. Adapted Aquatics. (2 cr; prereq current American Red Cross Water Safety Instructor certification or equiv YMCA certification to receive Adapted Aquatic Instructor certification or no prereq if no certification desired)
Approaches to teaching aquatics, aquatic programming options, accommodations, and adaptations for persons with disabilities; organization and administration, resources, assessments, and individualized education plans.

Kin 5111. Sport Facilities. (3 cr, §Rec 5111; prereq kin or rec major or #) Anderson
Planning of areas and facilities for athletics, physical education, and sport; emphasizing current trends and problems.

Kin 5120. Advanced Biomechanics. (4 cr; prereq biomechanics, 3111 or #; PEL)
Principles of mechanics applied to human movement and analysis of motor skills; application to individual projects.

Kin 5121. Contributions of Basic Science to Kinesiology. (3 cr) Hancock
Recent research in related physical sciences; applications in selected areas.

Kin 5122. Applied Exercise Physiology. (3 cr; prereq 3386 or equiv or #; PEL) Serfass
Application of concepts in human physiology to exercise physiology, sports training, and physical activities, with particular reference to respiratory and cardiovascular systems.

Rec 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

Educ 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

Educ 8888. Thesis Credits: Doctoral. (36 cr required)

Section 3. Recreation, Park, and Leisure Studies

Note—Recreation, park, and leisure studies course listings immediately follow the kinesiology course listings below.
**Kin 5124. Human Factors Physiology.** (3 cr)
Hancock
Concepts, problems, and issues associated with ergonomic applications to design and operation of human work space. Ergonomic tools and methodologies, hands-on experience in criticism and redesign of existing systems, and principles for design of more efficient future systems.

**Kin 5126. Advanced Psychological and Sociological Dimensions of Physical Activity.** (3 cr; prereq kin major or #; PEL) Krotee, Wiese-Bjornstal
Advanced insight into substance, nature, and significance of these dimensions of physical activity; focus on current research, issues, and trends as well as potential practical contributions.

**Kin 5127. Observation and Analysis of Teaching Physical Activity.** (3 cr; prereq PEL or sr kin major or MA or Med student or #)
Developing skills in using observation and supervision tools to analyze teaching/coaching of physical activity.

**Kin 5132. Motor Development.** (3 cr, §CPsy 5322; prereq 3132 or #; A-F only; PEL) Wiese-Bjornstal
Developmental aspects of movement skill learning across life span, emphasizing processes underlying skill changes.

**Kin 5135. Motor Learning and Human Performance.** (3 cr; prereq 3135 or #; A-F only; PEL) Hancock
Theories of movement skill learning, coordination, and control, with applications to human performance.

**Kin 5136. Psychology of Coaching.** (3 cr)
Wiese-Bjornstal
Psychological aspects of coaching, including leadership and communication skills, motivation, and mental skills training for performance enhancement.

**Kin 5140. Biomechanics of Sport Safety.** (3 cr; prereq undergrad kin major) Stoner
Forces and torques developed in sports activities; tolerances of the human body: techniques for preventing injury; design of protective equipment.

**Kin 5141. Nutrition for Exercise and Physical Performance.** (3 cr; prereq 3115 or FScN 1612 or equiv) Leon, Serfass
Application of basic nutritional principles to active populations; current issues related to dietary modifications for possible improvement of physical performance; strategies for educating clientele about nutrition and physical performance.

**Kin 5151. Curriculum Implementation.** (3 cr; prereq admission to initial licensure or Med PE prog or #; PEL)
For initial licensure students and those without previous teaching experience; objectives, organization, task analysis, teaching styles, and assessment.

**Kin 5152. Curriculum Development.** (3 cr; prereq admission to initial licensure or Med PE prog or #; PEL)
Trends, issues, and problems at selected levels of interest: elementary, secondary, junior college; for beginning and experienced teachers.

**Kin 5163. Developmental Motor Assessment.** (3 cr; PEL) Burton
In-depth view of concepts, problems, and issues in assessment of motor functioning of children who may be handicapped or nonhandicapped, including critical survey of existing assessment tools and experience in developing specific assessment tool.

**Kin 5170. Foundations of Kinesiology.** (3 cr; prereq grad student or Med student) Wade
Establishment of guidelines for individual and group professional action; examination of pertinent social forces, educational philosophies, and general ethics.

**Kin 5328. Proseminar: International and Comparative Sport and Physical Education.** (4 cr; prereq 3131 or #) Krotee
Secondary literature detailing and interpreting development and cultural integration of sport and physical education in global marketplace.

**Kin 5371. Sociology of Sport.** (4 cr, §Soc 5371; prereq kin major or #) Krotee
Sport within and among societies and nations; social organizations: socioeconomic development, contemporary structure, personnel, fans; relationship to other institutions: economy, education, family, government, religion; social differentiation: status, ethnicity, gender, age; careers; ethical and social problems: honesty and violence.

**Kin 5375. Competitive Sport for Children and Youth.** (3 cr) Wiese-Bjornstal
Cognitive, behavioral, and biological factors affecting competitive sport participants from early childhood through high school. Emphasis on translating sport science research into practical applications for youth sport coaches, teachers, and administrators.

**Kin 5380. Computer Applications in Kinesiology.** (3 cr; prereq kin major or #)
Potential uses of computers in testing and research; introduction to hardware selection, interfacing of computers and data acquisition devices, and management of data for analysis and presentation.

**Kin 5385. Exercise for Special Populations.** (3 cr; prereq undergrad physiology or biol; PEL) Leon
Problems associated with exercise for persons with conditions or diseases such as arthritis, cancer, diabetes, mental disorders, obesity, old age, or paralysis. Recommended exercise prescriptions and potential benefits for special populations.

**Kin 5387. Detection and Prevention of Coronary Heart Disease.** (4 cr; prereq 3386 or equiv or #) Leon, Serfass
Introduction to causes, detection, and prevention of major cardiovascular disease emphasizing risk factor identification and modification, role of exercise in prevention, and measurement and interpretation of exercise electrocardiograms.
Kin 5388. Exercise Testing, Conditioning, and Cardiac Rehabilitation. (4 cr; prereq 3386 or equiv, 5387 or #; A-F only for day-school students) Leon, Serfass: Administration and interpretation of exercise tests, cardiopulmonary resuscitation, and exercise prescription; survey of exercise programs for apparently healthy adults and CHD patients; familiarization with principles for establishment of intervention and rehabilitative programs.

Kin 5389. Practical Experience in Graded Exercise Testing, Prescription, and Direction. (3-6 cr [max 6 cr]; prereq 5388 or #; Serfass): Supervised on-site training in testing, prescription, and direction of programs for adults.

Kin 5455. Recreational Sports. (3 cr, §Rec 5455; prereq kin or rec major or #; Anderson): Programming and participation; in-depth view of foundations, programs, and operational considerations.

Kin 5460. Foundations of Sport Management. (3 cr, §Rec 5460; prereq kin or rec major or #; Anderson, Kane): Principles of sport management and fitness, including theories and techniques in marketing, administration, and management of sport enterprises. Organizational theory and policy, with practical examples of sport management skills and strategies.

Kin 5510. Women in Sport and Leisure. (3 cr, §Rec 5510) Kane: Historical, cultural, philosophical, and sociopsychological factors that have shaped the growth and development of women’s involvement in sport and leisure; obstacles to full involvement.

Kin 5521. Pedagogy I: Elementary Physical Education. (6 cr; prereq initial licensure or MEd student; PEL): Class planning, structuring, communicating, and managing; evaluating role of K-6 physical educator in diverse settings.

Kin 5522. Pedagogy II: Secondary Physical Education. (6 cr; prereq initial licensure or MEd student; PEL; Spletzer): Class planning, structuring, communicating, and managing; evaluating role of grade 6-12 physical educator in diverse settings.

Kin 5530. Biological and Physical Foundations of Education. (2 cr; prereq student in foundations of educ or educ tchr licensure program; PEL) Burton: Overview of biological and physical development from birth through adulthood and relationship of this development to education.

Kin 5540. Technology in Sport and Physical Education. (3 cr; prereq kin major or #; Current technology for developing materials for physical education and sports science; software and video reviewed and evaluated.

Kin 5561-5562-5563. Clinical Experience I-II-III: Physical Education. (6,6,9 cr; prereq admission to initial licensure or MEd PE prog or #, 5521, 5522; 5561 is S-N only; PEL; Spletzer: supervised observation and teaching in school physical education; 5562 and 5563: supervised teaching only.

Kin 5620. Advanced Athletic Training. (3 cr; prereq 3114, CBN 1027, kin major or #; PEL; Broxterman, Mays): Overview of problems (recognition, evaluation, assessment techniques) related to athletic injuries. Clinical instruction in advanced athletic training techniques and implementation.

Kin 5720. Topics in Kinesiology. (1-12 cr [max 12 cr]; prereq #): Current issues related to kinesiology and applied activities.

Kin 5740. Workshop: Coaching of Individual, Dual, or Team Sports. (1-12 cr [max 12 cr]; PEL): Instruction at advanced level, including analyses of skills, game strategies, specific techniques of coaching, and methods of training and conditioning.

Kin 5860. Legal Aspects of Sport and Physical Activity. (4 cr; §Rec 5860; prereq 3143 or 5460 or Rec 3550, kin or rec major or #): Survey of legal considerations involved in sport and physical activity programs in schools, colleges, and the private sector.

Kin 5980. Research Methodology. (3 cr, §Rec 5980; prereq kin or MEd student or #; PEL): Methods and design for research in kinesiology, and leisure studies.

Kin 5983. Readings: Kinesiology. (Cr ar [max 9 cr]; prereq educ or grad student, #): Independent study under tutorial guidance.

Kin 5985. Applications of Research. (3 cr; prereq educ or grad student; PEL; Stoner): Strategies and techniques for applying and interpreting research related to physical education in public school setting.

Kin 8126. Seminar: Psychological and Sociological Dimensions of Physical Activity. (3 cr; prereq 5126 or #; Krotee, Wiese-Bjornstal): Analysis of current literature, theoretical constructs, research methodology and design relative to these dimensions of physical activity; focus primarily on student-selected problems.

Kin 8128. Psychology of Sport. (3 cr; prereq 5126 or equiv or #; Wiese-Bjornstal): Emergence of field of sport psychology, current research methodologies, and advanced theory and research.

Kin 8132. Seminar: Motor Development. (4 cr; prereq 5132 or equiv, stat course or #; Burton, Wade): Review and critique of contemporary research literature focusing on motor skill development from before birth to adolescence, emphasizing interaction between physical constraints, environmental constraints, and coordination and control of movement.
Kin 8135. Seminar: Motor Learning and Human Performance. (3-9 cr [max 9 cr]; §8330; prereq 5130 or 5135 or #; offered alt yrs) Hancock, Wade
Advanced reading and discussion of research on specialized topics in the field.

Kin 8320. Seminar: Biomechanics. (3-9 cr; prereq 5120)
Application of one or more techniques of analysis to an individually selected problem.

Kin 8381. Exercise Physiology: Research Techniques. (3 cr; prereq 5980 or #) Serfass
Demonstration and student participation in lab procedures involving assessment of exercise parameters.

Kin 8382. Biomechanics: Research Techniques. (3 cr; prereq 5120 or #)
Lab course: developing expertise in techniques used for biomechanical research in human motion.

Kin 8607. Comparative Physical Education and Sport. (4 cr; prereq Educ 5603 or #) Krotee
Comparative analysis of selected physical education and sport delivery systems and structures. Physical education and sport policies, practices, systems, and management of prominent sporting countries and of lesser developed nations. Sociocultural impact and issues concerning conduct of sport.

Kin 8980. Graduate Research Seminar. (1-9 cr; prereq #; S-N only) Burton, Hancock, Krotee, Leon, Serfass, Wade, Wiese-Bjornstal
Reporting and discussion of student and faculty research activity. Required of all M.A. and Ph.D. candidates.

Kin 8981. Research Problems. (Cr ar; prereq 8980 or #; S-N only)
Individual problems.

Recreation, Park, and Leisure Studies (Rec)

Rec 5100. Foundations of Recreation. (3 cr; prereq MEd or grad student or #) Kane, Schultz
Investigation of the historical, sociological, and educational bases of the recreative use of leisure in contemporary society.

Rec 5111. Sport Facilities. (3 cr, §Kin 5111; prereq kin or rec major or #) Anderson
Planning areas and facilities for athletics, physical education, and sport; emphasizing current trends and problems.

Rec 5160. Recreation Land Policy. (3 cr; prereq 1520 or 5100 or #) McAvoyst
Environmental considerations in relation to recreation and leisure services.

Rec 5190. Commercial Recreation. (3 cr; prereq 3550 or #) Schultz
Survey of the scope and development of profit-making recreation agencies, facilities, and services.

Rec 5210. Introduction to Therapeutic Recreation. (3 cr; prereq 1520 or ¶5100, rec major or #) Tabourne
Range of approaches and settings in which services are delivered to meet physical, emotional, cognitive, and social needs of persons with disabilities and other special populations.

Rec 5220. Therapeutic Recreation Services. (3 cr; prereq 5210 or #, rec major) Tabourne
In-depth analyses and application of techniques for comprehensive program design, best practices and protocols, and outcomes of participant, client, patient, and program management.

Rec 5230. Recreation and Persons With Developmental Disabilities. (4 cr; prereq 5210 or #) Schleien
Issues relating to leisure services for persons with developmental disabilities; approaches to programming in the institution and in the community.

Rec 5235. Leisure and Mental Health. (4 cr; prereq 5210, Psy 3604 or Psy 5604 or #) Tabourne
Role of leisure in preserving mental health and in intervening or reducing effects of mental illness; techniques of program design and assessment of benefits.

Rec 5240. Recreation and Aging. (4 cr; prereq 3540 or 5100 or #) Tabourne
Issues surrounding aging; theories supporting program design and delivery; procedures for therapy, leisure education, and counseling; and techniques for selecting choices of activities for leisure participation in home, community, outpatient, and clinical settings.

Rec 5250. Financing Leisure Services. (3 cr; prereq 3550 or #)
Methods and techniques of financing operations and capital improvements in public park and recreation agencies and non-public community leisure services; examination of sources of revenue, budgeting procedures.

Rec 5255. Leisure Education for Special Populations. (3 cr; prereq 5220 or #) Tabourne
Instruction, counseling, and other methods of education for awareness of leisure, self-in-leisure, leisure-related problem solving and decision making, and access to leisure services.

Rec 5270. Community Leisure Services and Persons With Disabilities. (4 cr; prereq 1520, rec major or #) Schleien
Concepts and techniques of normalization; least restrictive environment strategies to include recreation service delivery in community settings for persons with disabilities.

Rec 5288. Grant Writing in Human Services. (4 cr) Schleien
Identify, develop, and procure financial assistance for programs in human services, including education, recreation, and social programs. Strategies for preparing competitive proposals for grant support through federal agencies, private foundations, and corporations.
Rec 5299. Assessment and Evaluation in Leisure Services. (4 cr; prereq 1520 or #) Schleien
In-depth study and application of approaches to assessment and program evaluation in human services; introduction to research methods.

Rec 5300. Adventure Education. (3 cr; prereq sr, 1520 or 5100 or #) McAvoy
Classroom and fieldwork activities dealing with rationale and methods for experiential education and adventure programs; analysis and experience in adventure activities (initiative games, climbing walls, outdoor adventure trips) focusing on communication, trust, team building, self-discovery, risk taking, leadership development.

Rec 5310. Programming Outdoor and Environmental Education. (4 cr) McAvoy
Methods and materials for developing and conducting outdoor education, environmental education, and interpretation programs; emphasis on development of practical skills.

Rec 5350. Wilderness Outdoor Recreation Programming. (4 cr; prereq 3150) McAvoy
Exploration of leisure and educational resources of wilderness and management of wilderness-based outdoor recreation and outdoor education programs.

Rec 5455. Recreational Sports. (3 cr, §Kin 5455; prereq kin or rec maj or #) B Anderson
In-depth analysis of processes and benefits of recreational sports programming and participation.

Rec 5460. Foundations of Sport Management. (3 cr, §Kin 5460; prereq kin or rec maj or #) B Anderson
Principles of sport management and fitness areas, including theories and techniques related to marketing, administration, and management of sport enterprises. Organizational theory and policy, with practical examples of sport management skills and strategies.

Rec 5510. Women in Sport and Leisure. (3 cr, §Kin 5510) Kane
Historical, cultural, philosophical, and sociopsychological factors that have shaped the growth and development of women's involvement in sport and leisure; obstacles to fuller involvement.

Rec 5630. Practicum: Therapeutic Recreation. (3-9 cr; prereq recreation M.Ed or grad student; S-N only) Schleien, Tabourne
Supervised field-based experience in program operation; administrative and supervisory duties.

Rec 5640. Practicum: Leisure Services. (3-9 cr; prereq recreation M.Ed or grad student; S-N only) McAvoy, Schultz
Supervised experiences in program operation; administrative and supervisory duties.

Rec 5695. Practicum: Sport Management. (3-9 cr; prereq recreation M.Ed or grad student or sport mgmt maj or #) Anderson, Kane
Theory and application of principles in developing and managing sport programs, including supervised experiences in program operation.

Rec 5750. Legal Issues in Leisure Services. (4 cr; prereq 3550 or #)
Basic legal considerations in delivery of leisure services in public and private sectors.

Rec 5860. Legal Aspects of Sport and Physical Activity. (4 cr, §Kin 5860; prereq 3550 or 5460 or Kin 3143, kin or rec maj or #)
Survey of legal considerations involved in sport and physical activity programs in schools, colleges, and the private sector.

Rec 5900. Workshop: Contemporary Issues in Leisure Services. (1-12 cr [max 12 cr])
Contemporary issues emphasizing administrative and supervisory functions for recreation and allied professionals; individual offerings focus on special issues and/or professional groups.

Rec 5980. Introduction to Research. (3 cr, §Kin 5980; prereq M.Ed or grad student or #) Kane
Basic techniques; emphasis on social research methodology; survey of present status of recreation and park research.

Rec 5981. Problems. (Cr ar; prereq M.Ed or grad student or #)
Independent study in recreation, park, and leisure services under faculty supervision.

Rec 5983. Readings: Recreation. (1-3 cr; prereq M.Ed or grad student or #)
Independent study under tutorial guidance.

Rec 8310. Seminar: Recreation and Park Administration. (1-9 cr; prereq #)
Critical study and special problems in recreation, park, and leisure studies.

Rec 8320. Seminar: Theoretical Perspectives of Leisure Behavior. (3 cr; prereq 5100 or #) Kane
Analysis, synthesis, and evaluation of major theoretical paradigms of leisure from social and behavioral sciences in general and leisure science in particular. Examination and development of strategies for application of these theories and research findings.

Rec 8370. Seminar: Administrative Problems in Therapeutic Recreation. (3 cr; prereq 5220 or #) Schleien, Tabourne
Examination of organizational patterns, legal aspects, interdepartmental relationships; discussion and case study approach.

Rec 8380. Seminar: Administrative Problems in Recreation and Parks. (3 cr; prereq 3550 or equiv) Schultz
Investigation of legal, financial, personnel, public relations, political, and philosophical problems in management of federal, state, and local government agencies; discussion and case study approach.

Rec 8980. Seminar: Research Problems. (1-3 cr per qtr [max 3 cr]; prereq 5980 or #) Schultz
Designing, reporting on individual problems. Required of all M.A. and Ph.D. candidates.

Rec 8981. Research Problems. (Cr ar; prereq 8980 or #) Individual problems.
Landscape Architecture (LA)

Professor: Joan Nassauer, head; Roger B. Martin, director of graduate studies; Roger D. Clemence; John F. Hart; William R. Morrish; David G. Pitt

Associate Professor: Lance M. Neckar; Peter J. Olin; Robert D. Sykes

Assistant Professor: Susan M. Galatowitsch; John A. Koepke

Adjunct Assistant Professor: Deborah Karasov

Lecturer: Robert J. Gunderson; Barbara Lukermann

Research Associate: David W. Lime

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

Degrees Offered—M.L.A. and M.S. (Plan A only).

Curriculum—The M.L.A. prepares students to practice as registered landscape architects. It is a professional degree in an accredited program. Students without previous design experience can expect to take three years to complete the degree; students with advanced standing can expect to take two years.

The M.S. degree program is research-oriented and allows students to focus on specialized areas of landscape architecture. It is a 44-credit program for students with a clear research focus and takes about two years to complete. Students specialize within areas of faculty expertise, which include art and landscape architecture, landscape ecology, landscape architectural history, landscape architectural theory, rural and suburban landscape planning, landscape reclamation, waterway planning and design, landscape perception studies, and transportation design. Prospective students may request a summary of faculty research for a comprehensive description of potential specializations.

Prerequisites for Admission—M.L.A. program applicants must have completed a baccalaureate degree. M.S. program applicants must have completed a baccalaureate degree in landscape architecture or a related discipline. All applicants will also be asked to explain the relationship of their previous academic work and work experience to their proposed graduate study.

Special Application Requirements—M.L.A. program applicants must apply by January 15 for entry the following fall. The department requires the following materials: a letter of intent, which includes whether or not the applicant is interested in financial aid; three letters of reference; a photocopy of official transcripts; and examples of creative work. Applicants with degrees in related design professions such as architecture or planning should clearly indicate in their letter of intent an interest in being evaluated for advanced standing in design. The Graduate Record Examination (GRE) is not required for entry but can be helpful to applicants applying for fellowships.

M.S. program applicants must apply by January 15 for entry the following fall. The department requires the following materials: GRE scores; a statement of intent outlining research objectives that also includes whether or not the applicant is interested in financial aid; and examples of previous research and/or design work related substantively or methodologically to the applicant’s proposed research, or examples of academic or professional work that includes 10 to 30 pages of writings, published or unpublished. Successful applicants will have secured the participation of a faculty adviser before completing their applications.

Degree Requirements—M.L.A. students without previous design experience must take 129 credits of coursework, of which 121 are graduate credits. Students with advanced standing in other design disciplines normally must take 90 graduate credits. The core curriculum for both is 54 credits of studio, with one studio required each quarter. Students also take four technology courses, two landscape architectural history courses, and courses in planting design, geographic information systems, ecology, professional practice, and graphics. A total of 16 credits in seminars and in advanced coursework in other disciplines is also required, as is LA 8200 and a research colloquium series.

Applicants who have completed an accredited, professional bachelor’s degree in landscape architecture may complete the M.L.A. degree with 44 graduate credits, including 18 credits of landscape architecture studio courses, the 5 credit research methods course (8200), 1 credit of the research survey course (8820), and 8 credits of coursework outside the department. Up to 12 credits earned as part of the M.L.A. may be applied to the M.S.
The M.S. requires 44 graduate credits, which includes a minimum of 7 credits in landscape architecture, 16 credits for a Plan A thesis, and a minimum of 8 credits in an area of focus outside of landscape architecture. M.S. students are also required to take a 5-credit course on research issues and methods and a colloquium series.

Language Requirement—None.

For Further Information and Applications—Contact the Department of Landscape Architecture, University of Minnesota, 125 Architecture Building, 89 Church Street S.E., Minneapolis, MN 55108 (612/625-6860; fax 612/625-7525).

LA 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

LA 5131. Directed Studies in Landscape Architecture History and Theory. (1-6 cr; prereq LA student or Δ; A-F only)
Advanced independent studies.

LA 5133. Directed Studies in Landscape Architecture Technology. (1-6 cr; prereq LA student, Δ; A-F only)
Advanced independent studies.

LA 5134. Directed Studies in Emerging Areas of Landscape Architecture. (1-6 cr; prereq LA student, Δ; A-F only)
Advanced independent studies in areas of student’s choice.

LA 5140. Interdisciplinary Studies in Landscape Architecture. (2-6 cr per qtr [max 18 cr] prereq #; A-F only)
Research, planning, and/or design project. Topics may include energy efficient design, historic preservation, downtown revitalization, agricultural land use, computerized land-use planning, housing.

LA 5200. Directed Studies in Landscape Architecture Design. (1-6 cr, §5132; prereq #; A-F only)
Advanced independent studies.

LA 5201. Field Techniques for Landscape Analysis. (3 cr; prereq LA grad student or BED student or Δ; A-F only)
Vegetation, soil, and landform description. Applying techniques to agricultural, urban, and natural landscapes. Includes one-week session at Lake Itasca Forestry and Biological Station before fall term and weekly field trips during fall term.

LA 5202. Landscape Ecology. (3 cr; prereq ecology course or #; A-F only)
Relationships among spatial patterns, temporal patterns, and ecological processes in landscapes. Factors affecting landscape pattern, measurement of landscape pattern, material transport through landscapes, effects of landscape pattern on population dynamics, and landscape planning.

LA 5211. Making Landscape Space. (6 cr, §3081; prereq BED or BLA student or Δ; A-F only)
Design exploration using three-dimensional models to make outdoor space for human habitation and use, with landforms, structures, and plants. Development of form vocabulary to provide spatial order. Use of metaphorical thinking to imbue designed space with meaning.

LA 5212. Ecological Informants of Design. (6 cr, §3082; prereq 5211; A-F only)
Draws on landscape ecology, aesthetics, and design arts to help students select and analyze ecological phenomena that influence function and human experience of landscape and to use fundamental aesthetic principles to portray those phenomena in design.

LA 5213. Making Landscape Types. (6 cr, §3083; prereq 5211; A-F only)
Theory, precedents, and practice in making fundamental space types in professional landscape architecture. Order, form, and meaning in designing discrete landscape types and types in combination.

LA 5221. Planted Form. (5 cr; prereq 5211, 5213; A-F only)
Lectures, presentations, field trips, readings, and projects exploring design principles related to using plants in the landscape. Explores cultural and ecological principles through design projects of various scales.

LA 5228. Seminar: Topics in Campus Planning. (4 cr; prereq 3093 or #; A-F only)
Lectures, discussion, presentations, field trips, readings, and paper. Contemporary and historic issues in campus planning, use of energy-efficient buildings, efficient land use, and site planning.

LA 5431. History of Landscape Architecture: Individual Influences. (4 cr, §5265; prereq 3413; A-F only) Neckar
Lectures, presentations, field trips, readings, papers, and/or projects. Assessment of influences of individuals on formation of the profession, 1800-present.

LA 5562. Introduction to Geographic Information Systems. (4 cr; prereq jr or sr or grad major in Geog or LA or #; A-F only) Nassauer
Theory and applications for landscape location and resource analysis and regional planning. Location principles, data structure, variable attributes.

LA 5571. Landscape Construction: Landform Systems. (4 cr, §3065; prereq 5211 or #; A-F only)
Theory and professional applications of landform systems for design. Landform typology, representation methods, manipulation techniques, use of survey data, and earthwork construction issues. Landscape integrity assurance and economic performance.

LA 5572. Landscape Construction: Spatial Performance. (4 cr, §5063; prereq 5211 or #; A-F only) Sykes
Theory and application of appropriate standards, proportions, and dimensions for spatial performance in landscape architecture; spatial accommodation of people and automobiles in landscape applications; land use and development controls.
LA 5621. Professional Practice. (4 cr; §5226; prereq terminal yr of study; A-F only)
Office and project management analyzed using case studies. Organizational behavior, marketing, sales, strategic planning, financial and cost accounting, insurance, legal issues and contracts.

LA 5810. Visions of Paradise: Garden Design and the Good Life. (4-6 cr; prereq LA or Arch or BED student or #; A-F only)
Theoretical inquiry and studio exploration into the art of garden design as a lamp to illuminate ideals for living. Aristotelian and Objectivist thought on art and happiness as a whole good life provide the foundation for exploration and artistic expression.

LA 5911. Urban Design Journal. (4.5 cr; prereq admittance to Denmark International Study program; given in Denmark)
Methods and theories in urban design and human behavior. Students develop journal as tool for experiencing, analyzing, and recording the urban landscape, its fabric, spatial elements, and individual components, and for analyzing design solutions.

LA 5912. Landscape Architecture Studio. (9 cr; prereq admittance to Denmark International Study program; given in Denmark)
Individual and small-group projects focusing on urban issues; design process in Danish conditions; solutions based on knowledge of Danish problems in landscape and urban design and an understanding of how these problems are solved within Danish and European context.

LA 5913. Landscape Architecture, Architecture, and Planning. (4.5 cr; prereq admittance to Denmark International Study program; given in Denmark)
Methods and theories in urban design and human behavior. Students develop urban design journal as tool for experiencing, analyzing, and recording the urban landscape, its fabric, spatial elements, and individual components, and for analyzing design solutions.

LA 8110. Graduate Landscape Planning and Design. (6 cr; prereq 5101, 5103, 5015 or 5107, grad student; A-F only)
Studio experience in comprehensive landscape planning, or design project in area of student’s choice.

LA 8111. Directed Studio in Landscape Architecture. (6 cr; prereq 8222, grad student; A-F only)
Studio experience in comprehensive project execution in landscape planning, or design in area of instructor’s specialty.

LA 8200. Landscape Architectural Research Issues and Methods. (5 cr; §8281, §8282; prereq LA student or #; A-F only)
Alternative methodological approaches to landscape architectural research and their appropriateness to contemporary research topics.

LA 8221. Design of Landscapes for Dwelling. (6 cr; §3091; prereq 5213, 5572, LA student or #; A-F only)
Design studio. Theory and applications of the meaning of home, dwelling, and associated human behavior issues related to professional design of residential landscape architecture. Studies range from individual home landscapes to neighborhoods as dwelling places.

LA 8222. The Landscape Architectural Design of Community Places. (6 cr, §3092; prereq 8221, LA student or #; A-F only)
Design studio. Public places as settings for the gathering of people. Historical precedent used as idea resource for designing streets and outdoor public gathering spaces in context of mixed-use urban and suburban settings.

LA 8223. Regional Landscape Design. (6 cr, §5107; prereq 5562 or FR 5130 or Geog 5562 or PA 5562, 8222, LA student or #; A-F only)
Design exploration of landscape ecology, landscape perception, and public policy as informants of design decision making in regional landscapes at or exceeding a township level. Geographic information systems used as design tools.

LA 8231. Urban Landscape Design. (6 cr, §5103; prereq LA student or #; A-F only)
Advanced design studio exploring urban and landscape design principles through analysis of case studies and development of strategies from landscape systems within the urban environment.

LA 8232. Design of Recreational Landscapes. (6 cr, §5105; prereq 8223; 2 lect, 10 lab hrs per wk; A-F only)
Design studio. Analysis, development, and presentation of designs for diverse recreational landscapes.

LA 8233. Special Problems: Design Proposal. (2 cr, §5109; prereq 8223 or 8231; A-F only)
Individual research resulting in proposal for capstone project to be developed in LA 8234.

LA 8234. Advanced Landscape Planning and Design. (6 cr, §5110, §8110; prereq LA grad student in terminal qtr of study; A-F only)
Advanced studies in area of student’s choice.

LA 8500. Landscape Architecture Research Project. (1-6 cr; prereq 8283 or #; A-F only)

LA 8573. Landscape Construction: Structural Systems. (4 cr, §3067; prereq 5123, LA student or #; A-F only)
Lectures, projects, and exercises on professional design of pavements, enclosures, and decks. Theory and principles of structural design, properties and use of materials, construction communication. Landscape integrity and economic viability as performance issues.
LA 8574. Landscape Construction: Mechanical Systems. (4 cr, §3069; prereq 8221, LA student or #: A-F only)
Lectures, projects, and exercises on landscape architectural applications of storm water management, urban utilities, irrigation, and electrical and lighting systems and techniques. Systems planning and design; historical precedents; professional design communication; landscape construction, integrity, and performance issues.

LA 8600. Landscape Architecture Education. (1-4 cr; prereq MLA candidate or #: A-F only)
Planning and execution of undergraduate landscape architecture course under direct supervision of a course instructor.

LA 8801. Concepts of Landscape Evaluation. (4 cr, §8330; prereq LA student or #: A-F only)
Nassauer
Philosophical basis for wide-ranging approaches to evaluating qualitative aspects of landscape. Emphasis on aesthetic factors and integration of landscape evaluation into regional design decision making.

LA 8802. Perception Manipulation in Design of Exterior Space. (4 cr, §8320; prereq LA or Arch grad student or #: A-F only)
Martin
Historic and modern design devices that alter sense of spatial control and arrangement to create illusionary situations in exterior environment. Readings, lectures, and research projects inform and test principles of perception distortion in exterior space.

LA 8803. The Sublime, the Beautiful, and the Picturesque: Theory and Practice. (4 cr, §8370; prereq LA or Arch grad student or 3411 or 5431; A-F only)
Neckar
Reading, discussion, and research paper on 18th- and early 19th-century theoretical bases for landscape design. Analysis of executed designs, theoretical relationships to current design issues.

LA 8804. Landscape Ecology and Design. (4 cr, §8390; A-F only)
Nassauer
Readings, discussion, and field investigations to establish a landscape ecological basis for designing ecosystems as part of human settlement. Design and planning implications of scientific conclusions and theory: meaningful techniques for creating high-functioning ecosystems in inhabited landscapes.

LA 8820. Survey of Landscape Architecture Research. (1-3 cr, §8284; prereq LA student; S-N only)
Nassauer
Critical review of invited lectures and discussion on current topics.

Latin
See Classical and Near Eastern Studies.

Law
Professor: Daniel A. Farber, director of graduate studies: Carl A. Auerbach; Stephen F. Befort; Karen B. Brown; David Bryden; Laura Cooper; John J. Cound; Barry C. Feld; Mary L. Fellows; Richard S. Frase; Philip P. Frickey; Daniel J. Gifford; Joan S. Howland; Robert E. Hudec; William D. Kilbourn, Jr.; K. Bart Koeppen; Victor H. Kramer; Maury S. Landsman; Robert J. Levy; Donald G. Marshall; John H. Matheson; C. Robert Morris; Fred L. Morrison; Steve H. Nickles; Roger C. Park; John a. powell; M. Kathleen Price; Stephen B. Scallen; Ferdinand P. Schoettle, Jr.; Suzanna Sherry; Robert A. Stein; Michael Tonry; Gerald Torres; Thomas L. Waterbury; David Weissbrodt; Judith T. Younger

Associate Professor: Edward S. Adams; Karen C. Burke; Ann M. Burkhard; Jim C. Chen; Carol L. Chomskey; Tahirih V. Lee; Michael S. Paulsen; Susan M. Wolf

Clinical Professor: Beverly Balos; Kathryn J. Sedo; Stephen M. Simon; Carl M. Warren

Research Associate: Keith Bellairs

Course of Study—Minor in law, applicable to master’s (M.A. and M.S.) and doctoral programs.

For Further Information and Applications—Contact Meredith M. McQuaid, Assistant Dean of Students and Director of International and Graduate Programs, Law School, University of Minnesota, 285 Law Building, 229 19th Avenue South, Minneapolis, MN 55455 (612/625-3025; fax 612/626-1874).

Liberal Studies (LS)
Professor: Ronald R. Aminzade (sociology); Frederick M. Asher (art history); Kent Bales (English); Terence W. Ball (political science); Subir Banerjee (geology and geophysics); Darrell R. Lewis (educational policy and administration); Paul T. Magee (genetics and cell biology); Toni A. H. McNaron (English); David W. Noble (American studies); Robert J. Poor (art history); Dwight H. Purdy (English); Harvey B. Sarles (cultural studies and comparative literature); Naomi B. Scheman (philosophy)

Associate Professor: William E. Adams (German, Scandinavian, and Dutch), director of graduate studies; Catherine E. B. Asher (art history); Kevin Dooley (mechanical engineering); Roger S. Jones (physics and astronomy); Nita Krevans (Classical and Near Eastern studies); Judith A. Martin (Center for Urban and Regional Affairs); Carol A. Miller (American studies); David V. Taylor (General College)

Adjunct Associate Professor: Nicholas Hayes

Assistant Professor: C. Victor Fung (General College)

Lecturer: Carol M. Bly (English); Stephen L. Daniel (University College); Sarah M. Dennison (University College); DonnaMae J. Gustafson (University College); John

1 University of Minnesota, Morris
Haaland (University College); Alan R. Kahn 2 (University College); Judith Katz (University College); Roseann Lloyd (University College); Katherine Kolb Reeve (French and Italian); David A. Shape (University College)

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

Degree Offered—M.L.S.

Curriculum—The graduate major in liberal studies offers an interdisciplinary curriculum that includes four M.L.S. seminars, six elective courses, and a final project course. Although courses for the M.L.S. are scheduled mainly late afternoons and evenings, most graduate-level courses offered during the day are also open to M.L.S. students. Careful selection of courses, with the help of the student’s graduate faculty adviser, is crucial to insuring a coherently interdisciplinary program of study.

Prerequisites for Admission—In addition to a bachelor’s degree, students must indicate an ability to succeed in graduate study.

Special Application Requirements—A statement of purpose, letters of support, an undergraduate transcript, and examples of written work should accompany the application. Graduate Record Examination scores may also be submitted, but are not required.

Master’s Degree Requirements—The minimum requirement is 44 credits (normally 11 courses).

Language Requirements—None.

For Further Information and Applications—Contact University College, University of Minnesota, 306 Wesbrook Hall, 77 Pleasant Street S.E., Minneapolis, Minnesota 55455 (612/625-3898; fax 612/625-2568; e-mail jlundbla@mail.cee.tc.umn.edu).

LS 5100. Topics in Liberal Studies. (4 cr per qtr)


Goethe’s critique of Newton: its historical context and issues raised. Important phase in historical debate concerning relationship of human beings to nature.

LS 5610. Environmental Ethics, Politics, and Public Policy. (4 cr, §Pol 5610; University College only)

Moral obligations, meaning of “freedom,” responsibilities of freedom, and legitimate limits on freedom to speak and act; who and what deserves protection.

2 University of Minnesota, Duluth

LS 5910. Lively Imagination: Ethics and Aspects of Moral Thinking. (4 cr, §Engl 5910; University College only)

Considers first-rate stories and essays; effects of telling, hearing, and interpreting stories; empathy with respect to stories and stage development theory. Involves creative writing.

LS 5970. Directed Studies. (1-4 cr per qtr [max 15 cr]; prereq #, ∆)

Tutorial for qualified graduate students. Guided individual reading or study.

LS 5990. Directed Research. (1-4 cr per qtr [max 15 cr]; prereq #, ∆)

Tutorial for qualified graduate students.

LS 8000. Introduction to Graduate Liberal Studies. (4 cr; prereq MLS student or ∆)

Topic varies.

LS 8001. Final Project for Graduate Liberal Studies. (4 cr; prereq MLS student)

Linguistics (Ling)

Professor: Jeanette K. Gundel, director of graduate studies; Patricia A. Broen; Andrew D. Cohen; Michael B. Kac; Michael P. Maratsos; Gerald A. Sanders (emeritus); Joseph P. Stemberger; Elaine E. Tarone

Associate Professor: Betsy K. Barnes; Bruce T. Downing; Charles R. Fletcher; G. Lee Fullerton; Larry G. Hutchinson; Carol A. Klee; Amy L. Sheldon; Nancy J. Stenson; Polly E. Szatrowski

Assistant Professor: Michael Hegarty; Maria D. Sera

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

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

Curriculum—Areas of specialization include language acquisition (first and second), language processing, core linguistics (phonology, syntax, semantics/pragmatics), and the interface of two or more of these areas.

Prerequisites for Admission—There are no specific prerequisites for admission. Students admitted normally have a broad undergraduate background that includes some linguistics courses.

Special Application Requirements—Applicants must submit a completed application, scores from the Graduate Record Examination, three letters of recommendation, and a supplementary questionnaire detailing background, interests, and accomplishments.
Applicants wishing to be considered for financial support should apply no later than January 7 of the preceding academic year. Entry is usually in fall quarter but may be permitted in other quarters in exceptional cases.

Degree Program Prerequisites—Consult with the director of graduate studies.

Master’s Degree Requirements—Twenty-five credits in the major field, including coursework in phonetics, phonology, syntax, semantics, and field methods. Other coursework is selected in consultation with the student’s adviser.

Doctoral Degree Requirements—Same as for the master’s degree plus an individualized plan of study (including 8xxx courses) to be determined in consultation with the student’s committee. All Ph.D. students must pass preliminary written examinations in phonology, syntax, and their primary and secondary areas of concentration. Papers judged to be of publishable quality by the student’s committee can be substituted for examination questions in any of these areas.

Language Requirements—For the M.A. degree, knowledge of one language not native to the student. For the Ph.D. degree, knowledge of two languages not native to the student. Mechanisms for demonstrating knowledge are described in the program’s Information for Graduate Students.

Minor Requirements for Students Majoring in Other Fields—For the master’s degree, 5001, 5201, and 5302, or their equivalents, are required. For the doctoral degree, six courses approved by the director of graduate studies, including those required for the master’s minor, are required.

For Further Information and Applications—Contact the Program in Linguistics, Institute of Linguistics and Asian and Slavic Languages and Literatures, University of Minnesota, 190 Klaeber Court, 320 16th Avenue S.E., Minneapolis, MN 55455 (612/624-3331).

Ling 5001. Introduction to Linguistics. (5 cr, §3001; prereq grad standing or #) Phonetics, phonology, morphology, syntax, semantics, and historical-comparative linguistics; language learning and psychology of language; linguistic universals; language in society.

Ling 5002. Linguistic Analysis. (4 cr, §5201, §5302; especially recommended for nonmajors; prereq 3001 or 5001 or #) Gundel, Kac, Stenson Techniques for analyzing phonological, morphological, and syntactic data from a wide variety of languages; discovering, stating, and justifying generalizations; comparison of diverse languages.

Ling 5201-5202. Introduction to Syntax. (4 cr per qtr; prereq 3001 or 5001 or #) Gundel, Hutchinson, Kac 5201: Principles of grammar construction and evaluation; examination of syntactic phenomena in a variety of languages. 5202: Survey of modern syntactic theory.

Ling 5211. Semantics. (4 cr; prereq 5011, 5202 or #) Gundel, Hutchinson, Kac Linguistic analysis and explanation of synonymy, analyticity, presupposition, and other meaning phenomena in natural language; comparison of alternative theories of meaning.

Ling 5212. Linguistic Pragmatics. (4 cr; prereq 5002, 5201 or #) Gundel Analysis and description of linguistic phenomena in relation to beliefs and intentions of language users; speech act theory, conversational implicature, shared knowledge and presupposition, topic-comment structure, discourse coherence.

Ling 5301. Phonetics. (5 cr, §3301, §5003; prereq 3001 or 5001 or ¶5001 or #) Stemberger Production, acoustics, and perception of speech sounds; practice in production and transcription.

Ling 5302-5303. Introduction to Phonology. (4 cr per qtr; prereq 3301 or 5301 or #) Stemberger 5302: Formulation and evaluation of phonological descriptions; phonological processes in a variety of languages. 5303: Current approaches to phonological theory;metrical, autosegmental, and lexical phonology.

Ling 5401-5402. Computational Linguistics. (4 cr per qtr; prereq 3001 or 5001 or #; some programming experience helpful) Methods and issues in computer understanding of natural language. LISP and Prolog programming languages, with emphasis on their linguistic applications. Lab projects.

Ling 5503. Introduction to Applied Linguistics. (4 cr; prereq 3001 or 3005 or 5001 or #) Cohen, Downing, Stenson, Tarone Role of linguistics in neighboring disciplines; applications to practical fields such as lexicography, orthography, translation, language planning, reading, English and foreign language teaching, bilingual education, education of the deaf and correction of language disorders; computer applications; forensic applications.
Ling 5601. Introduction to Historical Linguistics. (4 cr; prereq 5001 or #)
Historical change in phonology, syntax, semantics, and the lexicon; factors underlying language change; linguistic reconstruction; genetic relationship among languages.

Ling 5602. Phonological Change and Reconstruction. (4 cr; prereq 3601 or 5601, 5302 or #)
Change in phonological systems; factors underlying phonological change; internal and comparative reconstruction in phonology.

Ling 5603. History of Linguistics. (4 cr; prereq 3601 or 5001, 5202, 5303 or #)
Examination of various objectives and methods of linguistic analysis from antiquity to the present.

Ling 5701. Introduction to Second-Language Acquisition. (4 cr; prereq 5002 or 5201, 5302, 5003 or 5301 or #) Cohen, Sheldon, Tarone
Overview of second-language acquisition and processing; implications for second-language teaching.

Ling 5702. Second-Language Acquisition. (4 cr; prereq 5701 or #) Cohen, Sheldon, Tarone
Empirical and theoretical studies of second-language acquisition and processing.

Ling 5711-5712. Field Methods in Linguistics. (4 cr per qtr; prereq #) Hutchinson, Stenson
Techniques for obtaining and analyzing linguistic data from unfamiliar languages through direct interaction with a native speaker.

Ling 5720. Topics in Second-Language Acquisition. (3-4 cr [may be repeated for cr]; prereq 3001/5001 or #)
Topics specified in Class Schedule.

Ling 5732. A Contrastive Approach to Modern English. (4 cr; prereq 3001 or 5001 or #; does not fulfill degree requirements for majors in Ling or ESL)
Grammatical structures of standard English and contrastive analysis of these structures with those of another language. Implications for learning English as a second language.

Ling 5741-5742. Linguistic Description of Modern English. (4 cr per qtr; prereq 3001 or 5001 or #) Downing, Gundel
Word and sentence structure of present-day English.

Ling 5751. Conversation Analysis. (4 cr, §Spch 5461; prereq 3001 or 5001, Spch 3401 or #)
Discourse processes involved in dyadic and multiparty conversation. Applying concepts through analysis of conversations.

Ling 5752. Field Research in Spoken Language. (4 cr, §Spch 5462; prereq 5751 or Spch 5461 or #)
Transcribing, coding, and analyzing spoken and recorded conversations.

Ling 5910. Seminar in Linguistics. (4 cr; prereq #)

Ling 5970. Directed Studies. (1-5 cr per qtr; prereq linguistics or ESL major, #, ∆, CLA approval)

Ling 8200. Topics in Syntax and Semantics. (4 cr [may be repeated for cr as topics change]; prereq 5206 or #) Gundel, Hutchinson, Kac

Ling 8210. Seminar in Syntax. (4 cr; prereq 5206, 5211 or #) Hutchinson, Kac, Stenson

Ling 8211. Formal Semantics of Natural Language. (4 cr; prereq 5011 or Phil 5201 or #) Hutchinson, Kac
Truth-conditional model-theoretic semantics applied to treatment of opacity, intensionality, quantification, and related phenomena in natural language.

Ling 8220. Seminar in Semantics. (4 cr; prereq 5211 or #) Gundel, Hutchinson, Kac

Ling 8300. Topics in Phonology. (4 cr [may be repeated for cr as topics change]; prereq 5304 or #) Stemberger

Ling 8310. Seminar in Phonology. (4 cr; prereq 5304, 5602 or #) Stemberger

Ling 8500. Seminar: Topics in Linguistics. (4 cr [may be repeated for cr as topics change]; prereq #)

Ling 8600. Topics in Historical Linguistics. (4 cr [may be repeated for cr as topics change]; prereq 5603 or #)

Ling 8731. Research Methods in Language Acquisition. (4 cr; prereq 5702 or 5805 or CDIS 5305 or CPsy 5345 or #) Cohen, Sheldon, Tarone
Critical review of research methods and design in the study of first- and second-language acquisition.

Ling 8820. Topics in Language and Cognition. (4 cr; prereq 5001 or #) Gundel, Stemberger
Language-related issues in cognitive science from linguistic perspective.

Ling 8900. Independent Study. (1-5 cr per qtr; prereq linguistics major, #)
Related courses in other departments may be elected as part of a linguistics major with the approval of the director of graduate studies.

Luso-Brazilian Literature
See Hispanic and Luso-Brazilian Literatures and Linguistics.
Management of Technology (MOT)

Regents’ Professor: Vernon W. Ruttan (applied economics)

Professor: Yechiel Shulman (mechanical engineering), director, Center for the Development of Technological Leadership, and co-director of graduate studies; Mary Nichols (strategic management and organization), co-director of graduate studies; Carl R. Adams (information and decision sciences); Sandra O. Archibald (public affairs); Avram Bar-Cohen (mechanical engineering); Norman E. Bowie (philosophy); Norman L. Chervany (information and decision sciences); W. Bruce Erickson (strategic management and organization); Arthur V. Hill (operations and management sciences); Ettore F. Infante (mathematics); George John (marketing and logistics management); Edward J. Joyce (accounting); Timothy J. Nantell (finance); Dennis L. Polla (electrical engineering); Subbiah Ramalingam (mechanical engineering); Donald R. Riley (mechanical engineering); Kenneth Roering (marketing and logistics management); Aaron Shenhar (mechanical engineering); Andrew Van de Ven (strategic management and organization)

Associate Professor: Srinivasan Balakrishnan (strategic management and organization); Kevin J. Dooley (mechanical engineering); Karl Smith (civil and mineral engineering)

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

Degree Offered—M.S.MOT. (Plan B).

Curriculum—The management of technology program is an intensive, two-year practitioner-oriented program for experienced engineers and scientists who have achieved springboard positions in their organizations and want to manage technological activities. Students enter the program in the fall and advance as a cohort, taking a prescribed sequence of courses together, including a capstone project. Classes are held for a full day each week, on alternate Fridays and Saturdays, allowing students to carry on their full-time employment responsibilities while participating in the program. In addition to regular classes, the program includes three three-day domestic and one ten-day international residencies. Tuition and fees, books, supplies, weekly lunches, parking, a variety of services, and off-campus accommodations for all residences are included in an annual comprehensive fee. For current program costs, contact the management of technology graduate program. To maintain the atmosphere of teamwork in small groups and close contact among students, faculty, and invited lecturers, admission to the program is limited.

Prerequisites for Admission—A bachelor’s degree in engineering or in a natural science discipline from an accredited program is required. Applicants should also have completed coursework (or can show proficiency) in economics, mathematical modeling, statistics, and computer literacy.

Special Application Requirements—A minimum of five years of professional experience in the applicant’s technical field is required (in exceptional circumstances, promising candidates with less experience may be considered). Applicants are required to submit three letters of recommendation, a résumé, a statement of purpose, and Graduate Record Examination or Graduate Management Admission Test scores (if the applicant already holds a master’s or Ph.D. degree, this test requirement is waived). The professional track record of the applicant weighs heavily in the admissions process. A personal interview with the director of graduate studies is required. Admission is in fall quarter only.

Degree Requirements—in addition to course requirements, students must successfully complete an oral examination and a written report on the capstone project.

Language Requirements—None.

For Further Information and Applications—Contact the Management of Technology Graduate Program, Center for the Development of Technological Leadership, University of Minnesota, 107 Lind Hall, 207 Church Street S.E., Minneapolis, MN 55455 (612/624-5747; fax 612/624-7510; e-mail MOT@cdtl.umn.edu).

MOT 8111. Marketing Management in Technology-Based Organizations. (4 cr, §MBA 8045; prereq MOT student) Roering
Emphasizes marketing of industrial products. Overall consideration of marketing strategy. Issues of product strategy, including pricing, promotion, product mix, and sales and distribution decisions.
MOT 8112. Management Accounting. (4 cr, §MBA 8035; prereq MOT student) Joyce
Introduction to methods for estimating and analyzing product costs and using cost information for product mix and pricing decisions. Cases from manufacturing firms used for understanding principles of activity-based costing. Uses of cost data in managerial decision making, budgeting and control, and financial statement analysis.

MOT 8113. Manufacturing for Competitive Advantage. (4 cr, §MBA 8050, §OMS 5100; prereq MOT student) Hill
Overview of manufacturing functions and impact of manufacturing on competitiveness of firm. Strategic framework used to describe key relationships between operations and other functions in value chain (e.g., design, marketing, distribution) and to show how decisions within operations can be integrated to achieve strategic objectives. Product/process design, production, workforce issues, and role of technology.

MOT 8121. Managing in a Technical Environment. (4 cr; prereq MOT student) Erickson
General management principles, with applications to management of professional, research and development, and technical personnel. Discussion, readings, cases, and projects.

MOT 8122. Financial Management for Technology-Based Organizations. (5 cr, §MBA 8040; prereq MOT student) Nantell
Development of concept of creating value with the organization. Use of financial methods most important to managers of technology-based organizations, including capital budgeting, projection of financial needs, and management of working capital.

MOT 8131. Problem Formulation and Managerial Decision Making. (2 cr, §MBA 8070; prereq MOT student) Adams
Basic characteristics of managerial decision making and concept of bounded rationality. General approach to definition of unstructured problems frequently encountered by higher-level management. Specific methods for problem expansion based on different lines of reasoning, such as cause-effect and systems thinking.

MOT 8132. Quality Control and Management. (4 cr, §IEOR 5030; prereq MOT student) Dooley
Concepts, methodologies, and techniques used to continuously improve quality and productivity of products and services. Managerial and technical aspects. Evolution of quality function, definitions of quality, conceptual contributions to quality management, quality as an operational strategy, statistical process control, fault diagnosis, design of experiments, reliability, and quality in product development process.

MOT 8133. Communications in a Technical Environment. (4 cr; prereq MOT student)
Oral and written communications. Introductory and specialized workshops. Memo writing, presentation skills, visual aid design and integration.

MOT 8134. Support and Control of Manufacturing Processes. (4 cr; prereq MOT student) Ramalingam

MOT 8212. Managing Functional and External Interfaces in New Product Development. (4 cr; prereq MOT student) O'ohn
Need for and problems of organizational integration in development of product policy and execution of new product development process. Necessary organizational interactions among marketing, R & D, and operations in design and delivery of products.

MOT 8213. Business, Government, and Macroeconomics. (4 cr, §MBA 8055; prereq MOT student) Erickson
Business-government relations, especially as they affect scientific and technical issues, global competitiveness, and macroeconomic policies while they influence firms' domestic and international strategies and operations. Effects of legal and economic forces on management of firms, especially on their technical strategies.

MOT 8214. Understanding and Forecasting Technology Development. (4 cr; prereq MOT student) Van Wyk
Introduction to methods of technology assessment and forecasting, and their application to study of history of technology and industry. Technological developments and their economic, social, and industrial impacts.

MOT 8221. Project Management and Leadership. (4 cr, §OMS 8041; prereq MOT student) Shenhar, Smith
Principles and methods for planning and controlling a project, including development of a project plan, resource planning and scheduling (PERT/CPM), project monitoring, and termination. Students develop skills for managing interdisciplinary project teams.

MOT 8222. Technology Competitiveness and Development. (2 cr, §Econ 5312; prereq MOT student) Ruttan
Technical change and economic growth, sources of productivity change, economics of research and development, science and technology policy.

MOT 8223. Organizational Communication. (3 cr, §Spch 5441; prereq MOT student)
Organizations as open systems, cultures, and politicized environments. Identification and management of problems developing from integration of organization and communication. Ethics and strategies in corporate communications.
MOT 8224!. Pivotal Technologies for the 1990s. (4 cr; §ME 8701; prereq MOT student) Bar-Cohen
Guest experts present state-of-the-art in pivotal technologies and principal barriers to their commercialization. In workshops, students work in groups to develop and present concepts for applying these technologies to an industrial setting.

MOT 8231. Managing Information Resources in a Technology-Based Organization. (3 cr; §IDSc 8101; prereq MOT student) Chervany
Selection of information technologies; discussion of such issues as power and politics of information systems, trade-offs between centralization of computing (for global coordination) and decentralization (for local autonomy and innovation), role of information technology infrastructures, and information systems as competitive weapons.

MOT 8232. Managing Innovation in a Technological Environment. (4 cr; prereq MOT student) Shenhar, van de Ven
Inputs, processes, and outputs of innovation ventures as they develop from concept to implementation. Developing a “road map” to guide innovation managers. Conditions that facilitate and inhibit innovation, typical patterns of innovation development, and adoption of innovations developed elsewhere.

MOT 8233. Strategic Technology Management. (4 cr; prereq MOT student) Chakravarthy
Technology from general manager’s standpoint, as key strategic resource for building competitive advantage of a firm. Important links between technology and strategic planning. Technology and global competition; creating, acquiring, and leveraging technology competence.

MOT 8241!. Project. (4 cr; prereq MOT student) Shulman
Practicum carried out in cooperation with each student’s home organization. Background research and full development, analysis, and proposed resolution of significant issue, applying concepts and methods learned in program. Faculty adviser provides support and evaluation.

MOT 8241!. Fundamentals of Simulation Modeling. (1 cr; §IEOR 5445, §OMS 8671; prereq MOT student)
Computer simulation and hands-on work in building models using high-level simulation software.

MOT 8910. Corporate Responsibility. (2 cr; prereq MOT student) Bowie
Principles of stakeholder management. Ethical framework for responsible management of investors, employees, customers, suppliers, and external community. Moral leadership, trust in organizations, and quality control. New metaphors and techniques for managing socially responsible firm.

Mass Communication

Professor: Hazel F. Dicken-Garcia; Ronald J. Faber; Irving E. Fang; Donald M. Gillmor; Chin Chuan Lee; Daniel B. Wackman; William D. Wells
Associate Professor: Albert R. Tims, Jr., director of graduate studies; William A. Babcock; Tsan-Kuo Chang; Kenneth O. Doyle, Jr.; Kathleen A. Hansen; Nancy L. Roberts; Dona B. Schwartz
Assistant Professor: Michael S. Griffin

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

Degrees Offered—M.A. (Plan A only) and Ph.D.
Curriculum—A general mass communication M.A. is offered that emphasizes the theoretical study of mass communication and analysis of media systems. It is intended for those who wish to pursue teaching and research careers and/or a Ph.D. Individuals who have extensive professional experience in mass communication or a B.A. degree in journalism and are interested in graduate work are encouraged to enter the M.A. program.

The doctoral program offers training for academic careers primarily in communication instruction, research, or policy. Areas of specialization include communication law and regulation, media ethics, international mass communication, history of mass communication, and mass media structures, processes, and effects.

Special facilities include the Minnesota Journalism Center for Professional Studies, the Silha Center for the Study of Media Ethics and Law, the China Times Center, the Eric Sevareid Library, and the SJMC Research Division.

Prerequisites for Admission—The minimum requirement for admission is the B.A. or equivalent.

Special Application Requirements—in addition to Graduate School requirements, a department application, letters of
recommendation, academic work samples, and scores from the General (Aptitude) Test of the Graduate Record Examination (GRE) are required. For students whose native language is not English, scores are required from the Test of English as a Foreign Language (TOEFL), but not from the GRE. Admission is in fall quarter; the application deadline is December 15.

**Master’s Degree Requirements**—A minimum of 36 credits plus a thesis are required. Coursework must include 16 credits in required core courses, 8-12 credits in other journalism and mass communication seminars or courses, and 8-12 credits in other departments, in addition to the thesis. Students must also register for 16 master’s thesis credits (Jour 8777). A final oral examination is required. All graduate coursework must be taken A-F.

**Doctoral Degree Requirements**—In consultation with an adviser, students select a dissertation field and supporting coursework. Areas of specialization may be tailored to suit students’ interests, including communication law and regulation, media ethics, international mass communication, history of mass communication, and mass media structures, processes, and effects. Students complete a minimum of 88 credits, including 16 credits in required core courses, and 32 credits in departments outside of the school. Doctoral students must also register for 36 doctoral thesis credits (Jour 8888). All graduate coursework must be taken A-F. The written and oral preliminary examinations cover the proseminars and methodology courses, dissertation area, and supporting coursework.

**Language Requirements**—For the master’s program, foreign language study is recommended for students in international mass communication. Doctoral students pursuing international study are expected to have high language proficiency, or obtain it, in the appropriate area. Doctoral students in other areas are encouraged to consult advisers regarding the appropriateness of language study for their chosen specialization.

**Minor Requirements for Students Majoring in Other Fields**—Minor programs are planned in consultation with the director of graduate studies or another member of the graduate faculty in mass communication. A master’s minor consists of a minimum of 12 credits in a coherent area, with at least 8 credits at the 8xxx level. A doctoral minor consists of a minimum of 18 credits in a coherent disciplinary area. Students completing a doctoral minor in mass communication are required to take a preliminary written examination covering their coursework.

**For Further Information and Applications**—Contact the Graduate Studies Center, School of Journalism and Mass Communication, University of Minnesota, 15 Murphy Hall, 206 Church Street S.E., Minneapolis, MN 55455 (612/625-4054; fax 612/626-8251; e-mail sjmcgrad@tc.umn.edu).

**Jour 8666. Doctoral Pre-Thesis Credits.** (max 18 cr per qtr; doctoral student who has not passed oral prelims)

**Jour 8777. Thesis Credits: Master’s.** (16 cr required; Plan A only)

**Jour 8888. Thesis Credits: Doctoral.** (36 cr required)

**Journalism and Mass Communication (Jour)**

**Jour 5251.* Psychology of Advertising.** (4 cr; prereq jour major or minor, 3004, Psy 1001, Δ) Faber

Psychological principles, research techniques, and applications in advertising and selling. Consumer attitudes and behavior. Psychological mechanisms upon which effectiveness of advertisements and commercials depends.

**Jour 5274.* Advertising in Society.** (4 cr; prereq jour major or minor, 3004, Δ) Wackman


**Jour 5316.* Theories of Visual Communication.** (4 cr; prereq jour major or minor, 3004, 3006 or #, Δ) Schwartz

Perspectives on study and analysis of visual communication; contributions from sociology, anthropology, psychology, and history. Message structure, systems of production, and use of visual media.

**Jour 5501.* Communication and Public Opinion I.** (4 cr; prereq jour major or minor, 3004, Δ) Doyle, Lee

Theories of communication process and of persuasion and attitude change. Functions of interpersonal and mediated communication in diffusion of information and in opinion formation.
Jour 5531.* Communication and Public Opinion II. (4 cr; prereq major, 3004, 5501 or Soc 5355, Δ) Chang, Doyle
Advanced study of theories and research findings on opinion formation, persuasion, and diffusion of information. Social science contributions to studies of the process and effects of mass communication.

Jour 5541.* Mass Communication and Public Health. (3 cr, §PubH 5394; prereq public hlth or epidemiology grad or jour grad student or #, social or behavioral science courses) Finnegan
Role, function, and effects of mass media on public health; planned and unplanned effects; review and analysis of literature to understand how theories, models, and assumptions of mass communication research relate to public health.

Jour 5601.* History of Journalism. (4 cr; prereq jour major or minor, 3004, Δ) Dicken-Garcia, Roberts
Development of American newspapers and periodicals, from beginnings in Europe to present day; rise of radio and television; relation of communications developments to political, economic, and social trends.

Jour 5606.* Literary Aspects of Journalism. (4 cr; prereq jour major or minor, 3004, #, Δ) Roberts
Literary aspects of journalism as exemplified in and influenced by works of English and American writers, past and present. Lectures, discussions, weekly papers.

Jour 5611.* Development of American Broadcasting. (4 cr; prereq jour major or minor, 3004, Δ) Fang
Historical and economic development of radio and television in the United States; government regulation, industry self-regulation, forms of social control, contemporary broadcasting issues; the journalist as broadcaster.

Jour 5615.* History of Visual Communication in the Mass Media. (4 cr; prereq jour major or minor, 3004, Δ) Griffin
Social history of photography, film, and video. Informational, documentary, propaganda, and entertainment functions of visual communication. Rise and influence of visual media industries and public image making.

Jour 5721.* Mass Media and U.S. Society. (4 cr; prereq jour major or minor, 3004, Comp 3027 or #, Δ) Hansen

Jour 5725.* The Management of Media Organizations. (4 cr; prereq jour major or minor, 3004, Δ)
Media organizations as businesses; economics of mass media; markets, finances, organizational structure, and management practices of principal media industries; issues in media management.

Jour 5726.* Case Studies in Modern Media Management. (4 cr; prereq for jour student; jour major or minor status, 3004, Δ; prereq for others: #, Δ; 5725 recommended)
How media managers make decisions dealing with money, marketing, product, personnel, and production information. Interaction between quality, price, service, and the limits of technology.

Jour 5731H.* Honors Course: Communications Problems and Issues. (4 cr; prereq jour major or minor, 3004, sr, #, Δ; honors div regis) Hansen, Roberts, Wells
Individual project and topical seminar of major problems and issues of communication.

Jour 5741. Minorities and Mass Media. (4 cr, §Afro 5910; prereq jour major or minor, 3004, Δ)
Relationships between mass media and communities of color in United States. Issues of content and control.

Jour 5771. Media Ethics: Principles and Practice. (4 cr; prereq jour major or minor, 3004, #, Δ) Babcock
What it means to act ethically; tools to identify and analyze ethical issues; ethical norms of print and broadcast journalism, photojournalism, public relations, and advertising.

Jour 5777.* Contemporary Problems in Freedom of Speech and Press. (4 cr; prereq jour major or minor, 3004, Δ) Gillmor
Legal and constitutional derivation of freedom of speech and press with emphasis on case law, judicial theories, doctrines, tests and values. Symbolic, commercial, compelled speech, speech plus, petition and assembly, leading press cases, legal research techniques.

Jour 5801.* International Communication. (4 cr; prereq jour major or minor, 3004, Δ) Chang, Lee
Structures, processes, and consequences of international mass communication. Problems in the free flow of information. Roles of international organizations. Mass communication in social, political, economic development; implications for conflict resolution.

Jour 5825.* World Communication Systems. (4 cr; prereq jour major or minor, 3004, Δ) Chang
Mass media systems of the world, described and analyzed regionally and nationally, with special reference to historical roots, social, economic, and cultural context, contemporary conditions and prospects, and the relevance of journalism and mass communication to international affairs.

Jour 5970.* Advanced Projects in Journalism. (1-4 cr per qtr [max 8 cr]; prereq jour major or minor, 3004, B avg, #, Δ, ⊖)
Independent study; projects.

Jour 5970H.* Honors Course: Advanced Projects in Journalism. (1-4 cr per qtr [max 8 cr]; prereq jour major or minor, 3004, B avg, #, Δ, ⊖, honors div regis)
Independent study; projects.
Jour 5990.* Special Topics in Mass Communication. (1-4 cr per qtr [max 8 cr]; prereq jour major or minor, 3004, #, Δ)
Topics announced in Class Schedule.

Jour 8010-8020.* Studies in Mass Communication. (4 cr per qtr) Chang, Dicken-Garcia, Faber, Griffin
8010: Historical development of mass communication studies in social sciences, humanities, and legal areas; survey of research literature using individualistic and structural approaches to mass communication. 8020: Survey of literature on history of mass communication; cultural and humanistic approaches to study of mass communication; legal/ethical issues in mass communication.

Jour 8501.* Seminar: The Process of Quantitative Mass Communication Research. (4 cr; prereq 12 cr soc sci, statistics course or ¶) Doyle, Wackman
Survey of quantitative research methods. Relationship between theory and research, concept explication, measurement, instrumentation, and design issues. Methods such as social surveys, content analysis, and experimentation.

Jour 8502.* Seminar: Mass Communication Research Design. (4 cr; prereq 8501, statistics course or ¶) Doyle, Faber
Application of social research methods to theoretical issues and problems in mass communication studies. Advanced issues in theory testing, problem definition, sampling and design considerations. Students design projects and gather data.

Jour 8503.* Seminar: Mass Communication Research Analysis. (4 cr; prereq 8502, statistics course or ¶) Doyle
Quantitative analysis of mass communication research. Analysis strategies, application of multivariate models, and reporting of research findings. Students analyze data from projects conducted in Jour 8502.

Jour 8513.* Seminar: Ethnographic Methods in Mass Communication Research. (4 cr; prereq proseminars or #, Δ) Schwartz
Theoretical foundations in anthropology and sociology; field projects.

Jour 8560.* Seminar: History of Mass Communication. (4 cr; prereq 5601, #, Δ) Dicken-Garcia
Research methods; development of a research project.

Jour 8620.* Seminar: Advertising Research. (4 cr; prereq 5251 or #, Δ) Faber
Advertising as persuasive communication. Current research findings and theory related to advertising decision-making process. Measurement issues in advertising and market research.

Jour 8630.* Seminar: Visual Communication Research. (4 cr; prereq 5316, proseminars or #, Δ) Griffin
Research in visual communication. Theoretical approaches, analysis of research methods, development of research designs and projects.

Jour 8640.* Seminar: Broadcast News. (4 cr; prereq 5442 or #) Fang
Major issues in broadcast journalism; confrontations between federal government and network news departments; historical studies of broadcast news.

Jour 8650.* Seminar: Mass Communication Theory. (4 cr; prereq proseminars, #, Δ) Lee, Tims
Research paradigms, concepts, and findings that offer promise for development of a general theory of mass communication.

Jour 8651.* Seminar: Mass Media and Social Change. (4 cr; prereq statistics course, #, Δ)
Research designs; procedures for quantitative studies of media control, content, audiences, and effects; structural models for mass media research; relationships between research and decision making.

Jour 8660.* Seminar: History of Mass Communication. (4 cr; prereq 5601, #, Δ) Roberts
Research in history and development of U.S. mass media.

Jour 8661.* Seminar: History of Mass Communication. (4 cr; prereq 5601, #, Δ) Dicken-Garcia, Roberts
Theories and models in historical literature; major research paper.

Jour 8662.* Seminar: Literary Aspects of Journalism. (4 cr; prereq 5606, #, Δ) Roberts
Research in literary aspects of journalism exemplified in careers and works of English and American writers.

Jour 8670.* Communication Agencies as Social Institutions. (4 cr per qtr; prereq 5721 or equiv or #, Δ) Babcock
Influence and effects of mass communication, internal dynamics of media organizations, criticism and modes of reform. Theoretical frameworks for analysis.

Jour 8671. Seminar: Communication Ethics—Public/Civic Journalism. (4 cr; prereq grad student, Δ) Babcock
Historical underpinnings, philosophical debate, theoretical dynamics, legal concerns, and ethical implications.
Jour 8673.* Seminar: Media Management. (4 cr; prereq #, Δ; 5725 or 5726 recommended) Management issues in media organizations; relation to dynamics of organization structure, employees, markets, and economics/finances.

Jour 8675. Seminar: Issues in Information Access and Communication. (4 cr; prereq 5731 or equiv or #, Δ; offered alt yrs) Hansen Information access issues as they relate to mass communication concerns. Societal, industry, technological, and policy aspects and developments that affect information access, particularly through mass media.

Jour 8678.* Government and Mass Communication: Constitutional Law. (4 cr; prereq 5777 or #, Δ) Gillmor Problems of constitutional and tort law affecting press and theories that underlie them.

Jour 8679.* Seminar: Research Methods in Media Ethics and Law. (4 cr; prereq Δ) Babcock Focuses on research at intersection of the first amendment and media ethics.

Jour 8681, 8682.* Seminar: International Mass Communication. (4 cr per qtr; prereq 5801 or 5825 or #, Δ) Lee Main problems and currents of international mass communication. Focus on concepts, research, and policy relevant to global development, including issues of freedom and constraint, media technology, and role of journalism in world affairs.

Jour 8970.* Advanced Projects in Mass Communication. (1-4 cr per qtr [max 8 cr]; prereq grad major or minor in mass communication, #, Δ) Individual research.

Jour 8990.* Special Problems in Mass Communication. (4 cr per qtr; prereq #, Δ) Special topics for seminars.

Professional (Skills) Courses

While open to graduate students, these courses typically are not included in a mass communication master’s or doctoral degree program.

Jour 5131.* Interpretive Reporting. (4 cr; prereq jour major, 3004, 3121 or 3173 or 5155, Δ; pass 40 wpm keyboarding test with 6 or fewer errors) Advanced problems in reporting about government, politics, social problems, and the arts.

Jour 5155.* Advanced Reporting Methods. (4 cr; prereq jour major, 3004, C or higher in 3101, pass 40 wpm keyboarding test with 6 or fewer errors, Δ) Investigative techniques for mass media, including quantitative research methods, use of records and documents, analysis of statistics, advanced interviewing, and methods for adverse conditions.

Jour 5159. Case Studies in Public Relations. (4 cr; prereq jour major, 3004, 3159, Δ) Tims Case study approach to application of public relations principles to solution of problems in business, government, education, and community. For sharpening perceptions, insights, and judgments in examining practical and ethical questions.

Jour 5171.* Arts Reviewing and Reporting. (4 cr; prereq for jour students: jour major status, 3004, C or higher in 3101, pass 40 wpm keyboarding test with 6 or fewer errors, Δ; prereq for nonmajors: #, Δ) Covering the arts and entertainment beat, both as a reviewer and a reporter. Assignments follow Twin Cities arts and entertainment season, including its controversies. Weekly writing assignments, readings, field trips, guest lectures from artists and arts journalists.

Jour 5174.* Magazine Editing and Production. (4 cr; prereq jour major, 3004, 3155 or 3173 or 3321 or 5302 or prof exper, #, Δ) Roberts Writing, editing, illustration, design, layout, photocomposition of a single-issue magazine.

Jour 5261.* Advertising: Media Analysis. (4 cr; prereq jour major, 3004, 3261 or #, Δ) Tims Print and electronic media, their role in advertising: selection and scheduling; rate structures and policies; evaluation and use of media and market measurements and data.

Jour 5263.* Advertising Campaign Planning. (4 cr; prereq jour major, 3004, 5261, Mktg 3000 or #, Δ) Faber, Wells Development of campaign strategy and tactics. Emphasis on planning and decision-making skills needed to design effective advertising campaigns.

Jour 5321. Publication Graphics. (4 cr; prereq jour major, 3004, 3321, Δ) Tims Role of design process in production of magazines, brochures, and newsletters. Computer as design tool; preparing electronic documents for printing process.

Jour 5441.* Electronic News Gathering. (4 cr; prereq jour major, 3004, 3451, Δ; lect, lab, news production hrs) Modern television news reporting. Demonstrations and field exercises in planning, lighting, shooting, editing, and scripting typical broadcast news assignments.

Jour 5442.* Advanced Television News. (4 cr; prereq jour major, 3004, 3451, pass 40 wpm keyboarding test with 6 or fewer errors, Δ; lect, lab, news production hrs) Fang Preparation and delivery of television newscasts. Current problems of the industry. Legal and ethical considerations. Social impact of electronic journalism.
Materials Science and Engineering

See Chemical Engineering.

Mathematics (Math)

**Professor:** Naresh Jain, head; Donald W. Kahn, director of graduate studies; Alfred Apell; Stephen B. Agard; Greg W. Anderson; Donald Aronson; John Baxter; Thomas Berger; John A. Eagon; Paul H. Edelman; Eugene B. Fabes; Mark Feshbach; Avner Friedman; Bert Fristedt; Paul B. Garrett; J. Gil de Lamadrid; Jay Goldman; Lawrence F. Gray; Leon W. Green; Robert D. Gulliver II; Morton Harris; Dennis Hejhal; Ettore F. Infante; Max A. Jodeit, Jr.; Harvey Keynes; Nicolai V. Krylov; Walter Littman; Mitchell B. Luskin; Gennady Lyubeznik; Albert Marden; Charles McCarthy; Richard McGehee; William Messing; Norman G. Meyers; Willard Miller, Jr.; Richard Moecckel; Wei-Ming Ni; Johannes C. C. Nitsche; Peter J. Oliver; Marian B. Pour-El; Karel Prikry; Edgar Reich; Peter A. Rejto; Joel Roberts; Mikhail Safonov; Fadil Santosa; David Sattinger; George R. Sell; Yasutaka Sibuya; Steven I. Sperber; Dennis W. Stanton; Marvin L. Stein; David A. Storvick; Vladimir Sverak; Peter J. Webb; Hans F. Weinberger; Dennis E. White

**Associate Professor:** Scot Adams; Bennett Chow; Bernardo Cockburn; Jack F. Conn; David Frank; E. Gebhard Fuhrken; Lisl N. Gaal; Hillel Gershenson; Laurence Harper; John S. Lowengrub; Chester L. Miracle; Wayne Richter

**Adjunct Associate Professor:** Blaise Morton

**Assistant Professor:** Satyanad Kichenassamy; Nai-Chung Leung; Victor Reiner; John M. Sullivan

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

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

**Curriculum**—Special areas of research include ordinary and partial differential equations; probability; real, complex, harmonic, functional and numerical analysis; differential and algebraic geometry; topology; number theory, algebra, and group theory; logic; combinatorics; mathematical physics and industrial mathematics. The M.S. Plan A includes a program with emphasis in industrial and applied mathematics. The M.S. Plan B includes a program with emphasis in mathematics education.

See also Control Science and Dynamical Systems, and Fluid Mechanics in this bulletin for Ph.D. programs that rely heavily on mathematics.

**Prerequisites for Admission**—A solid background in undergraduate-level mathematics is expected. For students whose goal is the Ph.D. degree, their background should include full-year courses in analysis, abstract algebra, and topology (roughly equivalent to Math 5612-5613-5614, 5282-5283-5284, and 5341-5342 and 5343).

Entering students are ordinarily admitted to the master’s degree program. Transfer to the Ph.D. program is made when the Ph.D. preliminary written examination is passed (and does not require earning a master’s degree).

**Special Application Requirements**—All applicants are expected to submit three letters of recommendation, a score from the Graduate Record Examination Subject (Advanced) Test in mathematics, and a supplementary application form available from the mathematics department. Applicants desiring financial assistance should submit their applications, including the departmental form, GRE scores, and letters of recommendation, to the director of graduate studies no later than January 15 to be considered for a fellowship, and no later than February 15 to be considered for a teaching assistantship.

**Master’s Degree Requirements**—There are two options: Plan A and Plan B. Under Plan A, students must write a thesis and complete a minimum of 28 credits of graduate-level coursework. Plan B allows more breadth; students must complete at least 48 credits of graduate-level coursework, of which 50 percent could be in areas outside of mathematics. A final oral examination is required.

For more information, see the *Graduate Studies in Mathematics* publication.

**Doctoral Degree Requirements**—The Ph.D. preliminary written examinations, given twice each year, cover real analysis, complex analysis, algebra, and manifolds and topology. Students are required to pass the examination by the end of their second year. After passing the written examination and completing the coursework for the program, students may take the preliminary oral examination for the Ph.D. degree. This examination is given at the convenience of students and faculty, and tests the thesis area and the minor or supporting program. Students are required to pass this examination by the end of their fourth year.
If a supporting program is chosen, it may consist partly or entirely of mathematics courses.

For more information, see the publication Graduate Studies in Mathematics.

**Language Requirements**—For the master’s degree—none. For the doctoral degree, two foreign languages are required from among the following: French, German, Russian, and Italian.

**Minor Requirements for Students Majoring in Other Fields**—For the master’s degree minor, a three-quarter 8xxx or 5xxx sequence is required. For the Ph.D. minor in mathematics, coursework must include 1) a three-quarter 8xxx sequence or a three-quarter 5xxx sequence that has two quarters of 5xxx coursework as prerequisites, or one of the following sequences: 5282-5283-5284, 5341-5342-5343, 5571-5572-5573 or 5612-5613-5614; and 2) any three-quarter 8xxx or 5xxx sequence or any two two-quarter 8xxx or 5xxx sequences.

**For Further Information and Applications**—Contact the School of Mathematics, University of Minnesota, 127 Vincent Hall, 206 Church Street S.E., Minneapolis, MN 55455 (612/625-1306; fax 612/626-2017; e-mail gradprog@math.umn.edu).

**Note**—Certain 5xxx courses are acceptable only for satisfaction of the minor requirements in mathematics and may not be counted toward the total credits required for a master’s or doctoral program in mathematics. Such courses are designated by the phrase “no grad cr for math majors.”

Because topics courses are offered only when feasible, primarily to serve the needs of Ph.D. candidates, all advanced students are urged to request useful topics by February 1 before the academic year containing the desired courses.

“Offered alternate years,” for the mathematics course listing only, means offered regularly, but not annually, and not necessarily every other year.

**Math 8666. Doctoral Pre-Thesis Credits.** (max 18 cr per qtr; doctoral student who has not passed oral prelims)

**Math 8777. Thesis Credits: Master’s.** (16 cr required; Plan A only)

**Math 8888. Thesis Credits: Doctoral.** (36 cr required)

**Math 5005, 5006, 5007. The Diversity of Mathematics.** (4 cr; prereq elem educ major, 1005-1006 or equiv, 10 more cr college-level math; no grad cr for math majors)

Mathematics enrichment topics for elementary school instructors. 5005: number theory, including prime numbers and congruences, and fractions and decimals. 5006: polyhedra, regular and semi-regular map coloring, graph theory and applications. 5007: analysis of two-person mathematical games.

**Math 5056. Theory of Interest.** (4 cr; prereq 1252 or equiv)

Application of compound interest formulas to determine present value, payment schedules, and effective interest and discount rates for installment loans, annuities, sinking funds, bonds, and other securities, including differing payment periods and interest conversion periods.

**Math 5057-5058-5059. Actuarial Mathematics I-II-III.** (4 cr per qtr; prereq 5056, 1 qtr 5xxx probability or statistics; carries grad cr for actuary math majors only)

Survival function; actuarial notation; actuarial present values for life insurance and life annuities. Equivalence principle; net premiums and reserves; multiple life functions and multiple decrement models; valuation of pensions. Further topics at instructor’s discretion.

**Math 5081. Fundamental Topics in Analysis.** (4 cr; prereq §3531H or 3211 or equiv; no grad cr for math majors)

Primarily for prospective secondary teachers. To develop analytic abilities and to broaden perspective on and enhance interest in mathematics. May include real number systems, theory of sets, continuous functions, and properties of limits.

**Math 5082. Fundamentals of Algebra.** (4 cr; prereq 3511H or 3212 or 3142 or 3221 or equiv; no grad cr for math majors)

Primarily for prospective secondary teachers. Number theory, including fundamental theorem of arithmetic and congruences; at least one general algebraic structure—group, ring, or field; equivalence relations; possibly other topics. Proofs by mathematical induction and by contradiction.

**Math 5083. Fundamentals of Geometry.** (4 cr; prereq 3142, 3211 or 3211, 3221 or 3212 or 3211H or equiv; no grad cr for math majors)

Primarily for prospective secondary teachers. One non-Euclidean geometry, including attention to the axiomatic approach; topics involving three or more dimensions; some use of transformations; possibly other topics. Proofs by contradiction.

**Math 5151. Elementary Set Theory.** (4 cr; prereq one 32xx Math course or equiv or #)

Basic properties of operations on sets, cardinal numbers, simply ordered sets, well-ordered sets, ordinal numbers, axiom of choice, axiomatics.
Math 5152. Elementary Mathematical Logic. (4 cr; prereq one 32xx Math course or equiv or #)
Grammar and semantics of first and second order languages; relational structures; a deductive system for first order logic; completeness theorem; axiomatics of formal theories.

Math 5162-5163-5164. Mathematical Logic. (4 cr per qtr; prereq 1 yr calculus or equiv or Phil 5202 or #)

Math 5209. Theory of Numbers. (4 cr; prereq one 32xx Math course or equiv or #; no grad cr for math majors)
Rigorous introduction to elementary theory of numbers developed up to classical results about congruences to a prime modulus (e.g., Fermat’s Theorem). Another advanced topic such as continued fractions, Gaussian integers, or quadratic reciprocity usually covered.

Math 5232-5233. Computer-Oriented Linear Algebra. (4 cr per qtr; §5242-5243, §5247, §5284; prereq 1261, 3261 or 3142 or equiv or #; no grad cr for math majors)
Linear transformations on finite dimensional vector spaces. Linear dependence, matrix algebra, inner products, orthogonality, matrix inversion presented from algorithmic viewpoint, with students constructing and running illustrative computer programs. Eigenvalues and eigenvectors, Jordan canonical form, polar representation of linear transformations, determinants.

Math 5242-5243. Linear Algebra With Applications. (4 cr per qtr; §5232-5233, §5247, §5284; prereq 1261, 3261 or 3142 or equiv or #; no grad cr for math majors)
Systems of linear equations, finite dimensional linear spaces, bases, linear transformations, matrices, determinants, eigenvalues, reduction to canonical forms, quadratic and bilinear forms, applications.

Math 5245-5246-5247. Introduction to Modern Algebra I-II-III. (4 cr per qtr; §5282 for 5245, §5283 for 5246, §5284 for 5247; prereq three 32xx Math courses or equiv or #; no grad cr for math majors)
Basic algebra at more concrete level than 5282-5283-5284. Group theory, including normal subgroups, homomorphism, theories of Lagrange and Cayley. Ring theory, including ideals, integral domains, Euclidean rings, polynomial rings; fields. Linear algebra, including an abstract approach to vector spaces; linear transformations and their structure.

Math 5282-5283-5284. Fundamental Structures of Algebra. (4 cr per qtr; prereq one soph-level sequence or #; some previous abstract math recommended)

Math 5331-5332-5333. Geometry I-II-III. (4 cr per qtr; §5161 for 5331, §5083 for 5332; prereq 1261 or equiv; no grad cr for math majors)
Advanced Euclidean geometry; axiomatic and analytic hyperbolic geometry; projective geometry; symmetry and geometrical transformations and their connections to linear algebra, group theory, and complex arithmetic; finite geometries, convex geometrical figures.

Math 5341-5342. Introduction to Topology. (4 cr per qtr; prereq one soph-level sequence or #; some previous abstract math recommended)

Math 5343. Introduction to Algebraic Topology. (4 cr; prereq 5342)
Classification of two-manifolds, fundamental group, homology theory.

Math 5375-5376-5377. Differential Geometry. (4 cr per qtr; prereq 3252 or equiv or # for 5375; 5375, 3261 or 3142 or equiv for 5376-5377)

Math 5381-5382. Introduction to Basic Algebraic Geometry. (4 cr per qtr; prereq multivariable calculus, 3521H-3531H or 3551H-3552H, #)
Geometry of polynomials defining curves and surfaces. Uses computer algorithms and packages for manipulating polynomials.

Math 5404. Variational Problems. (4 cr; prereq 3252, 3261 or equiv or #, offered when feasible)

Math 5428. Mathematical Models in Economics and the Social, Actuarial, and Management Sciences. (4 cr; prereq 3261 or equiv or #; no grad cr for math majors)
Mathematical models and associated mathematical techniques for describing behavior of and for optimizing various systems. How to find a model for a given situation.

Math 5447-5448-5449. Mathematical Thermodynamics. (4 cr per qtr; primarily for math majors interested in applications, for engineers, for scientists; prereq 5567, 5568 or 5607 or 5613 or #; offered when feasible)
Math 5457-5458-5459. Methods of Applied Mathematics. (4 cr per qtr; prereq 3252, 3261 or equiv; 3262 recommended) Modern analytic tools used in applications of mathematics; emphasis on technique. Linear algebra, ordinary and partial differential equations, calculus of variations, Fourier series, complex variables, optimization, numerical methods.

Math 5463-5464-5465. The Mathematics of Industrial Problems. (4 cr per qtr; prereq 2 yrs calculus including §3262 or equiv, familiarity with FORTRAN, Pascal or C, #) Industrial problems such as crystal precipitation, air quality modeling, color film developing, laser semiconductors. Theoretical foundations and computational methods involving ordinary and partial differential equations, calculus of variations, and numerical analysis.


Math 5477-5478-5479. Applied Numerical Analysis of Partial Differential Equations. (4 cr per qtr; prereq 5242 or equiv, 5608 or equiv, 5513 or equiv, computer skills or #) Numerical methods for the partial differential equations of linear and nonlinear elasticity, compressible and incompressible fluid flow, multiphase flow, heat transfer, and other selected systems of partial differential equations.


Math 5514. Integral Equations. (4 cr; prereq 3261 or 5512 or equiv or #; no grad cr for math majors) Integral equations; Fredholm formula, Neumann series, Laplace transforms, successive approximations, and numerical methods. Relation of integral equations to systems of linear algebraic equations and to differential equations.

Math 5521-5522-5523. Introduction to Ordinary Differential Equations. (4 cr per qtr; prereq one soph-level sequence or #; abstract math recommended) 5521: Existence and uniqueness theorems; successive approximations; differential inequalities; linear systems; fundamental matrix solutions; linear systems with constant coefficients; variation of parameters. 5522: Phase plane analysis; Poincaré-Bendixson theory; linear and nonlinear oscillations; stability theory; asymptotic behavior of solutions; control theory. 5523: Power series solutions, majorant method; regular and irregular singular points; error estimates, perturbation methods.

Math 5531-5532-5533. Dynamical Systems and Chaos. (4 cr per qtr; prereq multivariable calculus, linear algebra) Introduction to dynamical systems theory, emphasizing iteration of mappings of line, circle, and plane. Fixed points, periodic points, stability, bifurcations, invariant Cantor sets, rotation number, Smale horseshoe, fractal dimension, Julia sets, Mandelbrot sets, nonlinear oscillations, computer experiments.

Math 5567. Fourier Series and Boundary Value Problems. (4 cr; prereq 3261 or equiv or #; 3262 recommended; no grad cr for math majors) Partial differential equations of theoretical physics. Fourier series, proof of convergence, orthogonal systems. Sturm-Liouville systems, solution of boundary value problems by separation of variables, applications.


Math 5571-5572-5573. Elementary Partial Differential Equations. (4 cr per qtr, §5568 for 5572 and for 5573; prereq 5613 or §5608) Partial differential equations of theoretical physics, one-dimensional wave equation, characteristics, classification of second-order equations, heat and Laplace equations, uniqueness, maximum principle, orthogonal systems, Fourier series, separation of variables. Complex numbers, derivatives and integrals of analytic functions, elementary functions and their geometry, Cauchy’s integral theorem and formula, Laurent expansions, evaluation of contour integrals by residues. Fourier and Laplace transforms and their inversion, method of residues, applications to ordinary and partial differential equations, applications to heat, wave, and Laplace equations.
Math 5606-5607-5608. Advanced Calculus: A Rigorous Approach. (4 cr; §§5612 for 5606, §§5613 for 5607, §§5614 for 5608; prereq 3252 or equiv, ¶3262; no grad cr for math majors)
Basic analysis course at a more concrete level than 5612-5613-5614. Foundations of analysis: completeness of the line, limits, convergence, continuity, integration. Analysis on the line and in Euclidean space. Other topics chosen by instructor.

Math 5612-5613-5614. Introduction to Analysis. (4 cr per qtr; principally for non-math grad students and math undergrads planning grad work; prereq 3252 or equiv, ¶3262)
Theory of real numbers; elements of point set theory; limits; differentiation; multivariable analysis.

Math 5679. Probability. (4 cr, §§5681, §§Stat 5131; prereq 3252 or equiv; not recommended for those going on in probability or statistics; no grad cr for math majors)
Probability spaces, expectation; conditional probability and expectation, probability distributions and densities, repeated trials and independence.

Math 5681-5682-5683. Probability and Stochastic Processes. (4 cr per qtr, §§5679 and §§Stat 5131 for 5681; prereq 3252 or equiv; ¶3262 recommended)
Logical development and various applications of probability. Probability spaces, random variables and their distributions and expected values, law of large numbers and central limit theorem, generating functions. Topics from many random walks and Markov chains, branching processes. Poisson point processes, martingales, stationary sequences, second-order processes, stochastic differential equations.

Math 5701. Enumerative Combinatorics. (4 cr; prereq 3251 or equiv; 3xxx linear algebra recommended)
Basic enumeration. Sets, permutations, distributions, partitions, generating functions (exponential and ordinary), recurrence relations, methods of inclusion-exclusion, and Polya theory.

Math 5702. Graph Theory and Optimization. (4 cr; prereq 3251 or equiv; 3xxx linear algebra recommended)
Basic concepts in graph theory. Connectedness, Hamiltonian and Eulerian paths, trees, colorings, and matchings. Topics in optimization: networks, flows, spanning trees, and graph algorithms. Definitions and examples of designs, Latin squares, and codes.

Math 5703. Constructive Combinatorics. (4 cr; prereq 5701, knowledge of a computer language)
Algorithmic and bijective approaches to permutations, subsets, trees, tableaux, partitions, ranking and unranking algorithms. Connections with generating functions. Lagrange inversion formula.

Math 5900. Tutorial Course in Advanced Mathematics. (Cr ar; prereq §) Qualified students whose needs are not met by courses offered may make arrangements to study the content of other graduate courses regularly offered by the department.

Math 8000!. Preparation for Teaching College Mathematics. (2 cr; prereq math PhD student beyond 1st yr in good standing, §)
Teaching/learning, incorporating new approaches in teaching, issues in math education, components and expectations of being a college math professor.

Math 8140-8141-8142. Applied Logic. (3 cr per qtr; prereq §)
8140: Theory of computability: Turing machines, partial recursive functions, recursive functions, primitive recursive functions, Kleene Normal Form, Smn theorem, recursion theorem, reducibilities and degrees of unsolvability; complexity of computation-polynomial time, nondeterministic polynomial time, and polynomial space computabilities, O=aNP problem.
8141: Propositional and predicate logic with selected applications to computer science (e.g., program verification, machine proving, database theory).
8142: Selected topics.

Math 8150-8151-8152. Axiomatic Set Theory. (3 cr per qtr; prereq 5162-5163-5164 or #; offered alt yrs)
Axiomatic development of set theory, set theory as a foundation for mathematics. Consistency and independence of the axiom of choice, the continuum hypothesis and other questions, theory of types, theory of categories and other alternative systems.

Math 8166-8167-8168. Recursion Theory. (3 cr per qtr; prereq 5162-5163-5164 or #; offered alt yrs)
Detailed analysis of the concept of computability—including a discussion of the various equivalent definitions of this concept; primitive, general, and partial recursive functions—the enumeration theorem and the recursion theorem: recursive and recursively enumerable sets (including the priority method); relation between recursively enumerable sets and formal theories, creative and effectively inseparable theories; arithmetic and analytic hierarchies—including a discussion of constructive ordinals; higher order computability.

Math 8172-8173-8174. Model Theory. (3 cr per qtr; prereq 5164 or #; offered alt yrs)
Study of the interrelationship between formal languages (first order, as well as higher order, infinitary, etc.) and model structures based on the notion of satisfaction (two-valued, as well as other, e.g., Boolean valued); basic theorems (e.g., Lowenheim-Skolem theorems, compactness theorems); characterization of classes (e.g., EC, PC); preservation of properties under algebraic constructions; ultraproducts; special kinds of structures (e.g., homogeneous, saturated); applications to classical branches of mathematics.

Math 8181-8182-8183. Formal Languages and Automata. (3 cr per qtr; prereq 5162, ¶5163, ¶5164; offered when feasible)

Math 8190-8191-8192. Topics in Logic. (1-3 cr per qtr; prereq 5164 or #)
Math 8200-8201-8202. General Algebra. (3 cr per qtr; prereq 5284 or #)

Math 8203-8204-8205. Algebraic Geometry. (3 cr per qtr; prereq 8202, #; offered alt yrs)
Basic concepts of algebraic geometry: properties of curves, surfaces, varieties, schemes, morphisms, and cohomology of coherent sheaves.

Math 8206-8207-8208. Algebraic Number Theory. (3 cr per qtr; prereq 5342, 8202 or #; offered alt yrs)
Local and global fields, decomposition of primes, generalized L-functions, local and global class field theory.

Math 8209-8210. Homological Algebra. (3 cr per qtr; prereq 8202 or #; offered when feasible)
Math 8211-8212. Commutative Algebra. (3 cr per qtr; prereq 8202 or #; offered when feasible)

Math 8245-8246-8247. Group Theory. (3 cr per qtr; prereq 8202 or #)
Sylow theorems, p-groups, nilpotent groups, solvable groups, the Jordan-Hölder theorem for groups with operators, automorphism groups, permutation groups, representation theory for finite groups, finite simple groups, free groups, free products.

Math 8250-8251-8252. Topics in Group Theory. (1-3 cr per qtr; prereq #)
Math 8263-8264-8265. Topics in Algebraic Geometry. (1-3 cr per qtr; prereq #)
Math 8266-8267-8268. Topics in Number Theory. (1-3 cr per qtr; prereq #)

Math 8270-8271-8272. Lie Groups and Lie Algebras. (3 cr per qtr; prereq 8202 or #)
Groups of matrices, topological groups, local groups, Lie algebras and Lie groups. Structure theorems, classification of semisimple Lie algebras. Topics in homogeneous spaces and representations.

Math 8290-8291-8292. Topics in Algebra. (1-3 cr per qtr; prereq 8202 or #)
Topics vary depending on instructor and demand. Consult the instructor about topics to be covered during a particular quarter.

Math 8300-8301-8302. Manifolds/Topology. (3 cr per qtr; prereq 5282-5283, 5341 or #)
Covering spaces and the fundamental group; homology and cohomology of topological spaces, invariance of domain, degree of a mapping; smooth manifolds, Sard’s Theorem, differential forms, tensor fields, integration on manifolds; metric geometry, curvature, Gauss-Bonnet Theorem.

Math 8306-8307-8308. Algebraic Topology. (3 cr per qtr; prereq 5342 or #; offered alt yrs)
Axiomatic homology theory; various homology and cohomology theories; introduction to homotopy theory.

Math 8330-8331-8332. Differential Topology. (3 cr per qtr; prereq 5342 or #; offered alt yrs)
General introduction to algebraic topology, as far as is needed for development of special tools of differential topology. Theory and applications of differentiable sheaves.

Math 8342-8343-8344. Topological Dynamics. (3 cr per qtr; prereq 5341 or #; offered when feasible)

Math 8360-8361-8362. Topics in Topology. (1-3 cr per qtr; prereq 8308 or #)
Math 8365-8366-8367. Riemannian Geometry. (3 cr per qtr; prereq 5377 or #)

Math 8370-8371-8372. Topics in Geometry. (1-3 cr; prereq #)

Math 8380-8381-8382. Topics in Advanced Differential Geometry. (1-3 cr per qtr; prereq #)

Math 8406-8407-8408. Advanced Methods of Applied Mathematics. (3 cr per qtr; prereq 5459 or equiv or #)
Fundamental linear problems; linear transformations and quadratic forms, orthogonal series, linear integral equations, calculus of variations, eigenvalue problems and expansions, singular eigenvalue problems and expansions.

Math 8430-8431-8432. Mathematical Theory of Fluid Dynamics. (3 cr per qtr; prereq 5573, 5602 or #)

Math 8441. Variational Methods in Eigenvalue Problems. (3 cr; prereq 5573 or #)
Minimum, maximum-minimum, and minimum-maximum characteristics of eigenvalues and eigenvectors (“natural frequencies” and “normal modes”) of various differential operators occurring in mathematical physics. Methods yielding upper and lower bounds for eigenvalues. Approximation of eigenvectors.
Math 8445-8446-8447. Numerical Analysis of Ordinary and Partial Differential Equations. (1-3 cr per qtr; prereq 5567, 5571 or equiv, 5513 or equiv) Finite element and finite difference methods for elliptic boundary value problems (e.g., Laplace’s equation) and solution of the resulting linear systems by Gaussian elimination, SOR, conjugate gradients. Numerical methods for parabolic equations (e.g., heat equation) and hyperbolic equations (e.g., wave equation). Methods for the system of linear elasticity, Navier-Stokes equation, and systems of nonlinear conservation laws.

Math 8450-8451-8452. Topics in Numerical Analysis. (1-3 cr per qtr; prereq #) Topics vary yearly.

Math 8460-8461-8462. Mathematical Problems in Theoretical Physics. (3 cr per qtr; prereq #) Topics vary yearly.

Math 8470-8471-8472. Topics in the Mathematical Theory of Control Mechanics. (1-3 cr; prereq 5573 or #) Topics vary yearly.

Math 8480-8481-8482. Selected Topics of Celestial Mechanics. (1-3 cr per qtr; prereq #)

Math 8500-8501-8502. Theory of Ordinary Differential Equations. (3 cr per qtr; prereq 5614 or equiv, 5521 or #) Existence and uniqueness theorems, linear and nonlinear differential equations, singular points and series solutions, eigenvalue problems, oscillation and comparison theorems, stability of solutions, periodic solutions, Poincaré-Bendixson theory, equations of Duffing and van der Pol.

Math 8540. Topics in Differential and Difference Equations. (1-3 cr; prereq #)


Math 8560-8561-8562. Calculus of Variations and Minimal Surfaces. (3 cr per qtr; prereq 5614 or equiv, 5521 or #; offered when feasible)


Math 8590-8591-8592. Topics in Partial Differential Equations. (1-3 cr per qtr; prereq 8609, 8552 or #)


Math 8620-8621-8622. Theory of Singular Integrals. (3 cr; prereq 8602 or equiv or #) Differentiation of multiple integrals, maximal functions, covering theorems; BMO; singular integrals, scalar and vector-valued; Littlewood-Paley theory, multilinear singular integrals operators; Stein’s work on differentiation through surface averages, dimensional invariance of maximal constants for p>1; multiplier theory, relation to differentiation theory; restrictions of Fourier transforms; Hp theory.

Math 8640-8641-8642. Topics in Real Analysis. (1-3 cr per qtr; prereq 8602 or #)

Math 8650-8651-8652. Theory of Probability. (3 cr per qtr; prereq 8602 or #) Topics in modern probability theory, including recent advances in limit theorems and introduction to stochastic processes.

Math 8653-8654. Introduction to Stochastic Processes. (3 cr; prereq 8650 or 8656 or 8600, 5681-5682 or #) Weak convergence of measures, Kolmogorov’s consistency theorem, Brownian motion, Poisson process, conditioning, martingales, Markov processes, stationary processes, stochastic integration, stochastic control and filtering. Emphasis on parts of theory most useful to applied fields.

Math 8656-8657-8658. Measure Theory and Probability. (3 cr per qtr; prereq 5614 or #) Measure and measure spaces, measurable functions, integration, fundamental convergence theorems, Radon-Nikodym theorem, Fubini theorem, Kolmogorov consistency theorem. Random variables, distribution functions, characteristic functions, expectation, conditional expectation, martingales, sums of independent random variables, limit theorems including rates of convergence and the Berry Esseen theorem.
Math 8668-8669-8670. Introduction to Combinatorial Theory. (3 cr per qtr; prereq #)
8668: Basic enumeration, including sets and multisets, permutation statistics, inclusion-exclusion, permutations with restricted position, Ferrers diagrams, integer and set partitions, unimodal sequences, involutions, and Polya theory. 8669: Partially ordered sets, including lattices, distributive and semi-distributive lattices, chains, incidence and Mobius algebras, Mobius inversion, Zeta polynomials, Eulerian and binomial posets, generating functions, P-partitions, and Sperner theorems. 8670: Further topics in enumeration, including symmetric functions, Schensted correspondence, and standard tableaux; non-enumerative combinatorics, including graph theory and coloring, matching theory, connectivity, flows in networks, codes, and extremal set theory.

Math 8672, 8673, 8674. Topics in Combinatorial Theory. (1-3 cr per qtr; prereq #)
Combinational geometry, matroids, enumeration, ordered sets and Mobius inversion. Graph theory, coloring problems, matching theory, design, large sets, statistical physics, finite geometry, linear programming and algorithms.

Math 8690-8691-8692. Topics in the Theory of Probability. (1-3 cr per qtr; prereq 8652 or #)
Math 8700-8701-8702. Complex Analysis. (3 cr per qtr; prereq 5614 or equiv or 5573 or #)
Review of fundamental concepts of analysis, real and complex numbers, analytic functions and conformal mapping. Cauchy’s theorem and related concepts, sequences of analytic functions. Taylor and Laurent series, infinite products; residue calculus; the argument principle. Analytic continuation, algebraic functions.

Math 8790-8791-8792. Topics in the Theory of Analytic Functions. (1-3 cr per qtr; prereq 8702 or #)
Math 8800-8801-8802. Functional Analysis. (3 cr per qtr; prereq 8602 or #)
Basic properties of topological, locally convex and Banach spaces; theorems of Hahn-Banach, Krein-Milman, Mazur, Banach-Steinhaus, Eberlelin; also open mapping, closed graph, uniform boundedness, Riesz convexity theorems; resolvents, spectra, spectral theorem in Hilbert space, integration of vector-valued functions.

Math 8890-8891-8892. Reading and Research. (Cr ar)

Mathematics Education
See Curriculum and Instruction.

M.D./Ph.D.
A central theme of the M.D./Ph.D. program, a dual-degree program in the School of Medicine and the Graduate School, is the interface between basic biomedical science and clinical practice, and the constant interplay between them. The training period, which is typically about seven years, combines coursework, fundamental biomedical research, and clinical training culminating in a dissertation, a Ph.D. degree, and an M.D. degree. Students selected for the program receive a yearly stipend approximately equal to or greater than that received by predoctoral trainees supported by the National Institutes of Health (NIH) and also have their tuition paid. This support extends throughout the training period. The program at the University of Minnesota has been awarded a Medical Scientist Training Program grant by NIH.

Curriculum—The M.D./Ph.D. training period is divided into three phases: 1) two years of basic biomedical sciences coursework. During this period students select an area of basic biomedical science, choose a research adviser to supervise their thesis research, and begin their research; 2) approximately three years of coursework and research leading to the Ph.D. thesis. This research can be done in any graduate program approved by the Graduate School and the M.D./Ph.D. advisory committee, but most likely would be in anatomy, cell and developmental biology, biochemistry, genetics, microbiology, neuroscience, pathobiology, pharmacology, physiology, biomedical engineering, or biomedical science; and 3) approximately one year of clinical rotations.

Research projects take place in the laboratories of carefully selected, outstanding faculty who act as preceptors in the program. Research projects for the Ph.D. portion of the program have recently been carried out in the following areas: animal virology, biochemistry, cell biology, developmental biology, immunobiology, mechanism of pathogenicity, neurobiology, physical biochemistry, and plant biology.

Prerequisites for Admission—Applicants must have had excellent grades as undergraduates, outstanding scores on the MCAT examination or Graduate Record Examination, and strong letters of recommendation. Applicants must also have taken part in some research as undergraduates and have at least one letter of reference from a research adviser.

It is also possible for students in their first year of Medical School or Graduate School to transfer to the M.D./Ph.D. program; essentially the same prerequisites apply.
GRADUATE PROGRAMS

Special Application Requirements—Applications must be submitted to the Medical School through the American Medical College Application Service and to the Graduate School through the M.D./Ph.D. program. An M.D./Ph.D. selection committee reviews the applications and makes a recommendation to the Graduate School and to the Medical School admissions committees. Once accepted, students are admitted by the Graduate School to any participating graduate program of their choice. The deadline for application to the combined M.D./Ph.D. program is December 15.

For Further Information and Applications—Contact the M.D./Ph.D. Program, Medical School, University of Minnesota, Box 293 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/625-3680; fax 612/626-6800; e-mail mdphd@lenti.med.umn.edu).

Mechanical Engineering and Industrial Engineering

Regents’ Professor: Richard J. Goldstein, head; Ernst R. G. Eckert (emeritus); Benjamin Y. H. Liu

Professor: Thomas H. Kuehn, director of graduate studies; Sant Ram Arora; Avram Bar-Cohen; Perry L. Blackshear (emeritus); Max Donath; Arthur G. Erdman; Edward A. Fletcher; Darrell A. Frohrib; Steven L. Girshick; Joachim V. R. Heberlein; Warren E. Ibele; David B. Kittelson; Francis A. Kulaekci; Tarald O. Kvalseth; Jack L. Lewis; Virgil A. Marple; Peter H. McMurry; Katsuhiko Ogata; Suhas V. Patankar; Emil Pfender; David Y. H. Pui; Subbiah Ramalingam; James W. Ramsey; Donald R. Riley; Yecheziel Shulman; Terence W. Simon; Ephraim M. Sparrow; Patrick J. Starr; Kim A. Stelson; Kumar K. Tamma

Associate Professor: Thomas R. Chase; Jane H. Davidson; Kevin J. Dooley; William K. Durfee; David L. Hofeldt; Barney E. Klaleneck; Charles J. Scott; Paul J. Strykowski

Assistant Professor: Saifallah Benjaafar; John C. Bischof; Uwe R. Kortshagen; Susan C. Mantell

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


Curriculum—Coursework and research for all graduate degrees are offered in bioengineering; biomechanics; combustion; computer-aided design; computer-aided manufacturing; computer graphics; control systems; design; energy conservation; environmental control; environmental engineering; fluid mechanics; heat and mass transfer; history of science and technology; human factors engineering; industrial engineering; innovative methodologies; integration of structural and environmental systems; lubrication; manufacturing engineering; particle technology; plasma chemistry; plasma heat transfer; power, propulsion, and applied thermodynamics; socioeconomic systems; solar energy; solar processing and thermochemistry; statistics; structures; systems dynamics; technology assessment; thermal energy storage; thermal environmental engineering; thermodynamics; transportation; tribology; vibration; and interdisciplinary finite element methodology. Additional instructional and research programs can be formulated.

Prerequisites for Admission—An undergraduate degree in engineering or in a closely related scientific field such as physics, chemistry, or mathematics, is required. Unusually well-qualified students may be admitted directly to the Ph.D. program with a baccalaureate degree.

Special Application Requirements—Graduate Record Examination General Test scores are required for admission and also are used in evaluating requests for financial aid. For the Ph.D. program, three letters of recommendation from senior faculty members at the previous educational institution are required, including one from the master’s degree adviser. Students are admitted in the fall and spring quarters only.

Master’s Degree Requirements—For the M.S.M.E. and M.S.I.E. degrees, students are required to complete two credits of graduate seminars. The final examination is oral. For Plan B students, the number of Plan B papers required is from one to three, depending on their length, and is determined in consultation with the adviser. The papers may derive from any of the courses offered for majors in the graduate program or may address topics chosen by a graduate faculty member and the student. For the M.M.E. and M.I.E. degrees, see
Professional Master’s Degree in Engineering in the General Information section of this bulletin.

**Doctoral Degree Requirements**—Students are required to complete three credits of graduate seminars.

**Language Requirements**—None.

**For Further Information and Applications**—Contact the Mechanical Engineering and Industrial Engineering Graduate Programs, University of Minnesota, 121 Mechanical Engineering, 111 Church Street S.E., Minneapolis, MN 55455 (612/625-2009; fax 612/624-2010; e-mail gradinfo@me.umn.edu).

IEOR 8666. **Doctoral Pre-Thesis Credits.** (max 18 cr per qtr; doctoral student who has not passed oral prelims)

IEOR 8777. **Thesis Credits: Master’s.** (16 cr required; Plan A only)

IEOR 8888. **Thesis Credits: Doctoral.** (36 cr required)

ME 8666. **Doctoral Pre-Thesis Credits.** (max 18 cr per qtr; doctoral student who has not passed oral prelims)

ME 8777. **Thesis Credits: Master’s.** (16 cr required; Plan A only)

ME 8888. **Thesis Credits: Doctoral.** (36 cr required)

**Mechanical Engineering (ME)**

**Graduate Credit Courses for Nonmajors**

**ME 5190. Advanced Engineering Problems.** (2-4 cr; prereq #, A)
Special investigations in various fields of mechanical engineering and related areas including independent study project.

**ME 5254. Design Morphology With Applications.** (4 cr; prereq upper div ME major, 1025, 3201, 3205, 3303, 5342 or #, 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.

**ME 5260. Engineering Materials and Processing.** (4 cr; prereq upper div ME student, 3020, AEM 3016, Chem 1052, MatS 3400, Phys 1253; 3 lect, 1 rec hrs per wk, safety glasses required)
Introduction to materials and processing including physical and metallurgical properties, consolidation, etc. Material processing including machining, welding, and deformation processes.

**ME 5342. Heat Transfer.** (4 cr; prereq 3301, CE 3400 or AEM 3200, upper div IT or grad student or forest products student; 4 lect hrs per wk)
Steady and unsteady conduction of heat. Convection heat transfer in boundary layer and duct flows; forced and free convection; condensation and boiling; heat exchanges. Heat transfer by thermal radiation; radiative properties of black bodies and real surfaces.

**Advanced Courses in Mechanical Engineering**

**Design and Controls**

**ME 5203. Advanced Analysis and Synthesis of Mechanism Systems.** (3-4 cr; prereq 3203 or equiv, IT or grad student; computer programming desirable)
Analytical methods of kinematic, dynamic, and kinetoelastodynamic analysis and synthesis of mechanisms. Computerized design for function, path, and motion generation based on Burmeister theory.

**ME 5205. Creativity in Engineering Design.** (3-4 cr [1 cr term paper option]; prereq 3203, 3205, 3303, 5342 or equiv, IT or grad student; 3 lect hrs per wk)
Role of creative action at various stages in morphology of the design process. Creative decision making in developing design criteria, alternative solutions, and their evaluation.

**ME 5207. Experimental Stress Analysis.** (4 cr; prereq AEM 3016, IT upper div or grad student; 3 lect, 3 lab hrs per wk)

**ME 5209. Friction and Lubrication.** (3-4 cr [1 cr term paper option]; prereq CE 3400, AEM 3200 or equiv, IT or grad student; 3 lect hrs per wk)
Solid friction mechanism and boundary lubrication. Hydrodynamic and hydrostatic lubrication theory applied to bearing design. Introduction to gas bearings.

**ME 5220. Computer-Aided Design.** (4 cr; prereq 3020, IT or grad student, 3rd-yr ME courses, FORTRAN programming; 3 lect, 1 rec hrs per wk)
Application of computer-aided design techniques to engineering design. Engineering design projects/case studies using computer implementation of selected numerical techniques, design optimization, and computer graphical presentation of results.

**ME 5225. Finite Elements in Mechanical Design.** (4 cr; prereq 3205, 5342, programming, IT or grad student)
Introduction to fundamentals of finite element analysis, oriented to mechanical engineering design applications. Extensive examples from industry; student projects involve actual set-up and solution of descriptive problems using industry-accepted analysis codes and interactive graphics for model generation.
ME 5226. Finite Element Methods in Mechanical Engineering I. (4 cr; prereq Math 3221, AEM 3016, FORTRAN programming, IT upper div or grad student) Introduces computational methods, direct stiffness approach, elasticity, and energy methods. Interpolation, development of simple finite elements, assembling, and solution methods. Programming considerations and design application.

ME 5227. Finite Element Methods in Mechanical Engineering II. (4 cr; prereq 5226 or #; programming, IT upper div or grad student) Fundamental concepts of FEM; variational and weighted residual methods; interpolation functions; linear/higher-order elements; methodology and formulation for one- to two-dimensional problems in structural mechanics and heat transfer; axi-symmetric problems; solution schemes for linear/nonlinear static/steady-state models; computer implementation.

ME 5244. Vibration Engineering. (4 cr; prereq 3201 or equiv, IT or grad student; 4 lect hrs per wk) Applications of theory of vibration to design and optimization of isolators, detuning mechanisms, viscoelastic suspensions and structures.

ME 5255. Engineering Design Project. (4 cr [may be repeated for cr]; prereq 5254, ME upper div; 1 lect, 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.

ME 5271. Robotics. (3-5 cr [2 cr lab option]; prereq IT or grad student, 5283 or equiv) Design and analysis of computer control of multidegree-of-freedom systems. Robotics, multijointed manipulator kinematics, dynamics, control and integration with sensors. Position, velocity, path, force control. Lab projects.

ME 5272. Non-Contact Sensing. (3-5 cr [2 cr lab option]; prereq IT or grad student, 5271 or equiv) Optical- and acoustic-based sensing for inspection and closed loop control. Integration with robots. Mathematics of image processing as used in sensors for inspection, part classification, tracking, and ranging. Lab projects.

ME 5275. Computer Controlled Experimentation. (4 cr; prereq 5283 or equiv; 3 lect, 2 lab-rec hrs per wk) A/D and D/A conversion, Sampling Theorem, DFT and FFT, analog and digital filter design, simulation, real time micro- and mini-computer control.

ME 5283. Industrial Instrumentation and Automatic Control. (4 cr; prereq 3201 or equiv, IT or grad student; 2 lect, 2 lab hrs per wk) Basic theory of feedback control systems. Transfer function representation of electromechanical, pneumatic, and hydraulic components. Industrial automatic controllers. Root-locus and frequency-response methods of analysis and design.


ME 5285. Control Systems Laboratory. (2 cr; prereq IT major, 5283 or equiv) Experiments that illustrate and apply control theory to mechanical systems. Measurement techniques, calibration, timing of controls, characterization of sensors and control circuits.

ME 5288. Modeling and Simulation of Dynamic Systems. (4 cr; prereq 5283 or equiv, IT or grad student; 3 lect, 1 lab-rec hrs per wk) Generalized approach to developing models for describing complex dynamic interactions between mechanical, electrical, fluid, and thermal systems. Analog and digital simulation. Applications to electromechanical devices, transducers, hydraulic power, and thermofluid systems.

ME 8203. Advanced Planar Linkage Synthesis. (3 cr; prereq 5203) Burmester Theory: review, special cases, alternate formulations; dimensional synthesis of complex linkages; solution rectification; application of graph theory to mechanism synthesis; optimization as linkage synthesis technique.

ME 8226. Finite Element Methods for Nonlinear/Linear Transient/Dynamic Problems. (4 cr; prereq 5227, programming course or #) Concepts and techniques of Finite Element Methods; introduction to nonlinear/linear and transient/dynamic problems in engineering; formulations for conduction/convection/radiation, phase change and convective diffusion models; structural dynamics and wave propagation; stability, convergence, and accuracy for algorithms in structural dynamics and computational heat transfer.

ME 8227. The Finite Element Method in Metal-Forming Processes. (4 cr; prereq 5227, AEM 8511, AEM 8522, programming course or #) Finite Element Method (FEM) fundamentals; material and geometric nonlinearities; FEM for inelastic small and finite deformation problems; constitutive equations for finite deformation inelasticity; adaptive and deforming FEM techniques; applications to metal-forming operations (e.g., extrusion, rolling, casting).

ME 8250-8251-8252. New Product Design and Development. (4 cr per qtr; prereq 5254 or equiv; offered jointly with Carlson School of Management) Conception, design, and development of new product for client company by team of IT and CSOM graduate students and faculty coaches and client personnel, resulting in one or more working physical prototypes of new product and a comprehensive business plan detailing how product will be marketed and produced over its life cycle.
ME 8280. Multivariable Control Systems I.  
(4 cr; prereq 5283 or equiv)  
Integrated state space and frequency domain description of linear multivariable feedback control systems based on models of physical process; realizations and structures of multi-input, multi-output linear systems; multivariable system analysis, stability, controllability, observability, poles, zeros, and modal properties; Eigenstructure assignment; multivariable Nyquist criterion in singular value-based robustness test; impact of unstable poles, nonminimum phase zeros and time delays; extensive computer-aided homework.

ME 8281. Multivariable Control Systems II.  
(4 cr; prereq 8280)  
Unified computer-aided design of multivariable feedback control systems using time and frequency domain concepts; loop-shaping concepts via singular value plots; performance and robustness trade-offs; derivation of LQR and its properties in frequency domain; Kalman filter and its properties in time and frequency domain; linear quadratic gaussian compensator with loop-transfer recovery; recent methods in compensator design; extensive computer-aided homework.

Production Engineering
ME 5262. Material Working and Fabrication Processes.  
(4 cr; prereq 5260, IT or grad student; 3 lect, 1 rec hrs per wk)  
Theory and application of joining techniques, welding, brazing, and adhesive bonding. Metal forming operations, rolling, swaging, drawing, and similar operations. Inspection and test methods to control and evaluate fabrication processes including X-ray, magnetic, metallographic, and chemical methods.

ME 5268. Properties and Fabrication of Plastics.  
(4 cr; prereq 5260, IT or grad student; 3 lect, 1 lab-rec per wk)  

(4 cr; prereq 5260, IT or grad student; 3 lect, 1 rec hrs per wk)  
Fundamental properties of engineering materials including fabrication, treatment, physical and corrosive properties. Failure mechanism, cost and value analysis as related to material selection and specification.

Thermodynamics and Heat Transfer
ME 5343. Introduction to Thermal Design.  
(4 cr; prereq 5342, 5254 or equiv, upper div IT or grad student)  
Elements of thermal design. Development of design philosophy and governing relations for thermal configurations, including barriers and enclosures; longitudinal, radial and pin-fins; longitudinal fin arrays. Case studies from diverse thermal application areas, e.g., furnaces and ovens, HVAC systems, solar energy use, and electronic equipment.

ME 5344. Thermodynamics of Fluid Flow.  
(4 cr, §AEM 5201; prereq CE 3400 or AEM 3200, IT or grad student; 4 lect hrs per wk)  
Compressible flow of gases in engineering systems such as nozzles, ducts, combustion chambers, ramjets, pipe lines. Isentropic flow in variable area passages. One-dimensional discontinuities. Flow with wall friction, heat transfer, and mass transfer.

(4 cr; prereq IT or grad student, 5342; 3 lect, 1 rec hrs per wk)  
Development and application of analytical models of thermal phenomena in electronic equipment. Thermal characteristics and thermal failure modes of microelectronic components. Packaging configurations used for various microelectronic applications.

(4 cr; prereq 5342, upper div IT or grad student; 4 lect hrs per wk)  

ME 5351. Computational Heat Transfer.  
(4 cr; prereq 5342, IT or grad student)  
Numerical solution of heat conduction and duct flows. Use of computer program to solve complex problems involving steady and unsteady conduction, fully developed flow and heat transfer in ducts, and other special applications. Case studies illustrate design optimization.

ME 8310. Advanced Thermodynamics.  
(3 cr; prereq 3303)  
Critical examination of thermodynamic principles, equations of state for liquids, gases, and mixtures. Interpretation of thermodynamic functions and applications to processes, reactions, and equilibrium states.

ME 8311. Statistical and Nonequilibrium Thermodynamics.  
(3 cr; prereq 8310)  

(3 cr; prereq 5342 or #)  
Phenomena pertaining to boiling heat transfer and multiphase flow; superheat, nucleation, bubble dynamics, interfacial phenomena, boiling crisis, film boiling; flow patterns in two-component two-phase flows, two-phase critical and supercritical flows.

ME 8330. Conduction.  
(3 cr; prereq 5342)  
ME 8331. Convection. (3 cr; prereq 5342) Fundamentals and applications of heat transfer in presence of fluid motion. Heat transfer in fluids flowing around bodies and in tubes and ducts. Externally driven flows (forced convection) and buoyancy-induced flows (natural convection). Laminar and turbulent flow regimes. Application to heat exchange devices with complex geometries. Convection mass transfer and vapor-liquid phase change.

ME 8332. Radiation. (3 cr; prereq 5342) Heat radiation of black bodies and nonblack bodies. Radiation between surfaces and through participating media.

ME 8334. Turbulent Convection. (3 cr; prereq 8331) Heat and mass transfer in turbulent flows; turbulent transport, turbulence modeling, high speed flows, viscous dissipation, variable property effects, transpiration, and film cooling.


ME 8352. Advanced Computation of Fluid Flow and Heat Transfer. (3 cr; prereq 8351 or #; 3 lect, 1 rec hrs per wk) Use of computer program to solve complex problems involving fluid flow, heat transfer, and chemical reaction. Advanced models for turbulence and chemical reaction. The finite-element method and other methods of fluid flow computation.

ME 8360. Introduction to Plasma Technology. (3 cr; prereq 5342 or #) Atomic theory; kinetic gas theory, fundamentals of gaseous electronics; thermal excitation and ionization; nonequilibrium and equilibrium plasmas; local thermodynamic equilibrium (LTE); introduction to irreversible thermodynamics of a fully ionized plasma; plasma equations; thermodynamic functions; collisions across sections.

ME 8361. Introduction to Plasma Technology. (3 cr; prereq 8360 or #) The plasma state; plasmas generation; glow discharges; arcs; rf-discharges sparks and pulsed discharges; shock waves. Plasma diagnostics; potential probes; magnetic probes; plasma spectroscopy; microwave diagnostics; short-time and high-speed photography; enthalpy probes; laser methods; interferomery.

ME 8362. Introduction to Plasma Technology. (3 cr; prereq 8360, 8361, or #) Plasma heat transfer; transport equations; transport properties; heat transfer with and without current flow; electric and magnetic field effects. Plasma applications; arc furnaces; extractive metallurgy; plasma synthesis; plasma welding, spraying, and cutting; MHD power generation; nonthermal plasma processing; thermonuclear fusion.

ME 8370. Experimental Methods in Heat Transfer. (3 cr; 3 lect hrs per wk) Planning experiments: uncertainty, qualification, visualization, analogies; temperature, pressure, heat flux and flow measurements; signal processing and analysis.

ME 8372. Optical Diagnostics of Flow Systems. (3 cr; prereq IT grad student) Experimental techniques for measuring velocity, temperature, chemical composition, and particulates in high-temperature flows; basic principles of optics and spectroscopy, instrumentation; laser Doppler anemometry; use of emission and absorption; laser-induced fluorescence; light scattering techniques.

ME 8379. Thermal Sciences Graduate Seminar. (1 cr) Students attend tutorial on preparing and presenting a seminar, deliver a one-hour lecture, and attend nine student seminars.

Power, Propulsion, and Applied Thermodynamics

ME 5442. Vapor Cycle Power Systems. (4-5 cr [1 cr term paper option]; prereq 3303, IT or grad student; 4 lect hrs per wk) Vapor cycle analysis, regeneration, reheat, compound cycle modifications, combined gas turbine-vapor cycle systems, binary systems. Combustion problems, solar, nuclear, and unusual energy sources for space power systems. Variety of configurations evaluated using steam cycle computer code.

ME 5443. Turbomachinery. (4-5 cr [1-2 cr term paper option]; prereq 3301 or equiv, IT or grad student; 3-5 cr hrs per wk) Thermodynamic analysis of energy transfer between fluid and rotor; dimensional analysis; principles of axial, mixed, and radial flow pumps, fans, compressors, and turbines; cascade performance; computer flow simulations; applications to propulsion systems and power plants.

ME 5446. An Introduction to Combustion. (4 cr; prereq 5342 or equiv, IT or grad student; 4 lect hrs per wk) Flame propagation, quenching and ignition in a gaseous mixture; combustion of solid and liquid particles, and gaseous jets. Applications to selected propulsion systems.

ME 5455. Rocket Propulsion. (3-5 cr [1-2 cr term paper option]; prereq 3303, IT or grad student; 3 lect hrs per wk) Mode of operation and performance limitations of chemical rockets with liquid, and solid, thermal and electromagnetic propellant acceleration and the thermodynamics of the propulsion process.

ME 5460. Internal Combustion Engines. (4 cr; prereq 3301, IT or grad student; 4 lect hrs per wk) Principles of power production, fuel consumption, and emissions of gasoline and diesel engines; fuel-air cycle analysis, combustion flames, knock phenomena, air flow and volumetric efficiency, mixture requirements, ignition requirements and performance.
ME 5461. Advanced Internal Combustion Engines. (4-5 cr [1 cr term paper option]; prereq 5460, IT or grad student; 4 lect hrs per wk)
Traditional and alternate fuels; engine lubrication and friction; engine emissions and measurement techniques; turbocharging; heat transfer and cooling; computer-based cycle modeling.

ME 5462. Gas Turbines. (4 cr; prereq 3301, IT or grad student; 4 lect hrs per wk)

ME 5480. Biological Fluid Flow. (3-4 cr [1 cr term paper option]; prereq IT or grad student, CE 3400, AEM 3200 or equiv; 3 lect hrs per wk)
Introduction to rheology and fluid dynamics of biological fluids. Blood flow, biological pumping, self-propelled particles, unusual viscoelastic behavior of biological fluids, and other fluid motions.

ME 8443. Applied Thermodynamics I. (3 cr; prereq 3303 or equiv)
Practical problems involving use of classical thermodynamics and thermochemistry. Equilibrium composition and flame temperature calculations. Chemical potential, fuel cells, and batteries. Efficient use of fuel, with emphasis on application of second law of thermodynamics.

ME 8444. Applied Thermodynamics II. (3 cr; prereq 8443 or equiv)
Application of statistical thermodynamics to calculation of thermodynamic properties, equilibrium constants, and energetics and kinetics of chemical reactions, with emphasis on application to combustion phenomena and exhaust product composition.

ME 8445. Advanced Combustion. (4 cr; prereq 8443, 8444 or #; 5446 recommended)
Conservation equations of reacting flows; asymptotic methods in combustion; spray combustion; combustion instabilities; turbulent combustion; solid combustion; fire dynamics; combustion modeling.

Environmental Engineering

ME 5603. Thermal Environmental Engineering. (4 cr; prereq 3303, 5342 or equiv; 4 lect hrs per wk)
Thermodynamic properties of moist air; H-W diagram for moist air; solar radiation; heat and water vapor transmission in structures; effects of thermal environments upon people, processes, and materials; thermal loads, thermal environmental control systems.

ME 5604. Heating and Cooling Loads in Buildings. (4 cr; prereq 5603; 4 lect hrs per wk)
Transient heat transfer through structures; lighting and other internal gains; ventilation; winter and summer design loads; seasonal energy estimation methods; computer simulation programs; codes and standards.

ME 5605. Refrigeration and Air Conditioning Systems. (4 cr; prereq 3303, IT or grad student; 4 lect hrs per wk)
Vapor compression and absorption refrigeration systems; heat pumps; heat exchangers; piping and duct layout and sizing; operation and control of building air conditioning systems.

ME 5609. Air Pollution. (4 cr; prereq 3303 or #; IT or grad student; 4 lect hrs per wk)
Air pollution sources, atmospheric transport, transformations and fate. Air pollution meteorology, dispersion, and models. Basic chemistry of secondary pollutant formation, aerosol growth, air pollutant-visibility relationships. Standards and regulations.

ME 5610. Air Pollution Control. (4 cr; prereq 3303, IT or grad student; 4 lect hrs per wk)
Control devices and techniques for gases and particulate emissions from stationary and mobile sources. Cyclones, electrostatic precipitators, bag houses, wet and dry scrubbers, combustion modification, and alternate fuels.

ME 5613. Principles of Particle Technology. (4 cr; prereq 3303, IT or grad student; 4 lect hrs per wk)
Definition, theory, and measurement of particle properties; particle statistics; fluid dynamics; optical, electrical, and thermal behavior of particles.

ME 5614. Principles of Particle Technology. (4 cr; prereq 5613, IT or grad student; 4 lect hrs per wk)
Gas cleaning, particle transport, comminution, classification, surface properties, packed beds, powder behavior, and miscellaneous topics.

ME 5616. Aerosol Measurement. (2 cr; prereq 5613, 5614 or #; IT or grad student; 3 lect-lab hrs per wk)
Principles of aerosol measurement. Modern aerosol instrumentation. Optical techniques, inertial collectors, electrical mobility techniques, Beta attenuation and piezoelectric mass sensing techniques, condensation nuclei counters and diffusion batteries.

ME 5617. Advanced Aerosol Measurement. (4 cr; §5616; prereq 5613 or #; IT or grad student)

ME 5620. Clean Room Technology and Particle Monitoring. (4 cr; prereq IT or grad student, 3303 or #; 3 lect, 2 lab hrs per wk)
Fundamentals of clean room technology for microelectronics manufacturing: particle mechanics and filtration; filter performance and testing; airborne and liquid-borne particulate contaminants; optical particle counters, condensation nucleus counter, wafer surface scanner; clean room design and operation; exhaust ventilation; high purity gas and water supply systems.
GRADUATE PROGRAMS

ME 8613. Fundamentals of Aerosol Behavior. (4 cr; prereq 5613, 5614 or #; 4 lect hrs per wk)
Kinetic theory applications to aerosol systems, including free molecules and transition regime treatments of transport phenomena; analytical and numerical solutions to aerosol dynamics problems; homogeneous nucleation theory; light scattering and absorption.

General
ME 5712. Solar Energy Utilization. (4 cr; prereq 3303, 5342 or equiv, IT or grad student; 4 lect hrs per wk)
History and potential of solar energy; clear and cloudy sky solar radiation availability on surfaces of various orientations; flat plate and concentrating solar collectors; solar thermal storage; solar heating and cooling systems; computer simulation codes; power generation.

ME 5990. Topics in Mechanical Engineering. (4 cr [may be repeated for cr]; prereq submission of approved dept permission form, #, IT upper div or grad student)
Current topics; may vary quarterly.

ME 8701, 8702. Design Studies in Engineering I, II. (3 cr per qtr; prereq grad student or #)
Interdisciplinary design exercises, primarily in mechanical and electrical engineering. Student teams create engineering design for selected problems. Written reports and oral presentations. Case study lectures on methodology.

ME 8770-8771-8772. Mechanical Engineering Research. (Cr ar; prereq Δ)
ME 8773-8774-8775. Graduate Seminar. (1 cr per qtr; for grads and staff)
Recent developments in industrial engineering and operations research.

ME 8800. Modern Developments in Mechanical Engineering. (1 cr per qtr)
Seminars on special topics in engineering science of importance to mechanical engineers. Invited scholars deliver a five-lecture series on each topic; two to five topics examined each quarter.

Industrial Engineering (IEOR)

Graduate Credit Courses for Nonmajors

The following courses may be taken for graduate credit by students majoring in fields other than industrial engineering upon the approval of the student’s adviser and the mechanical engineering graduate committee.

IEOR 5010. Introduction to Work Analysis. (4 cr; prereq 3000, IT or grad student; 3 lect, 1 rec hrs per wk)
Fundamentals of methods engineering, work measurement, and plant layout. Charting techniques, process charts, predetermined time systems, work sampling, time study, master standard data, cross charting, line balancing.

IEOR 5020. Engineering Cost Accounting, Analysis, and Control. (4-5 cr; prereq IT or grad student; 3000 and ME 3900 recommended; 3 lect, 1 rec hrs per wk)
Basic accounting concepts, financial statements, analysis and control of current assets such as cash, receivables, and inventory, income-tax planning, cost analysis, standard costs for product costing, time value of money, qualification of risk and uncertainty, utility theory, cost of capital and capital structure, capital budgeting under capital rationing, management decisions, and investment decisions.

IEOR 5030. Quality Control and Reliability. (4 cr; prereq Math 1231, ME 3900, IT or grad student; 3000 recommended; 3 lect, 1 rec hrs per wk)
History of quality control, quality policies and objectives, economics of quality, design for system effectiveness, reliability and maintainability, statistical aids to reliability, quality specifications, inspection, acceptance sampling, vendor relations, process control, motivation for quality, quality assurance, and quality control engineering.

IEOR 5040. Introduction to Operations Research. (4 cr; prereq Math 1231, IT or grad student; 3000 recommended; 3 lect, 1 rec hrs per wk)
Linear programming, algebra and geometry of linear models, simplex method, sensitivity testing, and duality, network models, network algorithms, and dynamic models.

IEOR 5180, 5181. Applied Industrial Engineering. (3-5 cr per qtr [1-2 cr term paper option]; prereq 3000, 5010, 5020, 5030, 5040, Δ)
Industrial engineering surveys and programs, case problems, studies in local plants.

Advanced Courses in Industrial Engineering

IEOR 5050. Engineering Economic Analysis. (4 cr; prereq 3000 or #, IT or grad student; 3 lect, 1 rec hrs per wk)
Fundamental principles and techniques of economic analysis of engineering projects including economic measures of effectiveness, time value of money, cost estimation, depreciation, taxes, break-even, replacement and investment analysis.

IEOR 5070. Introduction to Human Factors Engineering. (4 cr; prereq #, IT or grad student or public health major; 3 lect, 1 rec-lab hrs per wk)
Analysis and design of operations, machines, equipment, work stations, and work environments relative to capabilities, limitations, and needs of the human operator. Topics include human-machine systems, displays, controls, human-machine interface layout, workstation design, anthropometry, work physiology and biomechanics, illumination, noise, toxicology, climate.

IEOR 5071. Human Factors in System Design. (4 cr; prereq 5070 or 5010, IT or grad student; 1 lect-rec, 3 fieldwork hrs per wk)
Application of theory and principles from 5070 and 5010 to analysis and design of real industrial work settings in local industry.
IEOR 5221. Industrial Plants. (3-5 cr; prereq 5010, IT or grad student; 3 lect, 1 rec hrs per wk) Layout of production and service facilities in manufacturing operations, analysis of materials flow, development of materials handling systems, and industrial packaging techniques.

IEOR 5311. Management for Engineers. (4-5 cr; prereq 3000, IT or grad student; 4 lect hrs per wk) Historical development of management concepts. Organizational systems and authority relationships. Planning, communication, and management responsibility.

IEOR 5321. Industrial Safety. (4 cr; prereq, IT or grad student; 3000 recommended; 4 lect hrs per wk) Definition and philosophy of safety, safety training, safety requirements for production processes, equipment and plants, industry standards, safety devices, and product safety.

IEOR 5351. Analysis of Production Processes. (4 cr; prereq 5020, background in all industrial engineering areas [3000, 5010, 5030, 5040 recommended], IT or grad student) Case course of problems in production engineering and production management. Analysis of production problems from selected industries. Development of ability to recognize and diagnose industrial problems.

IEOR 5361. Inventory and Production Control. (4 cr; prereq 3000, 5040, ME 3900, IT or grad student; 3 lect, 1 rec hrs per wk) Forecasting techniques and analysis of inventory systems, aggregate planning, capacity decision, scheduling techniques, line balancing, use of linear programming and dynamic programming models in design, operation, and control of production and distribution systems.

IEOR 5441. Operations Research II. (4 cr; prereq 5040, IT or grad student; 3 lect, 1 rec hrs per wk) Dynamic programming, integer programming, nonlinear and probabilistic models.

IEOR 5442. Operations Research III. (4 cr; prereq 5441, IT or grad student; 3 lect, 1 rec hrs per wk) Optimization in probability models, Markov chains, queuing theory, and simulation.

IEOR 5445. Topics in Management Science. (3-5 cr [1-2 cr term paper option]; 5010, 5020, 5030, 5040, IT or grad student; 3 lect hrs per wk) Specialized topics in management science. Analytical tools for decision making and management of the production function. Emphasis on topics appearing in current literature. Topics vary quarterly.

IEOR 5446. Topics in Industrial Engineering. (4 cr [may be repeated for cr]; prereq IT or grad student; 5010, 5020, 5030, 5040 recommended; 4 lect hrs per wk) Current topics; may vary quarterly.

IEOR 5550. Design and Analysis of Experiments I. (4 cr; prereq ME 3900, IT or grad student; 3 lect, 1 rec hrs per wk) One-factor experiments, analysis of variance, estimation and comparison of effect, orthogonal contrasts, fixed, random, and mixed models, incomplete block designs.

IEOR 5703. Engineering Project Management. (4 cr, §CE 5703; prereq IT sr or grad student) Broad practical understanding of project management, including project planning, scheduling, budgeting, staffing, task and cost control, and how to communicate with, motivate, and manage team members.

IEOR 8110-8111-8112. Advanced Industrial Engineering. (3 cr per qtr; prereq #) Manufacturing policy; production engineering, plant operation, engineering economy, and industrial development.

IEOR 8310-8311. Production Engineering Problems. (3-5 cr per qtr; prereq #) Application of industrial engineering principles to solution of manufacturing problems in local plants.

IEOR 8410-8411-8412. Industrial Engineering Research. (3-5 cr per qtr; prereq #) Research studies in selected areas of industrial engineering, production, and management; work of thesis quality but lesser scope.

IEOR 8430. Nonlinear Programming. (3 cr; prereq 5040 or #; offered when feasible)

IEOR 8773-8774-8775. Graduate Seminar. (1 cr per qtr; S-N only) Presentation and discussion of recent developments in industrial engineering and operations research.

Mechanics
See Aerospace Engineering and Mechanics.

Medical Physics
See Biophysical Sciences and Medical Physics.

Medicinal Chemistry (MedC)

Professor: Rodney L. Johnson, interim head; Patrick E. Hanna, director of graduate studies; Yusuf J. Abul-Hajj; Herbert T. Nagasawa; Philip S. Portoghese; Wayne T. Shier; Marilyn K. Speedie; Robert Vinc
Associate Professor: Simon M. N. Efange; Rory P. Remmel; David H. Sherman
Assistant Professor: David M. Ferguson; William B. Gleason; Deborah A. Kallick; Carston R. Wagner

Please read the General Information section of this bulletin for Graduate School requirements that apply to all major fields.
Degrees Offered—Ph.D. and, under special circumstances, M.S. (Plan A only).

Curriculum—The program emphasizes the application of chemical principles to research on the action of drugs on biological systems. Areas of research include drug design and synthesis; chemical aspects of drug metabolism; chemical mechanisms of drug toxicity and carcinogenicity; computer-assisted drug design; pharmaceutical cell systems; delivery systems for gene therapy; nuclear magnetic resonance spectroscopic analysis of drug-protein interactions; design of catalytic antibodies; and development of radiopharmaceuticals.

Prerequisites for Admission—Applicants should have a B.S. or M.S. degree in an appropriate related science field such as pharmacy, chemistry, or biology. All applicants should have completed undergraduate chemistry through elementary organic chemistry. Undergraduate coursework in biochemistry and biology is desirable but not required.

Special Application Requirements—Scores from the General (Aptitude) Test of the Graduate Record Examination and at least three letters of recommendation from college-level faculty are required. Students usually are admitted fall quarter only. Admissions are generally for the Ph.D. program only.

Master’s Degree Requirements—Courses and credits are arranged on an individual basis. A final oral examination is required.

Doctoral Degree Requirements—All students must complete a core curriculum composed of advanced courses in organic chemistry (11 credits), biochemistry (12 credits), and medicinal chemistry (8–12 credits). Pharmacology coursework is also required of most students.

Ph.D. students must participate in the department seminar program, successfully complete a cumulative examination requirement, and prepare an original research proposal.

Language Requirements—None.

Minor Requirements for Students Majoring in Other Fields—Requirements include an introductory course (5600), advanced medicinal chemistry courses (8xxx level).

For Further Information and Applications—Contact the Department of Medicinal Chemistry, College of Pharmacy, University of Minnesota, 8-101 Weaver-Densford Hall, 308 Harvard Street S.E., Minneapolis, MN 55455 (612/624-9919; fax 612/624-2974).

MedC 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

MedC 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

MedC 8888. Thesis Credits: Doctoral. (36 cr required)

MedC 5185. Principles of Bio-molecular Simulation. (4 cr; prereq 5515 or Chem 5521 or #) Molecular simulation for students in medicinal chemistry, pharmaceutics, biochemistry, and chemical physics.


MedC 5495f. Vistas in Medicinal Chemistry Research. (1 cr) Selected topics of contemporary interest in pharmaceutical sciences.

MedC 5600f. General Principles of Medicinal Chemistry. (4 cr; prereq Phcl 1009, BioC 5001) Hanna, Johnson, staff General principles of drug design and molecular basis of recognition of receptor sites.

MedC 8100.* Medicinal Chemistry Seminar. (Cr ar; required of all majors in medicinal chemistry) Vince

MedC 8114f. Natural Toxins. (2 cr, §Phcg 8114; prereq #; offered when feasible) Shier

MedC 8116f. Steroid Drugs. (2 cr, §Phcg 8116; prereq #; offered when feasible) Abul-Hajj

MedC 8500w. Design of Chemotherapeutic Agents. (3 cr; prereq MedC 5600 or #; offered alt yrs) Vince Modern aspects of drug design, with emphasis on chemotherapeutic agents. Strategies for enzyme inhibition and metabolic blocks in development of anticancer, antimicrobial, and antiviral agents.

MedC 8600w. Chemical Aspects of Drug Metabolism and Bioactivation. (3 cr; prereq 5600 or #; offered alt yrs) Hanna, staff Chemical aspects of drug metabolism and toxicity. Mechanisms of biotransformations of drugs and other xenobiotics.

MedC 8700s. Advanced Concepts in Drug Design. (2 cr; prereq MedC 5600 or #; offered alt yrs) Wagner, staff Current approaches to rational design of drugs.
MedC 8760. Design of Peptidomimetics. (2 cr; prereq 5600 or #; offered alt yrs) Johnson
Current approaches to designing peptidomimetics of biologically active peptides. Rationale behind structures used in designing peptidomimetics and synthetic routes used to synthesize them.

MedC 8800. Medicinal Chemistry Laboratory Techniques. (Cr ar; prereq Chem 3303 or #)

MedC 8900. Research in Medicinal Chemistry. (Cr ar; prereq Chem 3303 or #)
Study and experimental investigation of topics in the area of natural products and synthetic organic medicinal agents.

Medieval Studies (MeSt)

Regents’ Professor: Rutherford Aris (chemical engineering and materials science)
Professor: Barbara A. Hanawalt (history), director of graduate studies; F. R. P. Akehurst (French and Italian); Bernard S. Bachrack (history); Caesar E. Farah (history); Evelyn S. Firchow (German, Scandinavian, and Dutch); Donna G. Cardamone Jackson (music); Klaus P. Jankowsky (English); Calvin B. Kendall (English); Anatoly Liberman (German, Scandinavian, and Dutch); Louise Mirrer (Spanish and Portuguese); Susan J. Noakes (French and Italian); Thomas S. Noonan (history); James A. Parente, Jr. (German, Scandinavian, and Dutch); William D. Phillips, Jr. (history); Kathryn L. Reyerson (history); Robert P. Sonkowsky (Classical and Near Eastern studies); David J. Wallace (English); Anthony N. Zahareas (Spanish and Portuguese)
Associate Professor: Rita Copeland (English); G. Lee Fullerton (German, Scandinavian, and Dutch); Kaaren E. Grimstad (German, Scandinavian, and Dutch); Michal A. Kobialka (theatre arts and dance); Nita Krevans (Classical and Near Eastern studies); Ronald L. Martinez (French and Italian); Oliver P. Nicholson (Classical and Near Eastern studies); John W. Steyaert (art history); Ray M. Wakefield (German, Scandinavian, and Dutch); John A. Watkins (English)
Adjunct Assistant Professor: Stephanie C. Van D’Elden (English)

Prerequisites for Admission—Admission to a medieval studies graduate minor is contingent upon prior admission to a master’s or doctoral degree-granting program in the Graduate School.

Minor Requirements—The master’s minor requires a total of 9 credits: two courses in medieval studies outside the student’s major department, including a Latin course (Latin 34xx taken as 8120, or any Latin course at the 5xxx level or above), and either one MeSt core course (5610, 8110, 8120, or 8130) or one MeSt colloquium course (8010, 8020, or 8030). The doctoral minor requires 18 credits: courses in medieval studies outside the student’s major department, including an additional Latin course at the 5xxx level or above.

Language Requirements—Latin.

For Further Information—Contact the Center for Medieval Studies, University of Minnesota, 304 Walter Library, 117 Pleasant Street S.E., Minneapolis, MN 55455 (612/626-0805; fax 612/626-7735; e-mail cmedst@tc.umn.edu).

MeSt 5610. Topics in Medieval Studies. (2-5 cr; prereq one-yr work on Middle Ages, reading knowledge of appropriate language[s])

From fall of Rome through end of Middle Ages (ca. 500 B.C. to ca. 1500 A.D.). Current topics specified in Class Schedule.

MeSt 8010, 8020, 8030. Medieval Studies Colloquium. (1 cr per qtr; prereq #)
Lectures by and discussions with faculty and visiting speakers.

MeSt 8110, 8120, 8130. Seminar in Medieval Studies. (1-5 cr per qtr; prereq #, offered when feasible)

Microbial Ecology

Regents’ Professor: Eville Gorham (ecology, evolution, and behavior)
Professor: Michael J. Sadowsky (microbiology; soil, water, and climate), director of graduate studies; Martin Dworkin (microbiology); Arnold Frederickson (chemical engineering); Greg Germaine (dentistry); Jean-Alex Molina (soil, water, and climate); Philip Regal (ecology, evolution, and behavior); Palmer Rogers (microbiology); G. David Tilman (ecology, evolution, and behavior); Lawrence P. Wackett (biochemistry; Biological Process Technology Institute)

1 University of Minnesota, Duluth
Associate Professor: Randall Hicks¹ (biology); Linda L. Kinkel (plant pathology)

Course of Study—Minor in microbial ecology, applicable to master’s (M.S. only) and doctoral programs.

Curriculum—Microbial ecology is an area of interdisciplinary research concerned with the relationships of microorganisms to their natural environment. The microbial ecology program offers a core curriculum of coursework in microbiology, microbial physiology, microbial genetics, microbial ecology, and theoretical ecology as well as additional courses and opportunities to interact with others interested in microbial ecology. The microbial ecology seminar series allows students and faculty to hear and interact with microbial ecologists from other universities. The curriculum encourages interdisciplinary interaction, communication, and synthesis.

Prerequisites for Admission—To be admitted to the microbial ecology graduate minor, a student must be admitted to a master’s or doctoral degree-granting program within the Graduate School, should have broad training in the biological sciences, and must be accepted by the director of graduate studies of the microbial ecology minor program. All students are expected to have had the equivalent of introductory microbiology (MicB 5105) and general ecology, but may fulfill deficiencies in these areas by taking these courses while in the program.

Special Application Requirements—Consult the director of graduate studies. Students are admitted each quarter.

Minor Requirements—For master’s students, 12 credits are required, all of which must be from outside the student’s major department. These 12 credits must include at least one laboratory course in microbiology (e.g., MicB 5322) and one ecology (EBB) course from the list below; the remaining courses, which are to be chosen with the guidance and approval of the director of graduate studies, can come from any of the other courses listed below. For doctoral students, a total of 24 credits are required, 17 credits of which must come from five required core courses (listed below). Contact the director of graduate studies for potential alternatives to these required courses. The remaining credits must come from at least two courses chosen from the additional courses listed below, but may not be in the student’s major area.

Language Requirements—None specific to the minor program.

For Further Information and Applications—Contact Dr. Michael Sadowsky, Microbial Ecology Minor Program, University of Minnesota, 246 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108 (612/624-2706; e-mail sadowsky@soils.umn.edu).

Core Courses
EEB 5052. Theoretical Population Ecology
MicB 5105. Biology of Microorganisms
MicB 5321. Physiology of Bacteria
MicB 5611. Microbial Ecology
MicB 8112. Microbial Genetics

Additional Courses
BioC 5301. Ecological Biochemistry
CE 5515. Water and Wastewater Microbiology
CE 8505. Aquatic Chemistry for Environmental Engineers
EEB 5601. Limnology
EEB 5608. Ecosystems: Form and Function
EEB 8602. Advanced Limnology
MicB 5322. Microbial Diversity and Physiology Laboratory
PBio 5103. Algae, Fungi, and Bryophytes
PIPa 5206. Biology of Fungi
PIPa 5211 (formerly 8111). Fungal Genetics
PIPa 5500. Epidemiology and Ecology of Plant Disease
Soil 5515. Soil Development, Classification, and Geography

¹ University of Minnesota, Duluth
Microbial Engineering (MicE)

**Professor:** Peter W. Carr (chemistry); Gary M. Dunny (microbiology); Anthony J. Faras (microbiology; Institute of Human Genetics); Michael C. Flickinger (biochemistry; Biological Process Technology Institute); James A. Fuchs (biochemistry); Richard S. Hanson (microbiology); Alan B. Hooper (genetics and cell biology); Wei-Shou Hu (chemical engineering and materials science); Theodore P. Labuza (food science and nutrition); Larry L. McKay (food science and nutrition); Palmer Rogers (microbiology); Michael J. Sadowsky (soil, water, and climate; microbiology); Janet L. Schottel (biochemistry); W. Thomas Shier (medicinal chemistry); David A. Somers (agronomy and plant genetics); Lawrence P. Wackett (biochemistry; Biological Process Technology Institute); James F. Zisser (microbiology)

**Associate Professor:** Friedrich Srienc (chemical engineering and materials science; Biological Process Technology Institute), director of graduate studies; Robert J. Brooker (genetics and cell biology; Biological Process Technology Institute); Lynda B. Ellis (laboratory medicine and pathology; Institute of Human Genetics); R. Scott McIvor (laboratory medicine and pathology; Institute of Human Genetics); Bernard C. Reilly (microbiology; oral sciences); David H. Sherman (microbiology; Biological Process Technology Institute); Peter J. Southern (microbiology); Robert T. Tranquillo (chemical engineering and materials science)

**Assistant Professor:** Daniel J. O’Sullivan (food science and nutrition); C. Rick Wagner (medicinal chemistry)

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

**Degree Offered**—M.S. (Plan A and Plan B)

**Curriculum**—Microbial engineering is an interdisciplinary program that combines an understanding of basic principles in microbiology, molecular biology, chemical engineering, and related sciences with development of technical knowledge and know-how in industrial microbiology. In addition to the major coursework, Plan B students participate in preceptorships at local private company research laboratories. Plan A students conduct research and write a thesis guided by a faculty member. Supporting coursework may be chosen from specific fields including biochemistry, food science, genetics and cell biology, or pharmacognosy.

**Prerequisites for Admission**—A baccalaureate degree in biological sciences, biochemistry, chemistry, or chemical engineering is preferred. Undergraduate coursework should include one year each of calculus, organic chemistry, physics, microbiology, and basic chemical engineering, as well as a background in basic biology, physical chemistry, biochemistry, and genetics. Deficiencies may be made up during the first year of graduate studies.

**Special Application Requirements**—Three letters of recommendation, scores from the General Test of the Graduate Record Examination, the TOEFL score for international applicants, transcripts, and an autobiographical statement including occupational goals must be submitted to the director of graduate studies. Applications are accepted at any time, but the majority of students are accepted for fall quarter. To receive full consideration for financial aid, students must apply for fall quarter admission by February 1.

**Degree Requirements**—The two-year program is planned by the student and adviser. Coursework is required in a specialized program of microbiology, molecular biology, immunobiology, and chemical engineering. In addition, students are required to present two seminars and assist with instructing one course in advanced microbiology, molecular biology, or biochemical engineering. At the end of the first year, Plan B students participate in an eight- to twelve-week industrial research preceptorship, which may form the basis of a Plan B paper. Plan A students complete a research thesis during the second year. Supporting coursework may be chosen from specified fields including biochemistry, food science, genetics and cell biology, or pharmacognosy. Proficiency in computer programming and one computer language must be demonstrated. A Plan B paper or Plan A research thesis and a final oral examination are required. For Plan A the minimum number of course credits required is 31-32 (plus 16 thesis credits); for Plan B the minimum number is 35-36 (plus 2-4 research credits).

**Language Requirements**—None.

**For Further Information and Applications**—Contact the M.S. Program in Microbial Engineering, Biological Process Technology Institute, University of Minnesota, 1479 Gortner Avenue, Suite 240, St. Paul, MN 55108 (612/625-0212; fax 612/625-1700; e-mail bpti@biosci.cbs.umn.edu).
GRADUATE PROGRAMS

MicE 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

MicE 5309. Biocatalysis and Biodegradation. (4 cr, §BioC 5309; prereq chem through organic chem, microbiol or adv chem, knowledge of word proc, e-mail, WWW access; access to college-level sci library recommended)

Note—The following courses are selected for major and minor programs; other courses are also available. Descriptions of all courses can be found in the course listings of the respective departments.

Biol 5003. Genetics. (4 cr, §GCB 3022, §GCB 5022, prereq 5001 or BioC 3021 or BioC 5331)

ChEn 5001. Computational Methods in Chemical Engineering and Materials Science. (4 cr, §MatS 5001; prereq chem engr or mat sci major)

ChEn 5101-5102-5103. Principles of Chemical Engineering I-II-III. (4 cr per qtr; prereq 5001 or §5001, IT student)

ChEn 5104. Unit Operations and Separation Processes. (4 cr; prereq 5101, upper div ChEn or MatS major)

ChEn 5301. Chemical Reactor Analysis. (4 cr; prereq 5202, upper div ChEn or MatS major)

ChEn 5751. Chemical Engineering in Biotechnology and Environment. (3 cr; prereq ChEn sr or grad student or #)

ChEn 5752. Biochemical Engineering III. (3 cr; prereq Biol 5001, ChEn grad student or sr or #)

ChEn 5756. Biochemical Engineering Laboratory. (2 cr; prereq 5751 or 5752)

ChEn 5780. Principles of Mass Transfer in Engineering and Biological Engineering. (3 cr; prereq upper div engr or science student)

FScN 5120. Food Microbiology. (5 cr; prereq 1102, 3112, VPB 3103 or MicB 5105 or #)

FScN 5123. Food Fermentations and Biotechnology. (3 cr; prereq 5120)

FScN 5555. Freezing and Dehydration of Foods. (5 cr; prereq 1102, 5135; offered alt yrs)

FScN 8323. Microbial Starter Cultures. (3 cr; prereq 5123, Biol 5001 or #; offered alt yrs)

MicB 5218. Immunology. (3 cr; prereq Biol 5001)

MicB 5232. Medical Microbiology. (3 cr; prereq 5105 or 3103 or 8110 or Biol 5013, 5216 or 5218)

FScN 8323. Microbial Starter Cultures. (3 cr; prereq 5123, Biol 5001 or #; offered alt yrs)

MicB 5218. Immunology. (3 cr; prereq Biol 5001)

MicB 5232. Medical Microbiology. (3 cr; prereq 5105 or 3103 or 8110 or Biol 5013, 5216 or 5218)

MicB 5234. Immunology and Medical Microbiology Laboratory. (3 cr; prereq 5218 or §5218, 5232 or §5232)

MicB 5321. Physiology of Bacteria. (3 cr; prereq 3103 or 5105 or Biol 5103 or VPB 3013, Biol 5001, 10 cr organic chem, 3 cr genetics)

MicB 5322. Microbial Diversity and Physiology Laboratory. (3 cr; prereq 5321 or §5321 or equiv)

MicB 5352s. Applied Microbial Biochemistry. (4 cr, §BioC 5352; prereq 5321 or BioC 3021 or BioC 5331, intro micro course or #)

MicB 5424. Biology of Viruses. (3 cr; prereq 5105 or Biol 5004 or Biol 5013, Biol 5003)

MicB 5425s. Virology and Microbial Genetics Laboratory. (3 cr, §Bio 5125; prereq 5424 or §5424, BioC 3021 or BioC 5331 or Biol 5001, 5003 or GCB 3022 or GCB 5022)

MicB 8110. Structure, Function, and Metabolism of Bacteria. (3 cr; prereq beginning microbiology, organic chemistry, biochemistry, general biology or #)

MicB 8112. Microbial Genetics. (3 cr; prereq grad major in micro or #)

MicB 8125. Microbial Ecology. (3 cr; prereq coursework in micro, biochem or #)

MIMP 8216. Frontiers of Immunology I: Molecular Immunology. (3 cr, §MicB 8216, §Path 8216; prereq MicB 5218)

MIMP 8217w. Frontiers of Immunology II: Cellular Immunology. (3 cr, §MicB 8217, §Path 8217; prereq Biol 5001 or equiv or #)

MIMP 8218s. Frontiers of Immunology III: Clinical Immunology. (4 cr, §MicB 8218, §Path 8218; prereq 8216, 8217)

Microbiology, Immunology, and Molecular Pathobiology

Regents’ Professor: Alfred Michael

Professor: Khalil Ahmed; Dwight L. Anderson; Fred S. Apple; P. Patrick Cleary; Agustin P. Dalmasso; Gary M. Dunny; Martin Dworkin; Anthony J. Faras; Michael C. Flickinger; Leo T. Furcht; Gregory R. Germaine; Ashley T. Haase; Richard Hanson; Robert P. Hebbel; Alan B. Hooper; Margaret K. Hostetter; Harry S. Jacob; Russell C. Johnson; M. Colin Jordan; John Kersey; Tucker W. LeBien; Walter C. Low; Paul T. Magee; James B. McCarthy; Larry L. McKay; Matthew F. Mescher; Theodore R. Oegema, Jr.; Harry T. Orr; Peter G. W.
Plagemann; Gundu Rao; Palmer Rogers; Andreas Rosenberg; Michael J. Sadowsky; Patrick Schlievert; Lawrence B. Schook; Janet Schottel; Burton L. Shapiro; Daniel Vallera; Brian G. Van Ness; Gregory M. Vercellotti; Lawrence P. Wackett; Lee W. Wattenberg

Associate Professor: Marc K. Jenkins, director of graduate studies; Peter B. Bitterman; Bruce R. Blazar; Aristidis S. Charonis; Kathleen F. Conklin; Lynda B. Ellis; Alejo Erice; Vincent F. Garry; Dale S. Gregerson; Betsy A. Hirsch; Ronald R. W. Jemmerson; R. Scott McIvor; Robert D. Nelson; Stewart Scherer; Leslie A. Schiff; Yoji Shimizu; Amy P. Skubitz; Keith M. Skubitz; Peter Southern; Michael Y. Tsai; Effie C. Tsilibary; Carol L. Wells

Assistant Professor: Vivian J. Bardwell; Timothy W. Behrens; Frederick T. Boyd; Rod M. Feddersen; Gregg B. Fields; William B. Gleason; Kristin A. Hogquist; Stephen C. Jameson; Vivek Kapur; Bruce R. Lester; Ambika Mathur; Daniel L. Mooradian; Daniel L. Mueller; Christopher A. Pennell; David H. Sherman; Catherine M. Verfaillie; Carston Wagner

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

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

Curriculum—The microbiology, immunology, and molecular pathobiology program was formed by the merger of the microbiology and pathobiology graduate programs. Students in the program complete a Ph.D. with specialization in one of three tracks (microbiology, immunology, or molecular pathobiology), but receive broad training in the other tracks as well. The program offers exceptional research opportunities for graduate training in the fields of genetic engineering of microorganisms, biotechnology, microbial pathogenesis, environmental microbiology, lymphocyte activation and development, autoimmunity, superantigens, cancer biology, vascular biology and inflammation, and the molecular genetics of disease. In their first year, students take courses and do laboratory rotations before identifying an adviser. Students also have weekly opportunities to participate in the program’s research seminar, journal clubs, and student research seminars. Students gain valuable teaching experience by assisting in laboratory courses for one or two quarters.

Prerequisites for Admission—College coursework, including a year of general chemistry; organic chemistry; physics; calculus; and one academic year or the equivalent of courses in the biological sciences supplemented by courses in biochemistry and genetics. A course in microbiology, immunology, or histology is highly recommended but not required.

Special Application Requirements—The following must be submitted to the program: three letters of recommendation; scores from the General (Aptitude) Test of the Graduate Record Examination; and a brief description of reasons for seeking an advanced degree, areas of research interest and reasons for these interests, and career objectives. A minimum TOEFL score of 600 is required of applicants whose native language is not English. Applicants are encouraged to apply for fall quarter admission only, because the core curriculum begins in fall. Applications should be submitted by January 1; those received after that date are considered only if space in the desired program is available.

Master’s Degree Requirements—The final examination for the master’s degree is a closed oral examination and covers all areas of microbiology as well as the student’s thesis research.

Doctoral Degree Requirements—Students choose a track early in the first year and complete the curriculum for that track. Four major field courses are required for each track. Eighteen additional credits make up the supporting program. Students complete a written preliminary examination at the end of the first year and an oral preliminary examination early in the third year. The oral preliminary examination consists of the oral defense of a written research proposition covering the student’s proposed thesis research as well as general questions in the areas of microbiology, immunology, and pathobiology.

Language Requirements—None.

Minor Requirements for Students Majoring in Other Fields—Contact the program office for information about the required minor curriculum.

For Further Information and Applications—Contact the Microbiology, Immunology, and Molecular Pathobiology Program, University of Minnesota, Box 196 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/624-5947; fax 612/626-0623; e-mail mimp@lenti.med.umn.edu).
MIMP 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

MIMP 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

MIMP 8888. Thesis Credits: Doctoral. (36 cr required)

Microbiology (MicB)

MicB 5105f, w,s.1 Biology of Microorganisms. (5 cr, §3103, §Biol 5013, §VPB 3103; prereq 5 cr biol sci, BioC 3021 or BioC 5331 or Biol 5001 or §) Hanson, Sherman

Taxonomy, anatomy, physiology, biochemistry, and ecology of microbes. Molecular structure in relation to bacterial function. Laboratory.

MicB 5201f. Microbiology for Dental Students. (8 cr) Anderson, Liljemark, Reilly
Nature and diversity of microorganisms; bacterial anatomy; nutrition and growth; variation and genetic exchange; fundamentals of immunology; pathogenic bacteria, fungi, and viruses; principles of sterilization and disinfection; chemotherapy; development and ecology of the oral flora; microbiology of dental caries and periodontal disease.

MicB 5205w. Microbiology for Medical Students. (5 cr; prereq regis med fr or #) Schlievert, staff
Basic medical aspects of immunology, parasitology, mycology, medical bacteriology, and virology with emphasis on pathogenesis. Principles and techniques enabling diagnosis, treatment (especially chemotherapy), and prevention of infectious disease.

MicB 5206s. Microbiology for Medical Students. (5 cr; prereq regis med fr or #) (Continuation of MicB 5205) Lecture and lab.

MicB 5218w. Immunology. (3 cr; prereq BioC 3021 or BioC 5331 or Biol 5001) Gray


MicB 5232w. Medical Microbiology. (3 cr; not open to med students; prereq 5105 or 3103 or 8110 or Biol 5013, 5216 or 5218) Cleary
Pathogenic bacteria and fungi; mechanisms of pathogenicity and virulence; properties of microorganisms and their animal hosts that influence the outcome of host-parasite relations analyzed from genetic and metabolic view.

MicB 5234w.1 Immunology and Medical Microbiology Laboratory. (3 cr; prereq 5218 or §5218, 5232 or §5232) Cleary, Gray
Principles that determine outcome of host-parasite interactions. Methods basic to host defense and immunology, including immunochecmical and microbiological methods for diagnosing infectious disease.

MicB 5235f. Microorganisms and Disease. (3 cr, §5233; prereq 10 cr chemistry, 5 cr biological sciences or #; not open to microbiology majors) Johnson
Lectures on nature of microorganisms, immunology, medical bacteriology, virology, mycology, and principles of disease control.

MicB 5321f. Physiology of Bacteria. (3 cr; prereq 3103 or 5105 or Biol 5013 or VPB 3103, Biol 5001, 10 cr organic chem, 3 cr genetics) Rogers
Chemical and physical organization of bacteria as related to function: growth; energy metabolism including oxidations and fermentations; nutritional requirements; antimicrobial agents; autotrophic mechanisms; microbial differentiation.

MicB 5322f. Microbial Diversity and Physiology Laboratory. (3 cr; prereq 5321 or §5321 or equiv) Dworskin, Rogers
Isolation from natural sources: physiology and metabolism of wide variety of microorganisms, such as Clostridium, yeast, Caulobacter, myxobacteria, Leptospira, photosynthetic bacteria, Bdellovibrio, luminescent bacteria, and others. Lab only.

MicB 5352s. Applied Microbial Biochemistry. (4 cr, §BioC 5352; prereq 5321 or BioC 3021 or BioC 5331, intro micro course or §) Flickinger
Biochemistry of microorganisms and enzymes of industrial interest. Heterologous peptide overproduction by microorganisms and yeasts; polymer, antibiotic, organic acid, and amino acid production; genetics of industrially useful microorganisms; biological systems useful for biotransformations and environmental mediation; introduction to fermentation technology.

MicB 5424s. Biology of Viruses. (3 cr; prereq 5105 or Biol 5004 or Biol 5013, Biol 5003) Plagemann
Structure, composition, and properties of bacterial, plant, and animal viruses; their interaction with cells and effects on host cell metabolism; biochemistry of viral replication; techniques used in study of viruses and viral infections; viral tumorogenesis.

MicB 5425s. Virology and Microbial Genetics Laboratory. (3 cr, §Biol 5125; prereq 5424 or §5424, BioC 3021 or BioC 5331 or Biol 5001, Biol 5003 or GCB 3022 or GCB 5022) Plagemann, Schif, Southern
Modern techniques: animal cell culture, virus infectivity titrations, analysis of viral nucleic acids and proteins by radiolabeling, gel electrophoresis and blot hybridizations, cell transformation by tumor viruses and DNA, analysis and mapping of mutants in microorganisms.

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1 Microscope required. Students may obtain use of microscope by purchasing a $6 microscope card from the bursar.
Sadowsky

prereq 3103 or 5105 or Biol 5013 or Soil 5610 or #)

adhesion molecules.

gene products; structure and function; costimulatory and

presentation; signal transduction in lymphokines; MHC

mechanisms of expression; antigen processing and

Molecular basis of immunological recognition: B and T

Molecular Immunology.

MIMP 8216f. Frontiers of Immunology I: Cellular Immunology. (3 cr, §MicB 8216, §Path 8217; prereq Biol 5001 or equiv or #) Jenkins Overview of B-cell/T-cell interactions, major histocompatibility complex, cell surface markers, B-cell development and responses, negative regulatory mechanisms, T-cell responses, PMNs, and macrophages.

MIMP 8217w. Frontiers of Immunology II: Clinical Immunology. (3 cr, §MicB 8217, §Path 8218; prereq 8216, 8217; offered alt yrs) Gray, Mueller Antibody-mediated hypersensitivity, cellular hypersensitivity, autoimmunity, transplantation, tumor immunology, immunocytopathy, immune deficiencies.

MIMP 8990f,w,s,su. Research in Microbiology, Immunology, and Molecular Pathobiology. (Cr ar; prereq grad major in microbiology or pathology or MIMP or #) Graduate students with requisite preliminary training may elect research project outside their thesis work.

Pathobiology (Path)

Path 5109. Seminar: Selected Topics in Pathobiology. (1 cr; prereq #; intended for Path grad students; A-F for students presenting seminars, S-N for all others) Current thesis topics and other aspects of pathobiology.

Path 5110. Seminar: Pathology. (1 cr; prereq #) Department research seminar series.

Path 8108f-8109w-8110s. Pathobiology I-II-III. (3 cr; prereq MdBc 5100, 5101 [or ¶MdBc 5100, 5101], CBN 5103, 5104 [or ¶CBN 5103, 5104] or #) McCarthy (8108), Orr (8109), LeBien (8110), staff In-depth examination of cell injury and death, cell adhesion/growth, cell cycle and aging, platelets and coagulation, immunology/immunopathology, carcinogenesis, molecular genetics and inborn errors of metabolism, inflammation and mechanisms of pathogenesis, cell biology, and biochemistry.

Path 8122w. Basic Science of Cancer. (1 cr; prereq MdBc 5100 or equiv) Wattenberg Causes of cancer and mechanisms by which neoplasia is produced.

Path 8130. Cell Biology of the Extracellular Matrix. (3 cr; prereq MdBc 5100-5101 or equiv, 8108-8109-8110 or # offered alt yrs) McCarthy Classification of extracellular matrices and structural nature of components within them; cell adhesion and spreading on extracellular matrix; extracellular matrix in certain normal and pathologic conditions.

Path 8135w. Biochemical Aspects of Normal and Abnormal Cell Growth. (3 cr; prereq # Ahmed Current studies on biochemical mechanisms in model systems relating to gene action, cell cycle, physiological, and pathological cell growth.

Path 8201. Research. (Cr and hrs ar; grads with necessary preliminary training may elect research, either as majors or minors in pathobiology) McCarthy, staff
Path 8263. Pathophysiology of Environmental Disease. (3 cr; prereq PubH 8261 or #) Garry
General mechanisms of environmentally induced tissue injury; compensatory mechanisms and repair processes; acute and chronic pathophysiology; tissue specificity of toxic agents; mutagenesis; teratogenesis.

Path 8300. Current Topics in Medical Genetics. (2 cr; prereq # or ∆) Hirsch, Orr
Current developments in medical genetics and concepts of pathogenesis of genetic diseases.

Path 8335. Mammalian Gene Transfer and Expression. (3 cr; prereq #) McIvor
Techniques, concepts, and application of gene transfer to mammalian physiology, pathology, and genetics; gene regulation, gene mapping, genetically engineered biologicals, transgenic animals, prospects for human gene therapy.

Mineral Engineering

Professor: Steven L. Crouch, head; Patrick L. Brezonik; Andrew Drescher; Charles Fairhurst; Efi Foufoula-Georgiou; Malcolm T. Hepburn; Kenneth J. Reid; Michael J. Semmens
Associate Professor: Emmanouil M. Detournay; Catherine E. French; Joseph F. Labuz; Karl A. Smith; Vaughan R. Voller
Assistant Professor: Randal J. Barnes; David E. Newcomb

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

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

Curriculum—The program is administered in the Department of Civil Engineering. The master of mineral engineering degree (M.Min.E.) is designed for engineering graduates who are interested in design, operations, or management.

Prerequisites for Admission—Adequate preparation in undergraduate subjects and in the sciences fundamental to mineral engineering is required. A bachelor’s degree in mineral engineering is required for the M.Min.E. program. Applicants to these programs who have B.S. degrees in other fields (e.g., geology, physics, chemistry) are required to make up deficiencies in the basic engineering curriculum.

Special Application Requirements—None.

Degree Requirements—For the M.Min.E. degree, see Professional Master’s Degree in Engineering in the General Information section of this bulletin. All students should consult the department publication General Information Bulletin for Graduate Students for further information.

The final examination for all master’s degrees is oral.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Civil Engineering, University of Minnesota, 122 Civil Engineering Building, 500 Pillsbury Drive S.E., Minneapolis, MN 55455 (612/625-5522).

Molecular Biology

See Biochemistry, Molecular Biology and Biophysics.
See Molecular, Cellular, Developmental Biology and Genetics.

Molecular, Cellular, Developmental Biology and Genetics

Regents’ Professor: James G. White (laboratory medicine and pathology)

Professor: Steven C. McLoon (cell biology and neuroanatomy), director of graduate studies; Dwight L. Anderson (microbiology); G. Eric Bauer (cell biology and neuroanatomy); Robert M. Brambl (plant biology); Jaroslav Cervenka (oral sciences); Bianca M. Conti-Fine (biochemistry); William P. Cunningham (genetics and cell biology); James W. Curtsinger (ecology, evolution, and behavior); Edward H. Egelman (cell biology and neuroanatomy); Robert P. Elde (cell biology and neuroanatomy); Stanley L. Erlandsen (cell biology and neuroanatomy); David P. Fan (genetics and cell biology); Anthony J. Faras (microbiology); James A. Fuchs (biochemistry); Leo T. Furcht (laboratory medicine and pathology); Burle G. Gengenbach (agronomy and plant genetics); Gordon D. Ginder (medicine); Perry B. Hackett (genetics and cell biology); David W. Hamilton (cell biology and neuroanatomy); Janet H. Heasman (cell biology and neuroanatomy); Robert K. Herman (genetics and cell biology); William S. Herman (genetics and cell biology); Mark C. Herzberg (preventive sciences); Alan B. Hooper (genetics and cell biology); Ross G. Johnson (genetics and cell biology); Richard A. King (medicine); William Krivit (pediatrics); Ryoko Kuriyama (cell biology and neuroanatomy); Hon Cheung Lee (physiology); Paul A. Lefebvre (genetics and cell biology); Paul C. Letourneau (cell biology and neuroanatomy); Richard W. Linck (cell biology and neuroanatomy).
Applicants with TOEFL scores of 650 or better will be considered.

Prerequisites for Admission—The program is sufficiently flexible to accommodate students with a wide range of backgrounds. Students with bachelor’s degrees in any of the biological, chemical, or physical sciences are encouraged to apply. Recommended academic preparation includes one year each of calculus, organic chemistry, and physics, and background in basic biology including biochemistry and genetics. Research experience is highly desirable. For students of demonstrated ability, background deficiencies can be made up during the first year of graduate study. Exceptional international applicants with TOEFL scores of 650 or better will be considered.

Special Application Requirements—Applicants are required to submit three letters of recommendation from persons familiar with their academic and research capabilities; scores from the General (Aptitude) Test and the Subject (Advanced) Test (in biology; chemistry; or biochemistry, cell and molecular biology) of the Graduate Record Examination; and a statement of interests, goals, and research experience. Recommended date for receipt of
completed applications is January 15. Graduate studies typically begin in summer session or fall term.

Master’s Degree Requirements—The average length of time required to obtain a master’s degree is two years. Students are admitted to the M.S. program only under exceptional circumstances (e.g., if, for personal reasons, they can be in the area for only two years) or if they are accepted into the genetic counseling specialization; in both cases, applicants must also be competitive for admission at the Ph.D. level.

Doctoral Degree Requirements—The Ph.D. program is designed by the student and the adviser to meet individual interests and goals. Advanced courses in genetics, molecular biology, cell biology, and biochemistry are required, in addition to special courses, topical seminar courses, laboratory research rotations, thesis research, department seminars, and journal clubs.

Language Requirements—None.

Minor Requirements for Students Majoring in Other Fields—Proposed minor courses typically include the genetics core series (GCB 8131 and 8132) and advanced cell biology courses (GCB 8148 and 8149) as appropriate to the student’s field of specialization.

For Further Information and Applications—Inquiries about admission and financial support should be directed to the Director of Graduate Admissions, Molecular, Cellular, Developmental Biology and Genetics, University of Minnesota, 250 Biological Sciences Center, 1445 Gortner Avenue, St. Paul, MN 55108 (612/624-7470; fax 612/625-5754; e-mail mcdbg@molbio.cbs.umn.edu). Inquiries about graduate program activities, courses, and research opportunities should be directed to the Director of Graduate Studies at the same address and phone number.

MCDG 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

MCDG 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

MCDG 8888. Thesis Credits: Doctoral. (36 cr required)

Molecular, Cellular, Developmental Biology and Genetics (MCDG)

MCDG 8920. Special Topics. (1-5 cr; prereq MCDG grad or Δ; S-N only)
Participation in organized symposia and short courses.

MCDG 8950. Teaching Practicum. (1 cr; prereq MCDG grad or Δ; S-N only)
Supervised experience in classroom, laboratory, and/or recitation instruction; development of skills in effective use of instructional materials, tests, and measurement.

MCDG 8970. Directed Studies. (Cr ar; prereq MCDG grad or Δ)
Content determined by student’s interests, in consultation with instructor; opportunity for independent, non-lab study.

MCDG 8990. Research. (Cr ar; prereq MCDG grad or Δ; S-N only)
Research determined by student’s interests, in consultation with faculty mentor.

Genetics and Cell Biology (GCB)

GCB 5015s. Histology: Cell and Tissue Organization. (5 cr; prereq Biol 5004 or #) Cunningham
Structure and function of vertebrate tissues and organs. Lectures combine electron microscopy, light microscopy, physiology, and cell biology of higher animals. Labs concentrate on light microscopy of mammalian tissues.

GCB 5024s. The Genetics of Development. (4 cr; prereq Biol 5003 or #) R Herman, Shaw
Introduction to current concepts of and experimental approaches to the genetic basis of morphogenesis and metazoan development. Emphasis on organisms amenable to genetic analysis, including some procaryotes and single-cell eucaryotes, a nematode and Drosophila.

GCB 5030s. Laboratory: Genetics. (2 cr; prereq 3022 or 5022 or BioC 5333 or Biol 5003)
Investigative approaches to analysis of genetic problems. Focus on a given organism or related group of organisms may differ quarterly.

GCB 5034w. Intermediate Molecular Genetics. (4 cr; prereq Biol 5003, 5004, advanced bioscience undergrad or non-bioscience grad student) Shaw
Molecular genetics of procaryotes and eucaryotes, concentrating on characterization and regulation of gene expression; techniques used to study gene expression.

GCB 5035f. Intermediate Cell Biology. (4 cr; prereq Biol 5004 or #) Iwanij
Selected scientific papers illustrating new concepts and experimental approaches to basic questions of cell organization and function. Membranes, secretion, endocytosis, the cytoskeleton, and the nucleus.

GCB 5061s. Developmental Biology. (4 cr; prereq Biol 3011 or Biol 3111, Biol 5004)
Animal embryology; morphogenesis and cellular differentiation with emphasis on vertebrates and pattern formation. Control mechanisms of development.
MOLECULAR, CELLULAR, DEVELOPMENTAL BIOLOGY AND GENETICS

GCB 5073s. Advanced Human Genetics. (4 cr; prereq 5034 or ♦) King
Application of molecular, biochemical, chromosomal, and population genetics to human variation and disease. Abnormal chromosome number and structure; abnormal enzyme, structural protein, receptor and transport; analysis of inheritance patterns; behavioral genetics; and genetic basis of common disease.

GCB 5114f. General Physiology. (3 cr; prereq Biol 3011 or Biol 3111, Biol 5001 or BioC 3021 or BioC 5331, Phys 1109 or Phys 1253 or Phys 1295) Goldstein
Quantitative approach to the study of cell function with emphasis on application of physical and chemical principles. Transport, electrical activity of cell membranes, cell contractility.

GCB 5134s. Endocrinology. (4 cr; prereq Biol 3011 or Biol 3111, Biol 5001 or BioC 3021 or BioC 5331 or ♦) W Herman
Survey of structure and function of invertebrate and vertebrate endocrine systems.

GCB 5605f. Cell Biology Laboratory. (2 cr; prereq Biol 5004 or §5004 or ♦)
Experimental approaches to cell structure, function, and replication, including microscopy, autoradiography, cell fractionation, and molecular and chemical analyses.

GCB 8131w. Advanced Genetics I. (4 cr; prereq 3022 or Biol 5003, Biol 5001 or BioC 5751 or ♦) R Herman, Simon
Comparative organization of genetic material in procaryotic and eucaryotic organisms. Mutation, complementation, and recombination as operational criteria for genetic analysis.

GCB 8132f. Advanced Genetics II. (4 cr) Hackett
Action of the gene in molecular, cellular, and organismal development. Mechanisms of information transfer and regulation of these processes in various biological systems; emphasis on examining original research.

GCB 8148w. Advanced Cell Biology I. (4 cr, §CBN 8148; prereq Biol 5004 or ♦ Brooker
Eucaryotic systems with emphasis on structure, function, and chemistry of cell organelles; also selected specialized cells. Membranes and secretion, including membrane methodologies, structure, function, synthesis, and turnover; cell surfaces, protein synthesis, glycosylation, membrane fusion, lysosomes, endocytosis, role of peroxisomes, and detoxification by endoplasmic reticulum.

GCB 8149s. Advanced Cell Biology II. (4 cr, §CBN 8149; prereq Biol 5003, Biol 5004) Hays
Eucaryotic systems with emphasis on structure, function, and chemistry of cell organelles; also selected specialized cells. Motility and cell nucleus. Roles of microtubules and microfilaments in cell locomotion, shape changes, cytokinesis, ciliary beating, and organelle redistribution; cell cycle, chromosomal structure, replication and mitosis; compartmentalization and autonomy of mitochondria and chloroplasts.

GCB 8213f. Advanced Molecular Biology II. (4 cr, §BioC 8213, §MdBc 8213; prereq BioC/MdBc 8002 or GCB 8132 or ♦)
Lectures, readings, and discussions. DNA replication, recombination and gene conversion, regulation of gene expression in procaryotes, regulation of gene expression in eucaryotes, chromatin structure and transcription, organellar gene expression.

GCB 8214w. Advanced Molecular Biology II. (4 cr, §BioC 8214, §MdBc 8214; prereq BioC/MdBc 8002 or GCB 8132 or ♦)
Lectures, readings, and discussions. RNA splicing, RNA stability, initiation and control of translation, animal viruses, gene families, transposable elements, somatic recombination, yeast molecular biology, oncogenes.

GCB 8900f, w, s. Seminar. (1 cr [may be repeated for cr]; S-N only)

GCB 8910f, w, s. Journal Clubs. (1 cr; prereq △; S-N only)
Critical evaluation of selected current literature.

GCB 8912s. Genetic Counseling in Practice. (4 cr; prereq admission to genetic counseling emphasis within genetics master’s program or ♦) LeRoy
Practical genetic counseling, communicating genetics and medical information to the family. Helping families with decision making.

GCB 8913f. Psychosocial Issues in Genetic Counseling. (3 cr; prereq admission to genetic counseling emphasis within genetics master’s program or ♦) LeRoy
Interviewing skills, supportive counseling, case study analysis.

GCB 8914w. Ethical and Legal Issues in Genetic Counseling. (3 cr; prereq admission to genetic counseling emphasis within genetics master’s program or ♦) LeRoy
Professional ethics and concerns with new technologies.

Cell Biology and Neuroanatomy (CBN)

CBN 5103. Human Histology. (3-8 cr [7 cr for med/dent fr]; prereq regis med/dent fr, Anat grad student or grad student with ♦)
Microscopic structure, cytochemical and functional aspects of cells, tissues, and organs.

CBN 8135. Biological Electron Microscopy: Techniques. (1-5 cr; prereq ♦; offered alt yrs) Erlandsen
Introduction to principles and techniques of electron microscopy. Laboratory emphasis on acquisition of skills in tissue preparation, photography, use of electron microscope and ancillary equipment.

CBN 8136. Biological Electron Microscopy: Techniques. (1-5 cr; prereq ♦; offered alt yrs) Erlandsen
Specialized ultrastructural techniques and their application to biologic problems. Laboratory emphasis on high resolution microscopy and use of scanning electron microscope.
GRADUATE PROGRAMS

CBN 8137. Biological Electron Microscopy: Interpretation. (1-5 cr; prereq 5103, 8135-8136, #; hrs ar; offered alt yrs) Erlandsen
Structure and function of cell organelles. Individual projects using advanced technics for both transmission and scanning electron microscopy.

CBN 8166. Seminar: Pancreatic Islet Biology. (3 cr; prereq #; offered alt yrs) Bauer, staff
Structure, development, physiology, and cell biology of pancreatic islets of Langerhans. Primary sources: original publications supplemented by recent reviews.

CBN 8210. Developmental Neurobiology. (3 cr; prereq 5111, Phsi 5112 or #) McLoon
Nervous system development. General mechanisms and experimental approaches.

Other Courses of Interest
Agro 8230. Cytogenetics
BioC 5025. Laboratory in Biochemistry
BioC 5529. Protein Structure and Folding
BioC 8206. Cell Signaling and Metabolic Regulation
BioC 8230. Membrane Biochemistry
Biol 5003. Genetics
Biol 5004. Cell Biology
Biol 5125. Recombinant DNA Laboratory
Biol 5951. Social Uses of Biology
CBN 8215. Molecular and Cellular Basis of Development
CBN 8223. Neurobiology of Endocrine Regulation
CBN 8301. Molecular Biology of the Cytoskeleton
EEB 5044. Evolution
MicB 5218. Immunology
MicB 5321. Physiology of Bacteria
MicB 5424. Biology of Viruses
MicB 8112. Microbial Genetics
MicB 8125. Microbial Ecology
MicB 8231. Advanced Topics in Microbial Pathogenesis
MicB 8421. Eukaryotic Molecular Virology and Tumor Biology
MIMP 8216, 8217, 8218. Frontiers of Immunology
NSc 5460. Cellular and Molecular Neuroscience
NSc 8210. Developmental Neurobiology
OPat 8012. Human and Medical Cytogenetics
OPat 8300. Human Development Genetics I
Path 8108. Pathobiology I
Path 8109. Pathobiology II
Path 8110. Pathobiology III
Path 8130. Cell Biology of the Extracellular Matrix
Path 8335. Mammalian Gene Transfer and Expression
PBio 5109. Molecular Genetics and Biochemistry of Yeasts and Filamentous Fungi
PBio 5141. Plant Cell Biology
PBio 5184. Plant Growth and Development
PBio 5221. Plant Molecular Evolution
PBio 8287. Plant Molecular Biology

Molecular Pathobiology
See Microbiology, Immunology, and Molecular Pathobiology.

Museum Studies (MSt)
Professor: Elmer C. Birney (Bell Museum of Natural History); Joanne B. Eicher (design, housing, and apparel); Robert J. Poor (art history); Janet D. Spector (anthropology); Peter S. Wells (ancient studies); Gayle Graham Yates (American studies)
Associate Professor: Suzanne J. Baizerman (design, housing, and apparel); Margaret K. DiBlasio (curriculum and instruction); Kerry J. Freedman (curriculum and instruction)
Adjunct Associate Professor: Gordon R. Murdock (Bell Museum of Natural History), director of graduate studies
Assistant Professor: Lyndel I. King (University Art Museum); David J. Rhees (history of science and technology)
Adjunct Assistant Professor: Robert Jacobsen (art history)

Course of Study—Minor in museum studies, applicable to master’s (M.A. and M.S.) and doctoral programs.

Curriculum—the museum studies minor offers a structured graduate curriculum for students interested in museums. It provides students from a variety of disciplines with an introduction to the issues involved in museum practices (e.g., educational, curatorial, administrative, and conservation). The curriculum can include seminars, directed readings, and internships.

Prerequisites for Admission—Admission to the museum studies graduate minor is contingent upon prior admission to a master’s or doctoral degree-granting program within the Graduate School. It is anticipated that no more than 15 students will be admitted to this minor each year.
Minor Requirements—Master’s students must take a total of 9 credits for the minor, doctoral students a total of 18 credits; for both master’s and doctoral students, 4 of these required credits are for the introduction to museum studies core seminar.

Language Requirements—None specific to the minor program.

For Further Information, Applications, and List of Courses—Contact the Museum Studies Minor, University of Minnesota, 300 Bell Museum, 10 Church Street S.E., Minneapolis, MN 55455 (612/624-4112).

MSt 8010. Museum History and Philosophy. (4 cr; prereq #) Historical and philosophical roots of museum development from Renaissance to modern-day museums and historical societies.

MSt 8012. Museum Practices: Curatorial and Education Departments in Museums. (3 cr; prereq 8010 or #; offered alt yrs) Practical aspects of museum work. Responsibilities and issues. Larger context of the museum in which these departments operate.

MSt 8013. Museum Practices: Technical and Administrative Departments. (3 cr; prereq 8010 or #; offered alt yrs) Practical aspects of work of technical and administrative departments in contemporary museums: standards, practices, and larger museum context in which these departments function. Collections management, security, funding, boards, public relations, installation, budgeting.

MSt 8016. Internship. (1-6 cr per qtr; prereq 8010, permission of MSt director of graduate studies after agreement between student and internship supervisor)

Music

Regents’ Professor: Dominick Argento

Professor: Everett L. Sutton, director; John E. Anderson; Lydia Artyimiw; David B. Baldwin; Alexander Braginsky; Margo Garrett; Paul A. Haack; James A. Hepokoski; Donna Cardamone Jackson; Craig J. Kirchhoff; Thomas S. Lancaster; Richard Leppert; Alex Lubet; Glenda Maurice; Ronald C. McCurdy; Sally O’Reilly; Tanya Remenikova; Judith L. Zaimont

Associate Professor: David A. Grayson, director of graduate studies; Thomas J. Ashworth; Dean W. Billmeyer; Michael Cerlin; David A. Damschroder; Jean Del Santo; Charles E. Furman; Alan L. Kagan; Young-Nam Kim; Korey B. Konkol; Claire W. McCoy; Duncan R. McNab; Stephen W. Schultz; Rebecca P. Shockley; D. Clifton Ware, Jr.; Lawrence Weller

Assistant Professor: Eric A. Becher; Mark P. Bjork; Fernando A. Meza; Paul M. A. Shaw

Affiliated Faculty: Kendall A. Betts1; Julia Bogorad2; Gary A. Bordner3; Christopher Brown4; James L. Clute1; Richard Dirlam; David W. Eagle; Elaine K. Eagle; Jorja Fleezanis1; Kathryn Greenbank2; David B. Kamminga1; Barbara G. Kierig; Adam Kuenzel1; Rosalind L. Laskin; Manuel Laureano2; James P. McGuire; Frances G. Miller; John W. Miller, Jr.1; Timothy Paradise2; Basil Reeve1; Kathy S. Romney; Ross Tolbert1; Charles Ullery2; Jeffrey W. Van; Herbert E. Winslow2

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


Curriculum—For the master of arts (M.A.) degree (Plan A and Plan B) in music (Graduate School application code 0580), emphases are offered in musicology and ethnomusicology. For the master of arts (M.A.) degree (Plan B only) in music (Graduate School application code 0580), emphases are offered in theory and composition. For the master of arts (M.A.) degree (Plan B only) in music education (Graduate School application code 0584), emphases are offered in music education and music therapy. For the master of music (M.M.) degree, emphases are offered in piano, harpsichord, organ, voice, violin, viola, cello, double bass, flute, oboe, clarinet, saxophone, bassoon, French horn, trumpet, trombone, euphonium, tuba, percussion, harp, guitar, piano pedagogy, accompanying and coaching, orchestral conducting, wind ensemble and band conducting, choral conducting, and church music (choral and organ concentrations). For the doctor of musical arts (D.M.A.) degree, emphases are offered in piano, organ, voice, violin, viola, cello, clarinet, woodwinds, trumpet, trombone, guitar, accompanying and coaching, and orchestral conducting. For the doctor of philosophy (Ph.D.) degree, emphases are offered in musicology, ethnomusicology, theory, composition, and music education/music therapy.

Prerequisites for Admission—Applicants to the M.A., M.M., Ph.D., and D.M.A. programs must hold a bachelor’s degree or its equivalent with a major emphasis in one of the following areas of music: musicology and/or ethnomusicology, theory and/or composition, performance, or music education and/or music therapy.

1 Minnesota Orchestra
2 St. Paul Chamber Orchestra
Special Application Requirements—Three letters of recommendation. In addition, applicants to emphases in musicology/ethnomusicology, theory, or composition must submit scores for the Graduate Record Examination (GRE) General Test and music Subject Test. For music education and music therapy, only the GRE General Test scores are required. Applicants whose primary language is not English must score a minimum of 500 on the TOEFL test for admission and 550 for exemption from further English study (ESL).

The various degree programs also require the following additional application materials:

<table>
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<tr>
<th>Degree Objective</th>
<th>Additional Materials</th>
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<tbody>
<tr>
<td>Theory (M.A., Ph.D.)</td>
<td>Original papers (tonal and post-tonal analysis)</td>
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<tr>
<td>Composition (M.A., Ph.D.)</td>
<td>Original scores</td>
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<tr>
<td>Musicology/Ethnomusicology (M.A., Ph.D.)</td>
<td>Original paper(s)</td>
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<tr>
<td>Music Education/Music Therapy (M.A.)</td>
<td>None</td>
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<tr>
<td>Music Education/Music Therapy (Ph.D.)</td>
<td>Original paper(s)</td>
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<tr>
<td>Accompanying/Coaching (M.M., D.M.A.)</td>
<td>Audition/Repertoire list</td>
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<tr>
<td>Choral Conducting (M.M.)</td>
<td>Audition/Interview</td>
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<tr>
<td>Church Music (M.M.)</td>
<td>Audition/Interview</td>
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<tr>
<td>Orchestral Conducting (M.M., D.M.A.)</td>
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<tr>
<td>Wind Ensemble/Band Conducting (M.M.)</td>
<td>Audition/Interview</td>
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<td>Piano Pedagogy (M.M.)</td>
<td>Audition/Interview</td>
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<tr>
<td>Performance (M.M., D.M.A.)</td>
<td>Audition/Repertoire list</td>
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</table>

For the M.M. and D.M.A. programs in performance, applicants living more than 200 miles from Minneapolis may submit a tape in lieu of a live audition. In the case of admission based on a taped recording, the appropriate level of study, including the possibility of remedial work, is determined by a live audition before registration. For the M.M. and D.M.A. in accompanying and coaching, a preliminary (audio) tape screening is required. For the M.M. and D.M.A. in orchestral conducting and the M.M. in wind ensemble/band conducting, a preliminary tape screening is required in both audio and video formats.

Although students may be admitted any quarter, opportunities for financial assistance are maximized by applying before January 15 for fall admission. Applicants to the musicology/ethnomusicology, theory, and composition emphases maximize their chances for admission by completing their applications before March 1 for fall admission.

Diagnostic Tests—Music Theory and Music History Placement Tests are administered to all entering students. All graduate students in music must demonstrate proficiency in the material found in the undergraduate music theory and ear training sequences, including the form and structure of tonal music and twentieth-century music theory and ear training. Similarly, they must demonstrate proficiency in music history from the Middle Ages to the present. Students in musicology and ethnomusicology degree programs must take an additional discipline-specific diagnostic examination at the onset of their study; during the first year, a piano proficiency test is administered for the musicology specialization and a transcription test for ethnomusicology. An audition is required for registration in all applied music courses.

Degree Requirements—Program descriptions may be obtained from the School of Music graduate studies office.

Language Requirements—For the M.M. degree and for the M.A. and Ph.D. degrees in music education, none. For the M.A. degree in music, a reading knowledge of French, German, or Italian is required. For the Ph.D. degree and the D.M.A. degrees in accompanying/coaching and orchestral conducting, two languages chosen from French, German, or Italian are required (German is required of theory and orchestral conducting majors). Substitution may be made with the approval of the relevant division when a different language is needed for an individual research project. For the Ph.D. degrees in theory and composition, one language may be replaced by a special research technique or collateral field of knowledge. For D.M.A. degree programs other than those named above, language requirements are at the discretion of the adviser according to the nature of the degree plan.

For Further Information and Applications—Contact the School of Music, University of Minnesota, 100B Ferguson Hall, 2106 4th Street South, Minneapolis, MN 55455 (612/624-0071; fax 612/626-2200; e-mail mus-adm@tc.umn.edu).
Music Applied (MusA)

Graduate courses in applied music are classified according to seven modes: elective, principal, major, secondary required, secondary elective, principal beyond requirement, and major beyond requirement. Students may not register for a course in applied music until they have passed the required applied entrance audition. The audition committee determines the mode(s) for which a student may register. Students should consult the School of Music, 100 Ferguson Hall, regarding the audition as well as the mode and level of music appropriate for fulfilling specific requirements for their degree programs. All scholarship students and all M.M. students enrolled in principal- or major-level lessons are required to register concurrently for a large ensemble. This requirement does not pertain to keyboard or guitar majors.

Applied music courses in the various modes offered at the graduate level are listed below. Credits and prerequisites for all MusA courses are:

MusA 5101 to 5123 (2 cr; prereq audition, Δ)
MusA 8201 to 8223; 8401 to 8723 (2 or 4 cr [max 12 cr]; prereq music major, Δ)
MusA 8301 to 8324 (2 or 4 cr [max 16 cr for MM; max 48 cr for DMA]; prereq audition, Δ)

Music (Mus)

Vocal/Choral/Opera Studies
(See also Music Applied section above and Ensembles)

Mus 5150. Body Awareness in Activity: The Alexander Technique for Musicians. (2 cr; University College only)
Introduction to Alexander Technique with specific applications to music performance. Emphasis on body/mind awareness to promote technical ease and freedom.

Mus 5270. Stage Movement and Acting for Singers. (2 cr; prereq audition, #)
Basic techniques; application to various forms of music theatre.

Mus 5370. Vocal Pedagogy Practicum. (1 cr per qtr [max 3 cr]; prereq sr or grad student, #)
Ware Application of principles and techniques for group or individual adult instruction at beginning, intermediate, and advanced levels. Observation of faculty while teaching students.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Elective</th>
<th>Principal</th>
<th>Major</th>
<th>Secondary Required</th>
<th>Secondary Elective</th>
<th>Principal Beyond Requirement</th>
<th>Major Beyond Requirement</th>
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</table>

Accompanying/Coaching 8324
GRADUATE PROGRAMS

Mus 5371f, 5372w, 5373s. Diction for Singers. (2 cr per qtr; prereq 12 cr of 1204 or #) Principles and techniques of singing in English, Italian, German, and French. International Phonetic Association alphabet used. 5371: English and Italian. 5372: German. 5373: French.

Mus 5374. Text and Language: A Singer’s Tools for Interpretation. (2 cr; prereq #) Maurice Specific meanings, properties, and inflections of words as used by singers for artistic interpretation; role of musical setting in defining meaning. Performance required.

Mus 5375. The Vocal Mechanism. (2-3 cr; prereq sr or grad student, #) Ware Mental and physical preparations for singing. Voice production basics of singing and speaking: respiration, phonation, registration, resonation, articulation. Anatomy and physiology of vocal mechanism. Efficient, healthy voice methods and techniques. Optional 1 credit research project.

Mus 5376. Vocal Performance. (2-3 cr; prereq sr or grad student, #) Ware Analysis and interpretation of art songs. Performance skills, styles, methods, and techniques; recital programming: career opportunities; pedagogical application of subject matter to art song performance. Optional 1 credit research project.

Mus 5377. Vocal Pedagogy. (2-3 cr; prereq sr or grad student, 5375, #) Ware Historical survey of voice pedagogues and comparative teaching methodology. Learning theory; general teaching methods and techniques; teaching child, adolescent, and aging voice; teaching pedagogy classes, individuals, and group voice. Optional 1 credit research project.

Mus 5378. Vocal Conference/Workshop. (1-2 cr; prereq sr or grad student, #) Ware Specific theme for each conference or workshop. Anatomy and physiology of vocal mechanism; scientific research and applications; vocal methods and techniques; voice use and care.

Mus 5383. Choral Conducting Technique. (2 cr; prereq #) Lancaster Techniques, rehearsal procedure. Shorter works from various eras.


Mus 5371f, 5372w, 5373s. Score Study (Choral). (4 cr; prereq grad student, #) Lancaster Analysis of various choral scores ranging from Renaissance era through 20th century. Reading of choral and choral/orchestral scores at piano, including scores employing C clefs and transposing instruments.

Mus 8754. Choral Literature: Renaissance Through Baroque Eras. (4 cr; prereq grad student, #) Lancaster Sacred and secular choral works of Renaissance and baroque eras.

Mus 8755. Choral Literature: Classical Era Through the 20th Century. (4 cr; prereq grad student, #) Lancaster Sacred and secular choral works of classical era through 20th century.

**Keyboard Studies**

(See also Music Applied section above and Ensembles and Jazz Studies)

Mus 5150. Body Awareness in Activity: The Alexander Technique for Musicians. (2 cr; University College only) See Vocal/Choral/Opera Studies for description.

Mus 5310. Piano Pedagogy Practicum. (1 cr per qtr [max 3 cr]; prereq 5351-5352-5353 or 5354-5355-5356 or #) Shockley Application of principles and techniques for group or individual instruction at elementary, early intermediate, and late intermediate levels in directed teaching setting.

Mus 5351f-5352w-5353s. Piano Pedagogy. (2 cr per qtr; prereq 12 cr in MusA 1201 or MusA 1301 or #; offered alt yrs) Shockley Demonstration and discussion of teaching techniques, methods, and materials for group and individual instruction at elementary, early intermediate, and late intermediate levels.

Mus 5354f-5355w-5356s. Advanced Piano Pedagogy. (2 cr per qtr; prereq grad piano major or 5353 or #; offered alt yrs) Shockley Demonstration and discussion of teaching techniques, methods, and materials for group and individual instruction at intermediate and early advanced levels.

Mus 5411. Instrumental Accompanying Skills and Repertoire. (2 cr; prereq accompanying major) Garrett Performance class in accompanying skills particular to orchestral reductions and “non-sonata” instrumental accompanying. Repertoire to include, but not be limited to, classical and romantic string concerti and “encore” pieces.

Mus 5421, 5422, 5423. Vocal Accompanying Skills and Repertoire. (2 cr per qtr; prereq French and German and Italian diction, accompanying or graduate vocal major) Garrett Performance class (Lieder, mélodie, opera) with emphasis on coaching techniques and performance skills of pianists and singers.
Mus 5521f-5522w-5523s. Advanced Keyboard Skills. (2 cr per qtr; prereq 3532, sr or grad student or #) Billmeyer
Students develop fluency of application of theoretical skills: diatonic and chromatic harmonic vocabulary of tonal music, transposition, modulation, improvisation, harmonization, figured bass realization and accompaniment, and reading music in C clefs and open score.

Mus 5744f, 5745w, 5746s. Piano Literature. (2 cr per qtr; prereq 12 cr of MusA 1201 or 1301 or # offered alt yrs) McNab
Literature for piano from late Baroque period to mid-20th century.

Mus 5747, 5748, 5749. Organ Literature. (2 cr per qtr; prereq 3606, 3532 or #) Billmeyer
Organ literature from 14th century to present. Influence of organ design from various periods and national schools on literature, performance.

Mus 8401, 8402, 8403. Sonata Seminar. (2 cr per qtr; prereq accompanying major; strings and winds by audition, #) Garrett
Performance class in standard Baroque, Classical, and Romantic sonatas for piano and violin, cello, viola, flute, clarinet, or oboe.

Mus 8421, 8422, 8423. Advanced Vocal Accompanying Skills and Repertoire. (2 cr per qtr; prereq French and German and Italian diction, accompanying major or DMA vocal major; MM vocal major by audition only) Garrett
Advanced performance class (Lieder, mélodie, opera) with emphasis on coaching techniques and performance skills of pianists and singers.

Instrumental Studies

(See also Music Applied section above and Ensembles)

Mus 5016. Trumpet Pedagogy. (2 cr; prereq 12 cr lower div trumpet lessons) Baldwin
Principles. Discussion of literature, history, method, and current teaching aids.

Mus 5150. Body Awareness in Activity: The Alexander Technique for Musicians. (2 cr; University College only)
See Vocal/Choral/Opera Studies for description.

Mus 5321-5322-5323. Suzuki Violin Pedagogy. (2 cr per qtr; prereq undergrad or grad string major with violin as principal performing instrument or #) Bjork
Intensive examination of philosophy and teaching techniques of Japanese pedagogue Shinichi Suzuki and their application in Western culture. Discussion, playing experience, and observation of children’s lessons in MacPhail Center Suzuki Program.

Mus 5324-5325-5326. Advanced Suzuki Violin Pedagogy. (2 cr per qtr; prereq 5323 or equiv, audition; offered when feasible) Bjork

Mus 5350. Orchestral Repertoire. (1 cr)
Performance problems in standard orchestral repertoire: style and interpretation.

Mus 5361f-5362w. Violin Pedagogy I. (2 cr per qtr; prereq 12 cr in 1205 or 1206 or 1305 or 1306 or #)
Private teaching of violin students at beginning, intermediate, and advanced levels. Discussion and demonstrations of pedagogical techniques.

Mus 5364, 5365. Cello Pedagogy. (2 cr; prereq 12 cr applied cello or MuEd 3501 or # offered when feasible) Remenikova

Mus 5366. Guitar Pedagogy. (2 cr; prereq guitar principal or major or #) Van
Teaching techniques, including historical survey of methods and etudes from late 18th century to present; variety of content and approach.

Mus 5391. History and Acoustics of Single Reed Instruments. (2 cr; prereq upper div standing in major instrument or #) Anderson
Clarinet and saxophone history and literature; mechanical design and development, acoustics, modern schools of performance.

Mus 5392, 5393. Woodwind Literature and Pedagogy I and II. (3 cr per qtr; prereq upper div standing in major instrument or grad student or #)
Anderson
5392: Major teaching methods for the five woodwind instruments, including solos and ensembles used primarily for pedagogical reasons. 5393: Major solo and chamber literature for the five woodwind instruments.

Mus 5731-5732-5733. Percussion Literature I-II-III. (2 cr per qtr; prereq upper div undergrad or grad perc major or #) Meza
Study, analysis, and performance. 5731: Orchestral/band repertoire for snare drum and percussion accessories; solo literature for percussion instruments. 5732: Orchestral/band repertoire for mallet instruments; literature for percussion ensemble. 5733: Orchestral/band repertoire for timpani; chamber music for mixed ensembles of percussion and non-percussion instruments.

Mus 5971. Music Transcription for Winds. (2 cr; prereq 3532) Baldwin
Transcription of three works with score and parts copied in ink. Principles of music manuscript and examination of examples of transcription.

Mus 8371, 8372, 8373. Wind Ensemble/Band Conducting I, II, III. (4 cr per qtr; prereq wind conducting major or #) Kirchoff
Practical conducting experience. 8371: Wind band repertoire of the 18th, 19th, and 20th centuries emphasizing stylistic and period practices; techniques of score study, analysis, and interpretation. 8372: Harmoniumusik tradition and music for small wind ensembles; rehearsal techniques and strategies. 8373: Music since 1960; contemporary notation systems; rehearsal techniques and strategies.
GRADUATE PROGRAMS

Preparing and performing a full wind ensemble/band conducting program with supporting document.

Mus 8380. Orchestral Conducting. (4-5 cr; prereq #; required for orchestral conducting majors) McCurdy
Orchestral conducting techniques, including work with diverse orchestral, operatic, choral, and dance repertoires of differing styles and periods; 17th century to present.

Mus 8389. Performance and Document: Orchestral Conducting. (4 cr; prereq 12 cr 8380, #)
Preparing and performing a full orchestral conducting program with supporting document.

Jazz Studies

(See also Ensembles)

Mus 5300. Jazz Rhythm Section Techniques. (1 cr per qtr; prereq jazz studies major or #) McCurdy
Study and function of instruments in jazz rhythm section. Bass line construction, voicings for piano and guitar, style patterns for percussion.

Mus 5301, 5302, 5303. Advanced Jazz Class Piano. (2 cr per qtr; prereq keyboard major, #) Hamilton
Jazz harmony and keyboard techniques for the advanced pianist with extensive knowledge of keyboard theory; reading chord progressions, realizing chord symbols; formula voicings, expanded harmonies, aural development, jazz style “comping” and improvisation techniques.

Mus 5331. Jazz Improvisation IV. (2 cr; prereq 3331, 3332, 3333 or audition) McCurdy
Analysis of and improvisation on advanced tunes from post-bop literature (ballads, Latin, swing, rock); application of harmony beyond seventh chords, quartal harmonies; development of knowledge of American standards.

Mus 5332. Jazz Improvisation V. (2 cr; prereq 5331 or audition) McCurdy
Analysis of and improvisation on advanced tunes from post-bop literature; application of advanced harmony; development of ability to execute in faster tempos; transposition and transcriptions.

Mus 5333. Jazz Improvisation VI. (2 cr; prereq 3331, 3332, 3333 or audition) McCurdy
Analysis of and improvisation on advanced tunes from post-bop literature; application of advanced harmony; development of ability to execute 5/4, 7/4, and other multimetered tunes, ballads, and transcribed solos.

Mus 5336. Jazz Arranging I. (2 cr; prereq 3532 or #) McCurdy
Beginning techniques for arranging for chamber jazz ensemble; vocal and instrumental.

Mus 5337. Jazz Arranging II. (2 cr; prereq 3532, 5336 or #) McCurdy
Intermediate and advanced techniques for arranging for chamber jazz ensemble; vocal and instrumental.

Mus 5341. Jazz Pedagogy. (2 cr; prereq 3532) McCurdy
Published and unpublished jazz improvisation methods and materials. Rehearsal techniques for big band, combo, and vocal jazz ensemble.

Mus 5342. Jazz Theory. (2 cr; prereq 3532 or #) McCurdy
Beginning techniques for basic chord construction, extended chords, and nomenclature in jazz idiom.

Ensembles

Mus 5290. Jazz Singers. (1 cr per qtr; prereq #) McCurdy
Sight reading, study, and performance of representative vocal jazz literature.

Mus 5330. Concerto Grosso Ensemble. (1 cr; prereq #) Kim
Study and performance of string orchestra and small chamber orchestra literature.

Mus 5340f,w,s. Jazz Ensemble. (1 cr per qtr [max 6 cr]; prereq audition, #) McCurdy
A 20-member performing organization covering significant jazz compositions and arrangements written specifically for this medium.

Mus 5360. Woodwind Ensemble. (1 cr per qtr; prereq audition) Anderson
Practice and performance of chamber music for combinations of woodwind instruments in small groups (3 or more players) and in large homogenous instrumental choirs.

Mus 5380. Brass Choir. (1 cr per qtr; prereq # Baldwin
Practice and performance of representative brass ensemble literature from antiphonal music of Giovanni Gabrieli to works of 20th century.

Mus 5390. Percussion Ensemble. (1 cr; prereq #)
Practice and performance of standard and contemporary compositions for percussion ensembles in various combinations.

Mus 5410f,w,s. University Wind Bands. (1 cr per qtr; prereq audition, #)
Wind ensemble and symphony bands perform standard and contemporary literature; concerts and tour appearances. Players from all colleges may participate.

Mus 5420f,w,s. Orchestra. (1 cr per qtr; prereq audition, #)
Symphony orchestra performs standard repertory and major works with chorus; concerts and tour appearances. Players from all colleges may participate.

Mus 5430f,w,s. Chorus. (1 cr per qtr; prereq audition, #)
Sec. 1—Women’s Chorus: Performance of concert music for women’s voices, 16th-20th centuries. Sec. 2—Men’s Chorus: Performance of concert music for men’s voices, 16th-20th centuries. Sec. 3—Concert Choir: Performance of concert music for mixed ensemble, 16th-20th centuries. Sec. 4—Choral Union: Large oratorio chorus that performs major works for chorus with orchestra. Sec. 5—Conducting Class Ensemble: Participation in laboratory ensemble for choral conducting class.
Mus 5440f,w,s. Ensemble. (1 cr per qtr; prereq #)
Performance of chamber music: duos (sonatas), trios, quartets, quintets, and other ensemble combinations for instruments and/or voices.

Mus 5460f,w,s. New Music Ensemble. (1 cr per qtr; prereq #)
Practice and performance of recent music for various combinations of vocal and instrumental ensembles.

Mus 5470f,w,s. Opera Workshop and Ensemble. (1 cr per qtr; prereq ability to sing arias satisfactorily by audition, #) Sutton
Preparation and performance of operatic arias, choruses, and scenes. Participation in fully staged or workshop productions of music-theatre repertoire.

Mus 5480. Opera Theatre. (2 cr; prereq advanced ability to sing arias satisfactorily by audition, #) Sutton

Mus 5490f,w,s. Chamber Singers. (1 cr per qtr; prereq audition, #) Lancaster
Mixed chorus of 24 voices. Performances each quarter.

Topics and Directed Studies

Mus 5950. Topics in Music. (1-5 cr [exact cr and prereq designated for each offering])
For topics, see current Class Schedule.

Mus 5970. Directed Studies. (1-5 cr; prereq #, CLA approval)
Guided individual reading or study.

Mus 8950. Topics in Music. (1-5 cr)
For topics, see current Class Schedule.

Mus 8990. Special Problems. (2-12 cr; prereq #)

Music Theory and Composition

Mus 5529. Twentieth-Century Music Theory and Analysis. (4 cr; prereq 3512 or equiv exam, grad student or #) Cherlin
Introduction; for graduate student music majors.

Mus 5532. Analysis of 20th-Century Music. (3 cr; prereq 3532)

Mus 5533. Music Since 1945. (4 cr; prereq 3532 or #)
Procedures and techniques of music composed since 1945.

Mus 5541f. Counterpoint. (4 cr; prereq 3531, 3511 or equiv) Lubet
Practice writing in polyphonic styles of Renaissance and Baroque.

Mus 5550. Composition. (2 cr per qtr [max 12 cr]; prereq 3532 or equiv, 3553 or grad student, #) Argento, Lubet, Zaimont
Original work in various forms.

Mus 5561f-5562w-5563s. Orchestration. (2 cr per qtr; prereq 3532) Argento, Zaimont
Scoring instruments for ensemble combinations and full orchestra.

Mus 5571. Schenkerian Analysis for Performers. (4 cr; prereq 3533; offered alt yrs) Damschroder
Theory and analysis of tonal music using principles developed by Heinrich Schenker. Basic concepts and notation, and their application to excerpts and short pieces from 18th and 19th centuries.

Mus 5572. Chromaticism in Late-Tonal Music. (4 cr; prereq 3534; offered alt yrs) Damschroder
Exploration of late-tonal chromatic practice through analysis of selected repertory, completion of written exercises (figured bass, harmonization of melodies, model composition), ear training, and keyboard drill.

History of technological developments that made electronic music possible; composers and compositions that reflect maturation of craft and connection with prevailing aesthetic values; equipment, principles, and techniques used in production.

Mus 5793. Analog Synthesis and Recording Techniques. (2 cr; prereq 5791 or #)
Studio work with stereo and quadraphonic tape recorders and selected microphones directed toward development of recording skills (e.g., splicing, dubbing, preparation of tape loops, and synchronization of recording on discrete channels); exploration of analog synthesis equipment and its compositional possibilities and techniques.

Mus 5795. Digital Music Synthesis and Processing Techniques. (2 cr; prereq 5793)
Studio work with digital synthesizers and processors, recording equipment, and computers (using variety of software) to develop skills in using digital equipment for composition, teaching, and performance.

Interrelations of poetic imagery, form, metrics, and sonic characteristics with aspects of musical form, including repertory from 18th through 20th centuries.

Mus 8540. Electronic Composition. (3 cr per qtr [max 12 cr]; prereq composition major, 5550 or 8550, 5795 or equiv or #)
Music composition including use of computers and MIDI equipment.

Mus 8550. Composition. (3 cr per qtr [max 18 cr]; prereq completion of undergrad major sequence in music theory and composition, #) Argento, Lubet, Zaimont
Comparative study of different approaches to teaching music theory; available literature (harmony, ear-training/sightsinging, counterpoint, composition, orchestration, form and analysis texts and anthologies); specific pedagogical problems.

Mus 8560. Readings in Music Theory. (4 cr; prereq #)
Seminars on major theoretical text or group of interrelated texts.
Mus 8565. **Text Setting.** (4 cr; prereq major in composition or choral conducting or voice or accompanying or music educ, #) Zaimont
Text setting techniques for many mediums (from jingle to art song to choral settings) through analysis of repertoire and original compositions. Emphasizes sense and sound features of language in general, nature of specific text, and special considerations in writing for voice.

Mus 8570. **Seminar in Composition.** (2 cr; prereq 8570) Zaimont
Aesthetic and technological influences on compositional attitudes and techniques; career concerns.

**Mus 8571. Composers’ Laboratory I.** (2 cr; prereq 8570) Zaimont
Current compositional styles focusing on works by class members. Project involving composing to specification for possible radio/TV/theatre/dance/film use.

**Mus 8572. Composers’ Laboratory II.** (2 cr; prereq 8570, 8571) Zaimont
Analytical/critical project based on research into current factors influencing criticism in arts/music journalism. Current compositional styles focusing on works by class members.

Mus 8575. **Women Composers.** (4 cr; prereq #) Zaimont
Contributions by women composers to development of European-American art music, primarily from the 17th through 20th centuries. Historical and current issues affecting women’s access to professional music sphere. Music analysis, listening list, research and performance components.

**Mus 8580. Topics in Tonal Analysis.** (4 cr; prereq #)
Seminars on major composition or group of interrelated compositions from tonal period.

**Mus 8581-8582. Schenkerian Theory and Analysis I-II.** (4 cr per qtr; prereq 3534 or #)
Damschroder
Critical reading of major treatises by Heinrich Schenker, including *Harmony, Counterpoint, and Free Composition*. Application of his method to representative repertoire from 18th and 19th centuries. Contrapuntal writing modeled after presentation in *Counterpoint*.

**Mus 8590. Topics in 20th-Century Analysis.** (4 cr; prereq #)
Seminars on major composition or group of interrelated compositions from 20th century.

**Mus 8863. Seminar: Theories and Concepts in Post-Tonal Music.** (4 cr; prereq completion of 3-yr undergrad theory program or equiv) Cherlin
Discussion of post-tonal music theories (as conceived by composers and theorists) and views of such music for which theories have not been articulated, using appropriate writings and scores.

**Musicology and Ethnomusicology**

**Mus 5182. Baroque Performance Practice.** (4 cr; prereq sr or grad student, 3606, 3532 or #)
Ornamentation, phrasing, articulation, and improvisation in music of period 1550-1759. Instruction books of period; analysis of performance of baroque music in baroque style.

**Mus 5644. Studies in 20th-Century American Music.** (4 cr; prereq 3606, 5532 or #) Hepokoski
Competing concepts of musical style and purpose in 20th-century America: stylistic and cultural bases of both “art” and “popular” music and their (often uneasy) interrelationships. Typical areas include Ives, Copeland, 1920s jazz, Broadway, and popular song.

**Mus 5645. Eighteenth-Century European Music.** (4 cr; prereq 3606 or equiv [12 undergrad cr in mus hist], 3534 or equiv, # for undergrads)
Survey of vocal and instrumental genres (opera and church, orchestral, chamber, and keyboard music) as they developed from High Baroque through Classical era.

**Mus 5646. Nineteenth-Century European Music.** (4 cr; prereq 3606 or equiv [12 undergrad cr in mus hist], 3534 or equiv, # for undergrads) Grayson, Hepokoski
Survey of major composers, issues, and problems in history of 19th-century European music: transformations of sonata and symphony, “absolute” and “program” music, opera and “music drama,” aesthetic conceptions of music, structural and harmonic innovations.

**Mus 5647. Twentieth-Century European/American Music.** (4 cr; 3606 or equiv, 12 undergrad cr in mus hist, 5532 or equiv, # for undergrads) Jackson

**Mus 5666. Stravinsky.** (4 cr; prereq 12 cr music history, 5532) Jackson
Changing styles and aesthetic principles of Stravinsky as seen in representative compositions and writings on music; contributions to artistic life in Europe and America (particularly ballet).

**Mus 5757, 5758. History of the Symphony.** (4 cr per qtr; prereq 3606, 3532; offered when feasible)

**Mus 5804. Folk and Traditional Music: Cross-Cultural Survey.** (4 cr; offered when feasible) Kagan

**Mus 5810. Asian Music in Performance.** (2 cr; prereq #) Kagan
Development of vocal and/or instrumental skills through applied training and lecture demonstrations.

**Mus 5811. Traditional Indian Music: The Sacred and the Profane.** (4 cr) Kagan
Vedic chant and regional folk music. Musical analysis and associations with belief systems, social institutions, history and aesthetic expression. Music theory of India, notational systems, tonal and rhythmic materials and classifications, musical forms and performance practices.
Mus 5841. Resources for Music Research. (2 cr; prereq 3606 or #) Probst
Introduction to use of basic bibliographies and indexes, reference works, periodicals and historical editions; techniques for preparing an annotated bibliography.

Mus 5863. Musical Instruments of the World. (4 cr; offered when feasible) Kagan
Repertoire and performance practice of American fiddle music; rural and urban contexts; social, stylistic, and regional history. Training in performance is optional.

Mus 5864. American Fiddle Traditions. (4 cr; prereq #) Kagan
Repertoire and performance practice of American fiddle music; rural and urban contexts; social, stylistic, and regional history. Training in performance is optional.

Mus 8631f. Music in Medieval Europe. (4 cr; prereq 3606; offered alt yrs) Jackson
Medieval styles from 9th through 13th centuries: chant and liturgy, lyric song forms, polyphonic genres. Analysis and criticism, performance traditions in sociocultural contexts.

Mus 8632w. Music of the Ars Nova and Early Renaissance. (4 cr; prereq 3606; offered alt yrs) Jackson
History of music from Machaut through Josquin: secular song, mass and motet. Analysis and criticism, performance traditions in sociocultural contexts.

Mus 8661. Seminar: Editing Lasso’s Music for Performance. (4 cr; prereq undergrad degree in music) Jackson
Preparation of scores from primary sources of vocal and instrumental music (partbooks and tablatures); performance traditions in sociocultural contexts.

Mus 8664. Research in Ethnomusicology. (4 cr; prereq 5861 or #) Kagan
Methods and techniques of fieldwork, eliciting and collecting. Practicum in field research with Minnesota ethnic and Indian music. Theories of transcription and actual transcription of materials collected. Description of musical compositions and analyses. Advanced readings in ethnomusicology.

Music Education (MuEd)

MuEd 5111. Research in Music Education: Bibliography. (3 cr) Schultz
Sources, materials, and techniques.

MuEd 5113. Research in Music Education: Techniques. (3 cr) Furman, Haack
Methods and techniques employed in investigating and reporting of music education problems; review of significant research and proposal development.

MuEd 5115. Research in Music Education: Measurement. (3 cr) McCoy
Measurement and assessment in music education; survey of testing materials and methods of assessment.

MuEd 5211. Philosophical Foundations of Music Education. (3 cr; offered alt yrs) Haack
Analysis and interpretation of philosophies in music and education as applied to teaching of music.

MuEd 5214. Psychological Foundations of Music Education. (3 cr; offered alt yrs) Furman
Analysis and interpretation of psychologies of music and education as applied to teaching of music.

MuEd 5217. Historical Foundations of Music Education. (3 cr; offered alt yrs) Furman
Analysis and interpretation of important elements in modern music teaching derived from the past.

MuEd 5313. Influence of Music on Youth Behavior. (3 cr) Haack
How music functions to influence human behavior; effects of commercial styles on children and youth. Particularly appropriate for teachers and parents.

MuEd 5606. Movement-Based Methods for Music Education. (3 cr) McCoy
Participation in movement activities; Dalcroze philosophy and techniques; applications of movement to music education; examination of research.

MuEd 5611. Teaching Music With Related Arts. (3 cr) Haack
Techniques and materials for teaching music in cultural context, including other art forms.

MuEd 5612. Multicultural Music for Teachers. (3 cr) Haack
For teachers of all subject areas. Educational uses of music from various cultures, including American subcultures, across the curriculum; music and sociocultural values; cross-cultural uses and functions of music; materials development for classroom use.
MuEd 5613. Teaching Music Literature. (3 cr; offered alt yrs) Haack
Principles, methods, and materials for teaching music literature, history, appreciation, uses, and functions in grades K-12.

MuEd 5621. Supervision and Administration of School Music. (3 cr; offered alt yrs) Analysis and evaluation of instructional, supervisory, and administrative techniques; readings, new trends.

MuEd 5633. Techniques and Materials: Choral Ensembles. (3 cr) McCoy
Empirical research and literature on voice development in individual, class, and choral work; instructional techniques for choral music classes; choral repertoire for varied ensembles.

MuEd 5647. Teaching the Percussion Instruments. (3 cr; offered alt yrs) Schultz
Practical performance, demonstrations, and discussion of research in performance techniques. Contemporary approaches for teaching in schools.

MuEd 5655. New Dimensions in Music Education. (3 cr) Haack
Analysis of recent curricular trends and current issues.

MuEd 5666. Microcomputers in the Music Classroom. (3 cr) Schultz
Using the microcomputer to enhance instruction; materials for theory, ear training, composition, electronic music; developing a database for music libraries, instrument inventories, budgets.

MuEd 5667. Computer-Based Music Instruction. (3 cr) Schultz
Design, development, and implementation of computer applications for the music classroom, emphasizing HyperCard environment with interactive audio, video, and MIDI.

MuEd 5668. Computerized Music Notation. (3 cr) Schultz
Fundamentals of music notation and printing using Macintosh computer, MIDI keyboards, and Finale software. Preparation of instrumental and vocal scores, part extraction, and page layout.

MuEd 5669. Conducting the Musical Show. (3 cr) Schultz
Rehearsal techniques, coordination of singing actors and instrumental accompaniment, conducting of pit orchestra; lab performance and listening activities focus on traditions and trends in musical theatre.

MuEd 5750. Topics in Music Education. (1-6 cr [max 12 cr])
Selected topics in music education. Each offering focuses on a single topic.

MuEd 5802. Psychology of Music II. (4 cr; prereq 3801) Haack
Elements of music and their psychological effects; music ability and its measurement; research methods applied in psychology of music studies.

MuEd 5804. Music in Therapy. (3 cr; grad student in mus educ or mus therapy or #) Furman
Principles and methods related to public school, hospital, and other community mental health and education settings; observation and laboratory sessions.

MuEd 5821. History of Music Therapy. (3 cr; offered when feasible) Furman

MuEd 5831. Music for Exceptional Children. (3 cr; offered alt yrs) Furman
Trends; methods and materials for a functional program of singing, playing, rhythm, listening, and creative activities for mentally and physically handicapped and gifted pupils.

MuEd 5970. Independent Study. (1-4 cr; prereq music ed/therapy or grad student, #)
Independent study project organized by the student in consultation with the appropriate instructor.

MuEd 5821. Music Education Seminar: Philosophical Issues. (3 cr; prereq MA in music or music educ or #) Haack
Survey and analysis of issues in philosophical foundations of music education.

MuEd 5822. Music Education Seminar: Historical Issues. (3 cr; prereq MA in music or music educ or #) Schultz
Survey and analysis of issues in historical foundations of music education.

MuEd 5823. Music Education Seminar: Psychological Issues. (3 cr; prereq MA in music or music educ or #) Furman
Survey and analysis of issues in psychological foundations of music education.

MuEd 8700. Seminar: Advanced Topics in Music Education/Therapy. (1-4 cr; prereq #)
Issues and problems in music education/therapy theory, research, and practice.

MuEd 8880. Master’s Research Project. (1-8 cr; prereq 5112 or #)
Individual Plan B projects.

MuEd 8990. Research Problems. (1-12 cr; prereq knowledge of elementary statistics, #)
Individual projects.

Music Education
See Music.

Neuroscience (NSc)
Professor: Timothy J. Ebner (neurosurgery), director of graduate studies; Alvin J. Beitz (veterinary biology); Gary Birnbaum (neurology); Dwight A. Burkhardt (psychology); Marilyn E. Carroll (psychiatry); Bianca Conti-Fine (biochemistry); Robert P. Elde (cell biology and neuroanatomy); Esam E. El-Fakahany (psychiatry); Apostolos P. Georgopoulos (physiology); Glenn J. Giesler, Jr. (cell biology and neuroanatomy); Boyd K.
Neuroscience is a relatively new field of scientific inquiry. The objects of this inquiry—the brain and nervous systems—are sufficiently complex and unique among biological systems as to require analytical approaches that cross the traditional boundaries of anatomy, behavioral biology, biochemistry, cell biology, genetics, pharmacology, physiology, and psychology. In some instances, neuroscientific inquiry also encompasses the disciplines of computer science, information processing, engineering, physics, and mathematics.

The neuroscience curriculum for the Ph.D. begins in the summer session with the intensive laboratory course in cellular and molecular neurobiology (5550), held at the Lake Itasca Biological Station at the headwaters of the Mississippi River in northern Minnesota. The core curriculum continues through the academic year at the Twin Cities campus with a series of seven courses: NSc 5460, NSc 5461, NSc 5480, NSc 5660, NSc 8210, CBN 5111, and Phsl 5112. While taking these courses, students explore research opportunities in the laboratories of the faculty and thereby select a thesis adviser. Elective courses and a minor or supporting program are selected through consultation between the student and the adviser. Students with sufficient background and previous course experience may apply for waiver of appropriate requirements. Because thesis research is expected to include statistical analysis of data, a course in statistics (such as Stat 5021) is required. Proficiency in at least one computer programming language is highly recommended.

Prerequisites for Admission—Applicants to the Ph.D. program must have a bachelor’s degree or its foreign equivalent from a recognized college or university. Undergraduate coursework should include instruction in several of the following disciplines: mathematics, physics, chemistry, computer science, information processing, engineering, psychology. In some instances, neuroscientific inquiry also encompasses the disciplines of computer science, information processing, engineering, physics, and mathematics.

Degree Requirements—The written preliminary examination is administered to students before the start of the second year. Upon completion of most of the elective and minor courses, students take the preliminary oral examination. The final oral examination is a defense of the research presented in the thesis.

Language Requirements—None, although a reading knowledge of a foreign language relevant to the student’s major field of interest is highly recommended.
Minor Requirements for Students Majoring in Other Fields—The program for an individual student is developed by consultation between the student and the director of graduate studies for neuroscience. Students must take NSc 5460, NSc 5461, NSc 5660, CBN 5111, Phsl 5112, and elective courses in one area, for a minimum total of 18 credits (including the core courses).

For Further Information and Applications—Contact the Neuroscience Program, University of Minnesota, 421 Lions Research Building, 2001 6th Street S.E., Minneapolis, MN 55455 (612/626-9206; e-mail neurosci@tc.umn.edu).

NSc 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

NSc 8888. Thesis Credits: Doctoral. (36 cr required)

Required Courses

NSc 5460-5461. Cellular and Molecular Neuroscience. (3 cr per qtr; for 5460: §GCB 5460, §MdBc 5460, §Phcl 5460, §Phsl 5460, §VPB 5460; for 5461: §GCB 5461, §MdBc 5461, §Phcl 5461, §Phsl 5461, §VPB 5461; prereq biochem) Boland, staff
Gene structure and regulation, cloning and molecular strategies for studying gene function, ion channels and membrane excitability, synaptic transmission, receptor structure and function, and signal transduction.

NSc 5480. Invertebrate Neurobiology. (2 cr, §Ent 5480) Mesce
Cellular bases of invertebrate behavior. Functional organization of nervous systems common to invertebrates and vertebrates. Sensory, motor, and central integrative systems, neuromodulation, learning, and neurogenetics.

NSc 5550. Itasca Cell and Molecular Neurobiology Laboratory. (6 cr; prereq NSc grad student or Δ) Poppele
Intensive laboratory introduction to cellular and molecular aspects of research techniques in contemporary neurobiology; held at Itasca Biological Station. Electrophysiological investigations of neuronal properties, neuropharmacological assays of transmitter action, and immunohistochemical studies in experimental preparations.

NSc 5660s. Behavioral Neuroscience. (4 cr; prereq NSc major or minor or #) Georgopoulos
Introduction to animal behavior from neuroscience perspective. Neural mechanisms for orientation and migration, rhythms, sleep, reproduction, motivated behaviors, perception, learning and memory, communication, and behavioral disorders.

NSc 8210s. Developmental Neurobiology. (3 cr, §CBN 8210; prereq CBN 5111, Phsl 5112 or #) Letourneau, McLoon
Nervous system development. General mechanism and experimental approaches.

NSc 8333. Lab Neuroscience. (Cr ar; prereq NSc grad student or Δ)

CBN 5111. Human Neuroscience A. (4 cr; prereq regis med fr or grad student, #; CBN 5111-Phsl 5112†) Giesler
Structure and function of nervous system, including organs of special sense.

Phsl 5112. Human Neuroscience B. (3 cr; prereq regis med fr or grad student; CBN 5111-Phsl 5112†) Giesler

Elective Courses

NSc 5031. Perception. (4 cr, §Psy 5031; prereq Psy 3051 or Psy 3031 or #) Legge
Data and principles of visual perception: color vision, pattern vision, object recognition, abnormal vision, and physiological optics.

NSc 5034. Psychobiology of Vision. (4 cr, §Psy 5034; prereq Psy 3031 [except for grads] or #) Burkhardt
Biological and physical aspects of hearing: auditory psychophysics; theories and models of hearing; perception of complex sounds, including music and speech; clinical and other applications.

NSc 5100. Introductory Neurobiology Laboratory at Itasca. (3 cr; prereq upper div student in biological or physical sciences, intro biol and chem, #) Concepts in cellular neurosciences in laboratory environment. Basis of membrane properties, including ionic and molecular mechanisms of resting, action, and synaptic potentials. State-of-the-art equipment and contemporary techniques used to examine experimental evidence.

NSc 5102. Veterinary Neurobiology. (3 cr, §VB 5102; prereq #) Fletcher
Structural and functional organization of central nervous system of domestic animals.

NSc 5150. Introduction to Neuroscience. (3 cr, §GCB 5150, §Phsl 5150; prereq Biol 3011 or equiv or Phsl 3055-3056, BioC 3021 or equiv or #) Fohlmeister
Survey of field from invertebrates to human. Ion channels and membrane currents, neurotransmitters and signal transduction, neuroanatomy, sensory and motor systems, learning and memory, emotion, disease states, neural networks, and development.

NSc 5201. Computational Neuroscience I: Membranes and Channels. (5 cr, §Phsl 5201; prereq Phsl 5112 or equiv) Fohlmeister
Comprehensive examination of membrane and ion channels using UNIX work stations to simulate their properties. Hodgkin-Huxley model, nonlinear dynamic systems, voltage and ligand gated ion channels, impulse propagation.
NSc 5202. Computational Neuroscience II: Cells and Circuits. (5 cr; prereq understanding of UNIX, Phsl 5201 or equiv) Miller
Comprehensive investigation of computational properties of single neurons and locally connected cell networks. Linear cable theory; compartmental modeling of single neuron properties; spatio-temporal interactions between synaptic inputs and neuronal dendritic trees; computational properties of passive and active dendritic spines and spine clusters; quantitative interpretation of whole-cell voltage-clamp data; and dynamics of locally connected cell networks.

NSc 5203. Computational Neuroscience III: Neural Systems and Information Processing. (5 cr, §Phsl 5203; prereq 5202 or equiv) Poppele, Soechting
Quantitative examination of information processing by networks of neurons based on experimental data and theoretical models. Neural codes, neural network models and information processing, neural control systems, computational maps.

NSc 5400. Veterinary Pharmacology. (3 cr, §VB 5400; prereq VB 5310 or equiv or §) Larson
General principles of drug action, disposition, and use, focusing on drug action in central and peripheral nervous systems. Pharmacology of autonomic drugs, local anesthetics, parenteral general anesthetics, tranquilizing agents, analleptics, anticonvulsants, and neuromuscular blockers.

NSc 5444. Muscle Contraction. (3 cr, §MdBc 5444, §Phsl 5444, §VB 5444; prereq undergrad biochem or physiology courses or §) Louis, Poppele, Thomas
Introduction to physiology, biochemical regulation, and physical chemistry of muscle contraction.

NSc 5462. Neuroscience Principles of Drug Abuse. (2 cr; prereq #) offered alt yrs) Law, Wilcox
Current research on drugs of abuse: their mechanisms of action, characteristics shared by various agents, and cellular and neural systems affected by them.

NSc 8026. Neuro-Immune Interactions. (3 cr, §PNL 8026, §Psy 8026, §VMic 8026; prereq 5111 or equiv, MicB 5218 or equiv) Sharp
Regulatory systems (neuroendocrine, cytokine, and autonomic nervous systems) linking brain and immune systems in a brain-immune axis. Functional effects of bidirectional brain-immune regulation.

NSc 8031. Seminar: Visual Perception. (3 cr, §Psy 8031; prereq Psy 5031 or #) Legge
Physiological, psychophysical, and cognitive determinants of visual perception.

NSc 8124. Recent Advances in Chemoreception Science. (1 cr; prereq #) Sorensen
Interdisciplinary and comparative seminar. Receptor function, signal transduction, coding, central pathways, animal behavior, and psychophysics.

NSc 8207. Seminar: Psychopharmacology. (3 cr on completion of 3 qtrs, §Phcl 8207; prereq #) Sparber
Topics on behavioral aspects of drug action.

NSc 8216. Selected Topics: Neurophysiology. (Cr ar, §Phsl 8216; prereq CBN 5111, Phsl 5112 or equiv or #)
Advanced seminar.

NSc 8217. Selected Topics: Systems and Computational Neuroscience. (2 cr; prereq CBN 5111, Phsl 5112 or equiv or #) Poppele, Soechting, staff
Advanced seminar.

NSc 8221. Neurobiology of Pain and Analgesia. (3 cr, §CBN 8221; prereq # offered in alt sequence with 8222 and 8223) Giesler
Neural systems underlying pain perception, production of analgesia.

NSc 8222. Central Regulation of Autonomic Function. (3 cr, §CBN 8222; prereq # offered in alt sequence with 8221 and 8223) Engeland, Osborn
Morphology and physiology of autonomic ganglia and enteric nervous system, neuronal circuitry underlying central regulation of pupil, exocrine glands, cardiovascular system, respiratory system, and pelvic viscera.

NSc 8247. Physiology of Hearing. (3 cr, §Otol 8247; prereq #) Javel
Structure and function of mammalian auditory systems. Cochlear anatomy; basilar membrane mechanics, cochlear potentials, and the anatomy and neurophysiology of auditor nerve and nuclei.

NSc 8248. Readings in Auditory Physiology. (1-3 cr, §Otol 8248; prereq #) Santi
Current research on biophysics and physiology of auditory system; topics selected for each student. Preparation and discussion of written reviews.

NSc 8324. Readings in Neurobiology. (1 cr per qtr, §NSu 8324; prereq Phsl 8104 or #)
Survey of major topics in neurobiology.

NSc 8325. Developmental Neuropsychobiology. (3 cr, §CPsy 8325; students taking course to fulfill core reqs for PhD in CPsy must take it A-F) Gunnar, C Nelson
Research and theory on human brain and endocrine activity and their relations with behavioral development. Memory development, stress and coping in children, development of sex differences.

NSc 8400. Neurobiology of Disease. (2 cr; prereq 5111 or CBN 5111, 5112 or Phsl 5112, 5460 or #) Ross
Major neurological diseases; pathogenic mechanisms of neurologic disease; potential applications of advances in basic neuroscience to human disease.

NSc 8450. Teaching in Neuroscience. (1 cr; prereq #)
Students serve as primary instructors in NSc 5150 and work with fellow students and faculty mentors to design curriculum, classroom sessions, exams, and course evaluations.
Nursing (Nurs)

Professor: Sandra R. Edwards, dean; Sheila A. Corcoran-Perry; Mark E. Nesbit; Muriel B. Ryden; A. Marilyn Sime; Mariah Snyder; Patricia S. Tomlinson

Associate Professor: Ellen C. Egan, director of graduate studies; Margaret J. Bull; Patricia Crisham; Sara S. DeHart; Laura J. Duckett; Bernadine M. Feldman; Cynthia R. Gross; LaVohn Josten; Barbara J. Leonard; Betty Lou Lia-Hougberg; Ruth D. Lindquist; Marilee A. Miller

Assistant Professor: Melissa D. Avery; Linda H. Bearinger; Donna Z. Bliss; Derryl E. Block; Helen E. Hansen; Merrie J. Kaas; Kathleen Krichbaum; Marsha Lewis; Linda L. Lindke; Carol Pederson; Janice Post-White

Adjunct Assistant Professor: Barbara Vellenga

Other: Donna J. Brauer; Christine A. Heine; Rhoda T. Hooper

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

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

Curriculum—Emphases in the M.S. program include nurse education, nurse administration, advanced clinical practitioner in psychiatric mental health nursing, child and family nursing, adult health nursing, gerontology nursing, oncology nursing, nursing for children with special health needs, and public health nursing; or practitioner preparation as a nurse midwife, pediatric nurse practitioner, gerontological nurse practitioner, women’s healthcare nurse practitioner, and family nurse practitioner. The Ph.D. program prepares creative and productive scholars in nursing. Students can gain a depth of knowledge and experience in the development and modification of health-related behaviors; human responses to environmental and life process events disruptive to health; phenomenon of health; organization and system of delivery of nursing knowledge; and organization and system of delivery of nursing care. An individualized program and independent research are planned by the student and adviser.

Prerequisites for Admission—In the M.S. program, a bachelor’s degree with a major in nursing or evidence of ability in health promotion, community health nursing, leadership/management, teaching/counseling, and systematic investigation, as well as licensure as a registered nurse, are required. For the Ph.D. program, a master’s degree with a strong background in the physical and/or behavioral sciences or a bachelor’s degree with an exceptionally strong background are required.

Special Application Requirements—For the M.S. degree, three letters of reference and a goal statement are required. Graduate Record Examination (GRE) General Test scores are required for applicants with narrative transcripts from previous college work; the scores are recommended for students competing for a Graduate School Fellowship. For the Ph.D. degree, GRE General Test scores, two letters of reference, and a statement of goals, objectives, and research interest are required. The application deadlines for the M.S. program are December 15 for spring, summer, or fall quarter admission; April 15 for summer, fall, or winter quarter admission; and October 25 for winter, spring, or summer admission. Acceptance into the Graduate School before February 1 is required for the nurse practitioner areas of study. The application deadline for the Ph.D. program is January 25 for fall quarter admission.

Master’s Degree Requirements—The Plan A program is individually planned with a faculty adviser and must include a course in nursing research methodology. The Plan B program must include 32 credits in the major distributed in specific categories; required are Nurs 8010, Nurs 8011, and Nurs 8014 (3 credits each) and 4 credits of 8050 for the Plan B project. For more information, see the School of Nursing publication Graduate Study in Nursing. A final oral examination is required for both plans. Graduate students admitted as of fall 1990 must be registered in the Graduate School each quarter they work with advisers on research projects.

Doctoral Degree Requirements—Students plan with their advisers individualized programs of study and independent research subject to approval by a faculty committee. A total of 18 credits in a minor field or supporting program is required. Graduate students admitted as of fall 1990 must be registered in the Graduate School each quarter they work with advisers on research projects.

Language Requirement—None.

For Further Information and Applications—Contact the School of Nursing, University of Minnesota, 6-101 Weaver-Densford Hall, 308 Harvard Street S.E., Minneapolis, MN 55455 (612/624-4454; fax 612/626-2359; e-mail hanso041@tc.umn.edu; http://www.nursing.umn.edu/).
Nurs 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

Nurs 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

Nurs 8888. Thesis Credits: Doctoral. (36 cr required)

Theoretical and Ethical Foundations of the Discipline

Nurs 5711. Spirituality and Nursing Practice. (2-3 cr; prereq Nurs sr or RN [for undergrad cr] or RN with baccalaureate degree [for grad cr])
Concept of spirituality as integral to the whole person. Spiritual nursing care interventions within context of nursing process.

Nurs 5738. Transcultural Nursing: Theories and Issues. (2-3 cr; prereq cultural anthropology course, Nurs grad student or RN or #)
Cultural factors that influence theories, issues, and nursing care practice in diverse cultures and subcultures. Emphasis on nursing within international systems of healthcare and nursing practices related to health-illness systems in United States and worldwide.

Nurs 5902. Nursing and the Politics of Health. (3 cr; prereq grad student, #) Feldman, Josten
Relationship of changing social policy to health services and impact on funding for nursing education, research, and service.

Nurs 5960. Advanced Public Health Nursing. (3 cr; prereq 8010 or #8010, Nurs grad student or nurse grad student in another field) Lia-Hoagberg

Nurs 8010. Structure of the Discipline of Nursing. (3 cr; prereq Nurs grad student or #) Block, Egan, Simé, Vellenga
Exploring purposes, characteristics, and kinds of structures with emphasis on theories, models, and conceptual frameworks.

Nurs 8011. Moral and Ethical Positions in Nursing. (3 cr; prereq Nurs grad student or #) Block, Corcoran-Perry, Crisham, Hooper
Influence of moral and ethical positions on behavior and decision making in nursing. Emphasis on bases for positions taken, such as selected moral and ethical theory, rights and responsibilities, and conflict.

Nurs 8012. Conceptual Framework for Nursing Practice. (3 cr; prereq 8010, Nurs grad student or #) Egan
Exploration and reconceptualization of assumptions, values, and beliefs underlying learner’s view of nursing and nursing practice. Analysis of structure of a nursing conceptual framework and development of personal framework. Concept of intervention model and systematic process that underlies development of such a model.

Nurs 8110. Theoretical Foundations of the Discipline. (4 cr; prereq 8012 or equiv, knowledge of philosophy of science, Nurs grad student or #) Sime
Analysis of knowledge systems and relevant research; identification of boundaries of knowledge and projection of needs for further knowledge development and testing.

Nurs 8111. Moral and Ethical Development in Nursing Science. (4 cr; prereq 8011 or equiv, Nurs grad student or #) Crisham
Interaction between research and theory in moral judgment and behavior, applied ethics, and nursing.

Nurs 8220, 8221. Seminar: Developing Nursing Knowledge I, II. (1 cr; prereq Nurs PhD student or #; Nurs grad majors must take both courses)
Critique of selected philosophical perspectives and research methodologies.

Nurs 8800. Phenomenon of Health. (3 cr; prereq Nurs grad student or #) Newman
Examination of assumptions and scientific perspectives of differing views of health; articulation and evaluation of holistic view of person-environment and health.

Nurs 8802. Phenomenon of Health II. (3 cr; prereq 8800, #)
Philosophical, theoretical, and methodological implications of nursing paradigm that incorporates transformative view of health as evolving pattern of the whole. Emphasis on integration of theory with appropriate methods of inquiry.

Nurs 8900. Theoretical Foundations of Health-Related Behaviors. (3 cr; prereq #) Snyder
Research and theory in development and modification of health-related behaviors and human responses to events disruptive to health. Formulation of hypotheses for nursing research.

Methodological Foundations of the Discipline

Nurs 5644. SPSS Programming and Data Analysis. (2 cr; prereq inferential statistics, grad or professional college student, # for undergrads)
Collecting and analyzing data using SPSS for Windows. Statistics reviewed, emphasizing analysis and interpretation of output.

Nurs 5720. Written Communication Skills for Health Professionals. (3 cr; prereq knowledge of medical terminology) Schoenfelt
Students critique each other’s work for organization, style, clarity of presentation, conciseness, accuracy, transitions, consistency, and writing mechanics. Examination of journal articles, work of professional authors, and writing guidelines.

Nurs 5820. Decision Making in Healthcare. (3 cr; prereq grad student in health-related major) Corcoran-Perry
Comparison of conceptual models of decision making. Developing plans for assessing, evaluating, teaching, and assisting others (health professionals, patients, and families) in making decisions about healthcare.

Nurs 8014. Research in Nursing. (3 cr; prereq inferential statistics) Block, Bull, DeHart, Duckett, Feldman, Lindquist, Vellenga
Exploring research process and research methodologies appropriate to nursing. Analysis of research reports.
Nurs 8020. Evaluating Quality of Healthcare in Communities. (3 cr; prereq 8014 or equiv research course or #) Bull
Models and measurement related to evaluating quality in community health/long-term care. Distinguishing characteristics of long-term care from those of acute care.

Nurs 8050. Problems in Nursing. (1-9 cr; prereq #)
Individual study of a problem.

Nurs 8051. Special Topics in Nursing Research. (1-9 cr)
Seminars and/or individual study in nursing research.

Nurs 8062. Qualitative Research in Nursing and Healthcare. (3-4 cr; prereq 8010 or 8014 or equiv or #) Bull
Characteristics of qualitative research methods such as ethnography, phenomenology, and grounded theory. Data collection, analysis, and applications in healthcare.

Nurs 8064. Research on Decision Making in Healthcare. (4 cr; prereq one grad-level research course) Corcoran-Perry
Analysis of selected conceptual models of decision making and critique of related studies. Formulation of research proposal to investigate decision making about healthcare by healthcare professionals, patients, and/or families.

Nurs 8114. Advanced Nursing Research. (4 cr; prereq 8014 or equiv, advanced inferential and non-parametric statistics, computer science, Nurs grad student or #) Bull, Sirne
Testing and validating methods of study unique to nursing science.

Nurs 8115. Advanced Nursing Research Practicum. (1-6 cr [must complete 6 cr before cr is granted; may be spread over 3 qtrs]; prereq Nurs doct student, #)
Participation as a collaborative team member in designing and/or implementing research; opportunities to synthesize knowledge in an area of study.

Nurs 8116. Principles and Methods of Implementing Research. (3 cr; prereq 8114 or other 8xxx research methods course, 2 grad stats courses, Nurs grad student) Gross
Integrates scientific, statistical, and practical aspects of research. Interrelationships among design development, sample selections, subject access, human subjects requirements, selection and evaluation of instruments, data management, analyses plans, and grant writing. Field experiences.

Nurs 8120. Conceptual and Methodological Issues in the Study of Family Health. (3 cr; prereq 5920, 8114 or equiv or #) Tomlinson
Formulating research designs for studying family health.

Nurs 8210. Theory Development in Nursing. (3 cr; prereq 8110, #) Egan
Examining strategies for theory development; synthesis of theoretical formulations in nursing using a selected strategy.

Nursing Knowledge Underlying Clinical and Functional Specialization

Clinical Specialization

Nurs 5634. Women's Issues: A Health Perspective. (3 cr; prereq upper div or grad student or #) Ringdahl
Multidisciplinary analysis of sexual and reproductive health, victimization, poverty, work, nutrition, physical activity, and mental health, emphasizing health promotion.

Nurs 5636. Menopause: A Multidimensional Approach. (2 cr; prereq upper div or grad student or #)
Physiological, developmental, historical, sociocultural, nursing, and medical perspectives. Issues and research regarding hormone replacement therapy; alternative interventions.

Nurs 5640. Common Response Patterns to Illness. (3 cr; prereq #; offered when feasible) Snyder

Nurs 5642. Behavioral Problems in Persons With Dementia. (2 cr; prereq grad student or upper div student with knowledge of research process, #) Ryden
Nature of aggression, agitation, and wandering in persons with dementia; theoretical perspectives for understanding such problems. Research studies about behavioral problems; relationship between knowledge about behavioral problems and clinical management.

Nurs 5650. Therapeutic Touch: Practice and Research. (2 cr; prereq Nurs student, #) Egan
Therapeutic touch as a healing modality. Explanations of its effects. Students learn and evaluate its practice. Analysis of research literature.

Nurs 5680. Theory and Practice of Occupational Health. (3 cr, §PubH 5167)
Introduction to major concepts and issues in occupational health and safety. Students identify conceptual framework for working with aggregate populations of workers.

Sociological, biological, and psychological aspects of aging, death, and bereavement; issues and problems of older adults in the United States; human services and their delivery systems (health, nutrition, long-term care, education); public policy and legislation; environment and housing; retirement.

Nurs 5810. Health Assessment for Advanced Nursing Practice. (3 cr; prereq Nurs grad student, #) Kubik
Health assessment skills; identifies variations across the life span. Performance and documentation of comprehensive, systematic, and integrated history and physical examination, while interpreting both normal and abnormal findings.

Nurs 5834. Primary Care: Reproductive Health. (4 cr; prereq Nurs grad student, §5835, §8030, concurrent with or completed course in health assessment and reproductive physiology, #) Avery
Explores theory, research, management of selected reproductive health concerns to provide basis for advanced nursing practice and nurse-midwifery.
Nurs 5835. Primary Care Practicum: Reproductive Health. (3 cr; prereq Nurs grad student, ¶5834, #)
Application of standardized techniques to establish client-centered database focused on reproductive health. Implementation and evaluation of healthcare plans that include reproductive and sexuality counseling, family planning interventions, education, screening, and referral.

Nurs 5881. The Biology of Cancer. (3 cr, §GCB 3008; prereq Biol 1009) McKinnell

Nurs 5882. Practicum in Environmental and Occupational Health. (1-6 cr, §PubH 5154; prereq environ health major or Nurs grad student) McGovern, Olson
Students work with organizations with environmental and occupational health concerns, under joint supervision of faculty adviser and organization’s staff.

Nurs 5883. Issues in Environmental and Occupational Health. (2 cr, §PubH 5155; prereq #) McGovern, Olson
The field, current issues, and principles and methods of environmental and occupational health protection. Independent field visits to observe, review, and analyze environmental/occupational health programs.

Nurs 5884. Employee Health Services and Cost Containment. (3 cr, §PubH 5166; prereq occ hlhs nurs or Nurs grad student) McGovern
Trends in corporate health cost containment; implications regarding planning and financing of healthcare for employees and families. Associated role development of occupational health nurse specialists.

Nurs 5885. Theory and Practice of Occupational Health: Field Experience. (1 cr, §PubH 5168; prereq 5680, PubH 5167) Olson
Arranged field experience and seminar course. Application of occupational health and safety concepts within conceptual framework of occupational health. Builds on theories explored in Nurs 5680/PubH 5167.

Nurs 5886. Field Problems in Occupational Health. (3 cr, §PubH 5218; prereq PubH 5211 or Nurs grad student or #) Olson
Guided evaluation of potential occupational health problems; recommendations and design criteria for correction, if correction is needed.

Nurs 5888. Geriatric Assessment. (4 cr, §SAPh 5870)
Multidisciplinary approach; comprehensive assessment of function, health, quality of life, strengths, financial status, and diversity issues.

Nurs 5891. Human Reproductive Processes. (3 cr; prereq nurse practitioner student or #) Avery
Development of placenta and fetus; female physiologic adaptations across reproductive life span. Physiologic relationship between pregnant woman and fetus, emphasizing biologic and environmental interactions.

Nurs 5917. Healthcare for Children and Youth With Special Healthcare Needs. (4 cr; prereq #) Leonard
Growth and development, pathophysiology, specific conditions, and a holistic, family-centered, community-based, culturally competent, coordinated approach to assessment and intervention.

Nurs 5918. Healthcare for Children and Youth With Special Healthcare Needs Practicum. (5 cr; prereq ¶5917 or ¶5917, 5925, #) Lindeke
Clinical course emphasizing assessment and management of acute and chronic conditions; holistic, family-centered, community-based, culturally competent, coordinated approach.

Nurs 5919. Assessment and Intervention Models in Families of Children with Special Healthcare Needs. (6 cr; prereq 5917, 5920, #) Lindeke, Tomlinson
In-depth, systemic, and theory-based study of family health assessment methods and intervention models, for identifying and intervening in patterns of functioning in families in which children have complex healthcare needs.

Nurs 5920. Conceptualization of Family Health. (3 cr; prereq Nurs grad student, 8010 or #) Tomlinson
Theoretical framework that serves as foundation for family nursing practice.

Nurs 5923. Primary Care Practicum: Health Assessment and Care of Well Infants, Children, and Adolescents. (5 cr; prereq Nurs grad student, 5810, ¶5924, #) Poe
Clinical course for beginning PNP and FNP student.

Nurs 5924. Primary Care: Nursing Assessment and Health Promotion From Infancy Through Adolescence. (4-5 cr; prereq Nurs grad student, 5810, ¶5923, #) Poe
Age-specific, family-centered prevention and health promotion services. Instruments and processes incorporated as means for establishing database. Emphasizes diagnostic reasoning and primary-care advanced-practice interventions.

Nurs 5925. Primary Care Practicum: Common Health Problems of Infants, Children, and Adolescents. (5 cr; prereq Nurs grad student, 5810, 5924, ¶5926, #) Poe
Advanced clinical course. Assessment of minor acute and chronic illnesses and their impact on the individual and family, healthcare management, evaluation strategies, and follow-up care.

Nurs 5926. Primary Care: Common Acute and Chronic Conditions Experienced by Infants, Children, and Adolescents. (4 cr; prereq Nurs grad student, 5923, 5924, ¶5925, #) Poe
Differentiation of health problems, interdisciplinary consultation and referral, and independent and collaborative healthcare management.

Nurs 5927. Primary Care: Assessment and Management of Families Experiencing Stress. (4 cr; prereq Nurs grad student, #)
Assessing and analyzing impact of minor acute, chronic illness and disruptive behavior on families. Behavioral intervention models, incorporating variety of cultural values, beliefs, and behaviors.
Nurs 5928. Primary Care: Pharmacotherapeutics. (3 cr; prereq Nurs grad student, #)
Pharmacokinetics, pharmacopidemiology, therapeutic dosages for various age groups, client patterns of drug use, prescriptive privileges, and prescription writing for advanced-practice nurses.

Nurs 5929. Primary Care: Synthesis of Advanced Pediatric Nursing Practice for the Child, Family, and Community. (7-9 cr; prereq Nurs grad student, 5925, 5926, #)
Refines skills to effectively intervene with common pediatric physical/psychosocial concerns. Role implementation issues and development of an ideal practice model.

Nurs 5932. Primary Care: Assessment and Management of Adult and Elderly Health. (3-5 cr; prereq Nurs grad student, 5810, ¶5933, #) Advanced-practice course. Data-based primary care management of common acute and chronic conditions. Clinical reasoning, independent and collaborative practice healthcare plans.

Nurs 5933. Primary Care Practicum: Adult and Elderly Health. (5 cr; prereq Nurs grad student, 5810, ¶5932, #) Kubik Application of advanced-practice comprehensive health histories and physical assessments in formulating client-centered databases; development and implementation of care plans and follow-up evaluation of primary care.

Nurs 5940. Nursing Assessment of the Elderly. (2 cr; prereq basic course in health history-taking and physical assessment, #) Camillo Taking gerontological health histories and performing physical assessment. Emphasis on theoretically and empirically based variations of normal, common health disruptions; interpretation and classification of data.

Nurs 5941. Care of the Elderly I: Physiological Concepts. (2 cr; prereq #) Snyder Functional patterns related to physiological aspects of aging; research-based interventions used to maintain or restore optimal functioning of elderly.


Nurs 5943. Care of the Elderly II: Psychosocial Concepts. (2 cr; prereq Nurs grad student, knowledge of adult human development across life span or #) DeHart, Ryden Psychosocial assessment and research-based interventions for elderly clients; emphasizes promotion of health and supportive care.

Nurs 5944. Nursing Care of the Elderly II. (4 cr; prereq Nurs 5940, Nurs grad student, #) Camillo Managing healthcare of elderly clients; testing nursing interventions for maintaining and restoring health. Focus on persons whose presenting concerns are primarily psychosocial.

Nurs 5945. Nursing Care of the Elderly: Assessment and Management. (6 cr; prereq 5940, 5947) Camillo Database management of common acute and chronic conditions and physiological, psychosocial, and pharmacological interventions. Family and community resources incorporated into nursing care interventions. Protocols of care analyzed and developed. Methods of evaluating interventions.

Nurs 5947. Pharmacotherapeutics for the Elderly. (2 cr; prereq basic pharmacology course, grad student or #) Camillo Issues related to prescriptive practice and other regulations. Case-based protocols for specific acute and chronic illnesses with emphasis on pharmacokinetics and pharmacodynamics.

Nurs 5950. Physiological Manifestations of Cancer. (3 cr; prereq Nurs grad student, 8011 or #) Post-White In-depth analysis of physical responses to cancer and its treatments, focusing on underlying physiology, assessments and management of symptoms, and measurement of outcomes. Research critiqued for clinical application.

Nurs 5951. Oncology Practicum I. (3 cr; prereq Nurs grad student, 5950 or ¶5950) Post-White Clinical management of complex care of individuals with cancer across the life span, focusing on nursing assessment, interventions, and evaluation associated with physiological manifestations/symptoms. Collaborative role with interdisciplinary team.

Nurs 5952. Psychosocial Dimensions of Cancer. (3 cr; prereq Nurs grad student, 8011 or #) Post-White In-depth analysis of psychosocial responses to cancer and its treatment. Assessment and intervention with patients and family in helping them adapt to cancer diagnosis, treatment, and survival. Discussions of interventions based on critique of research.

Nurs 5953. Oncology Practicum II. (3 cr; prereq Nurs grad student, 5951, 5952 or ¶5952 or #) Post-White Clinical assessment and interventions related to patient’s and family’s psychosocial responses to cancer and its treatment. Interventions designed to assist patient and family in adapting to cancer as a chronic illness.

Nurs 5954. Oncology Issues. (2 cr; prereq 5950, 5952 or #) Post-White Ethical, legal, and sociocultural issues surrounding cancer prevention, early diagnosis, treatment, and care. Analysis of advanced practice roles in response to healthcare reform. Impact of cancer across the life span on patient, family, and community.

Nurs 5955. Oncology Practicum III. (3 cr; prereq Nurs grad student, 5953, 5954 or ¶5954 or #) Post-White Assessing cancer risk practices of individuals, families, and communities. Educating professionals and public regarding cancer risks, prevention, and early detection. Sociocultural factors.
Nurs 5970. Advanced Health Assessment and Intervention with Adolescents. (3 cr; prereq #) Bearinger
Synthesis of nursing, public health, and adolescent development knowledge, integrated with legal and ethical principles and health behavior models as a framework for developing clinical assessment and intervention strategies targeting risk factors associated with major morbidities of adolescents.

Nurs 8021. Community Health Nursing in Long-Term Care. (3 cr; prereq 8010, Nurs grad student or #) Bull
Systematic inquiry into nature of long-term care and community health nursing for families with adult members who have self-care limitations.

Nurs 8022. Clinical Investigation in Community Health Nursing in Long-Term Care. (5-6 cr; prereq 5330, 8011, 8021, #) Bull
Systematic inquiry and clinical investigation of nursing care problems for communities with families who have adult members with self-care limitations. Students design, implement, and evaluate interventions for selected populations.

Nurs 8030. Nursing Intervention Models. (4-8 cr [8 cr must be completed before cr is granted]; prereq 8011 or 8012, #) Avery, Bliss, Kaas, Leonard, Lindquist, Pederson, Tomlinson
Developing, providing, and evaluating nursing intervention with a specified client population. Students register for a section that focuses on a desired population.

Nurs 8040. Public Health Interventions Across the Life Span. (3 cr; prereq 5609 or 8011, or 8012, #) Avery, Bliss, Kaas, Leonard, Lindquist, Pederson, Tomlinson
Synthesis of life-cycle developmental approach and public health perspective with nursing and behavior change conceptual theories to develop intervention models that effectively address priority public health problems across the life span.

Nurs 8042. Community-Based Public Health Nursing Interventions. (3 cr; prereq Nurs grad student or nurse grad student in another field, 5960 or #) Josten, Lia-Hoagberg
Systematic inquiry into community-based intervention models that integrate nursing knowledge, clinical research, and public health knowledge. Emphasizes community organization and social change models and development of community-based nursing intervention models for practice.

Nurs 8060. Advanced Clinical Nursing. (3-9 cr; prereq #; offered when feasible)
Nurs 8313. Care of the Childbearing Family in Risk. (4-6 cr; prereq physiology, #) Avery
Problems encountered during perinatal period with emphasis on nursing care of mothers with medical complications.

Nurs 8314. Nurse-Midwifery Management During Childbearing. (9-10 cr; prereq #) Avery
For students wanting to complete requirements for nurse-midwifery certification. Emphasis on labor and delivery management with opportunity to improve skills throughout childbearing period.

Nurs 8400. Nursing Interventions for Adult Populations. (3 cr; prereq 8014 or equiv, 8012, #; offered when feasible) Snyder
Nurs 8421. Psychiatric-Mental Health Nursing: Group Dynamics and Leadership Skills. (3 cr; prereq 8030, #) Kaas, Lewis, Vellenga
Group dynamics and process with emphasis on development of leadership skills. Integration and application of mental health concepts, clinical practice in group therapy.

Nurs 8422. Psychiatric-Mental Health Nursing: Family Dynamics and Therapy. (3 cr; prereq 8030, #) Kaas, Lewis, Vellenga
Family dynamics, development, and communication patterns. Relationship of selected family to community using concepts from systems theory. Clinical practice in family therapy.

Nurs 8431. Childbearing-Childrearing Family Nursing: Theoretical Formulations. (4-6 cr; prereq 8030, #) Pederson
Maintenance, promotion, improvement, and restoration of health in the childbearing-childrearing family unit. Theoretical concepts related to women, children and families, and family development.

Nurs 8450. Investigations of Stress and Coping From a Nursing Perspective. (3 cr; prereq grad in nursing or psychology or behavioral medicine, 8014 or equiv, #; offered when feasible) Snyder

Functional Specialization

Nurs 8451. Teaching-Learning Process in Nursing. (4 cr; prereq 8030, ¶course in learning theory, Nurs grad student or #) Krichbaum
Use of theories of learning to develop an intervention model for teaching nursing. Testing the intervention model in simulated situations.

Nurs 8701. Nursing Administration I. (6 cr; prereq #) Hansen
Intensive study of role of nursing administrator by application of major concepts in organization and management theories and nursing process to nursing administration. Emphasis on planning for and organizing nursing administration and assembling resources to carry out plans. Experiences planned to meet individual needs and to maximize previous experience and knowledge.

Nursing Role Development

Nurs 5660. Basic Management in Long-Term Care Facilities. (1-4 cr; prereq current RN licensure, RN with baccalaureate degree for grad cr) Krichbaum

Nurs 5890. Professional Issues in Nurse-Midwifery. (3 cr) Avery
Professional roles and responsibilities, legislation, ethical dimensions, public policy, and clinical practice issues.
Nurs 5934. Professional Issues for Advanced Practice Nursing. (2 cr; prereq Nurs grad student, #) Interdisciplinary team function, managed care, reimbursement, certification, ethical issues, and scope of advanced nursing practice.

Nurs 5946. Professional Issues in Advanced Gerontological Nursing Practice Roles. (2 cr; prereq 6 cr gerontological nursing focus or #) Feldman Professional and policy issues, including reimbursement, certification, professional relationships, standards of care, legislation and regulation as they pertain to nurse practitioners, professional practice, the healthcare system, and care of older adults.

Nurs 5948. Advanced-Practice Roles. (2-3 cr; prereq Nurs grad student, 12 grad cr) Snyder Advanced-practice roles within nursing care and healthcare delivery systems.

Nurs 5949. Practicum: Advanced Practice Nursing. (4-6 cr; prereq Nurs grad student, 12 grad cr, 5948 or #) Lia-Hoagberg Implementing and evaluating selected advanced practice roles.

Nurs 5963. Nursing Leadership for a Changing World. (3 cr; prereq Nurs grad student or nurse grad student in another field or #) Josten Visioning, change, organizational culture, power, negotiation, team building, forecasting, and personal growth analyzed to strengthen leadership skills for the future. Concepts within variety of nursing leadership roles (educator, manager, clinical specialist, consultant).

Nurs 5964. Public Health Nursing Leadership Practicum. (4 cr; prereq 5960, 5963 or #) Lia-Hoagberg Developing knowledge of and skills for specific leadership role within the field. Leadership and role theory.

Nurs 5965. Special Problems of Management of Community-Based Nursing Services. (3 cr; prereq 8010 or 8014, 8040, #) Josten Management problems common to community-based nonprofit or public nursing services. Developing skill in management problem solving to address such problems as working with a governing board, nonprofit budgeting, and missed appointments.

Nurs 5968. School Nursing in the Educational System and the Community. (3 cr) Lia-Hoagberg Major school health issues, educational systems, and roles of school nurses working within their communities. School health problems, assessment and intervention strategies, integration of research findings and applications with individuals, families, and communities.

Nurs 8063. Nursing Consultation. (3 cr; offered when feasible)

Nurs 8315. Nurse-Midwifery Management: Intrapartal and Postpartal. (8-10 cr; prereq 8314) Avery Theory and clinical experience in management and care of the laboring woman/couple through the six-week restorative period. Early care of the newborn is an integrated component.


Nurs 8455. The Nurse Educator in Higher Education. (6 cr; prereq #) Jennings Analysis of roles and responsibilities of nurse educator in higher education. Data for analysis obtained through review of relevant literature and testing of roles in an academic setting.

Nurs 8600. Healthcare Institutions and Nursing Leadership. (3 cr; prereq Nurs grad student or #) Nature of experiencing and its modes; a person’s relatedness to others and responsibility to the human community; characteristics of American society and their demonstration in healthcare institutions.

Nurs 8702. Nursing Administration II. (6 cr; prereq #) Hansen Intensive study of role of nursing administrator by application of major concepts in organization and management theory and nursing process to nursing administration. Emphasis on making operational and evaluating nursing administration goals.

Special Topics Courses

Nurs 5609. Special Educational Experiences in Nursing. (1-6 cr; prereq #) Planned to meet individual student needs.

Nurs 5620. Independent Study in Nursing Topics. (1-9 cr; prereq #) Elective course planned to meet individual student needs.

Nurs 5779. Self-Directed Study as a Means of Accomplishing Nursing Electives. (Cr ar; prereq #) Kaas, Lewis, Vellenga For students with a specific interest or wanting specific experience not provided in regularly offered courses. Student writes objectives and makes formal contract with instructor that specifies credits, types of experiences, and method of evaluation.

Nurs 8001. Special Educational Experiences in Nursing. (Cr ar; prereq #) Various learning experiences planned to meet individual needs.

Nurs 8009. Special Topics in Nursing. (Cr ar; prereq #)

Nurs 8509. Special Topics in Nursing Education. (Cr ar; prereq #)

Nurs 8609. Special Topics in Nursing Supervision. (Cr ar; prereq #)
**Nutrition (Nutr)**

*Professor:* Joanne L. Slavin (food science and nutrition), director of graduate studies; Paul B. Addis (food science and nutrition); Linda J. Brady (food science and nutrition); Judith E. Brown (epidemiology); Francis F. Busta (food science and nutrition); Frank B. Cerra (surgery); Agnes S. Csallany (food science and nutrition); William R. Dayton (animal science); Mary E. Dempsey (biochemistry); John H. Himes (epidemiology); Ralph T. Holman (*emeritus:* food science and nutrition); Theodore P. Labuza (food science and nutrition); Arthur S. Leon (kinesiology and leisure studies); Allen S. Levine (food science and nutrition)

*Associate Professor:* Elaine Asp (food science and nutrition); Margot P. Cleary (Hormel Institute); Patricia J. Elmer (epidemiology); Daniel D. Gallaher (food science and nutrition); Craig A. Hassel (food science and nutrition); Lawrence H. Kushi (epidemiology); Marla M. Reicks (food science and nutrition); Mary T. Story (epidemiology); Sally Weisdorf (pediatric gastroenterology); Michael E. White (animal science)

*Assistant Professor:* Roderick A. Barke (surgery); Paul S. Brady (food science and nutrition); Timothy P. Carr (food science and nutrition); Mary C. Gannon (food science and nutrition); Debra P. Keenan (food science and nutrition); Mindy S. Kurzer (food science and nutrition); Margaret C. Martini (food science and nutrition)

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

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

**Curriculum**—Three subspecialty areas are offered in the doctoral degree program: human nutrition, nutritional biochemistry, and public health nutrition. Thesis work can be conducted in the laboratory, clinic, or field, locally or internationally.

**Prerequisites for Admission**—A strong foundation in the biological and physical sciences is required. This background includes college mathematics through calculus, physics, the equivalent of one year of general and one year of organic chemistry, general biology, biochemistry, physiology, and two additional courses in the biological sciences. If there is evidence that the applicant has a good background in the sciences, some of the prerequisites can be met after admission.

Applicants interested in the M.S. degree with clinical emphasis must offer as prerequisites courses in general biology, human nutrition, microbiology, college algebra, one year each of general and organic chemistry, 20 or more quarter credits in food science and nutrition, and a dietetic internship or equivalent.

Applicants to the Ph.D. program who have completed the M.S. degree with a clinical emphasis must have completed the requirements described in the first paragraph above under Prerequisites for Admission.

**Special Application Requirements**—Graduate Record Examination scores and three letters of recommendation evaluating the applicant’s scholarship must be submitted. At least two letters should be from professorial-rank faculty.

**Master’s Degree Requirements**—Students must develop and demonstrate general competence in nutrition, including knowledge of basic biochemistry, physiology, food chemistry, and statistics. In addition, students must develop a minor or coherent related field program in a discipline(s) closely allied to nutrition—e.g., biochemistry, cell biology, epidemiology, food science, microbiology, or physiology. An oral final examination is required for both plans.

**Doctoral Degree Requirements**—Programs are designed by the student and adviser to develop appropriate skills in research and scholarship. A more comprehensive knowledge is required in the subject matter listed above for the master’s program. Core requirements include FScN courses 5622, 5623, 5624, 8101 (twice), and two 8xxx courses; and one course in biochemistry. Students complete a minor consisting of an individual subject (e.g., biochemistry) or a supporting program consisting of a cluster of subjects (e.g., biochemistry, physiology, and statistics).

**Language Requirements**—None, unless specified by an adviser.

**Minor Requirements for Students Majoring in Other Fields**—General competence in nutrition.

**For Further Information and Applications**—Contact the Nutrition Graduate Program, Department of Food Science and Nutrition, University of Minnesota, 1334 Eckles Avenue, St. Paul, MN 55108 (612/624-1290).

*Note*—The following courses are commonly selected for major and minor programs; other courses are also available.
Nutr 8666. Doctoral Pre-Thesis Credits. (max
18 cr per qtr; doctoral student who has not passed oral
prelims)

Nutr 8777. Thesis Credits: Master’s. (16 cr
required; Plan A only)

Nutr 8888. Thesis Credits: Doctoral. (36 cr required)

FScN 5612. Experimental Nutrition. (2 cr;
prereq 3612, Biol 5001) Gallaher
Use and evaluation of methods and interpretation of
results from clinical nutrition measures.

FScN 5614. Nutrition Education. (3 cr; prereq
3610) Keenan
Application of educational principles, models, and
theories to development, delivery, and evaluation of
nutrition lessons, curricula, and communications.

FScN 5622. Macronutrient Metabolism. (4 cr;
prereq 3612, Biol 5001, Psl 3051) Brady
Physiological function and metabolic fate of carbohydrates,
lipids, and proteins and their involvement in fulfilling
energy needs for maintenance, growth, and work.

FScN 5623. Vitamin and Mineral Biochemistry.
(4 cr; prereq 3612, Biol 5001, Psl 3051) Gallaher
Nutritional/biochemical and physiological function of
essential vitamins and minerals in humans and
experimental animal models.

FScN 5624. Human Protein and Energy
Utilization. (4 cr; prereq 5622, 5623) Kurzer
Regulation of human protein and energy use, interactions,
adaptations; critical evaluations of methods of determining
requirements; technical and ethical problems in human
experimentation and determination of recommended levels of
intake.

FScN 5643. World Food Problems. (3 cr, §AgEc
5790, §Agro 5200, §CAPS 5280; prereq sr or grad
student; limited enrollment) Brady, Schafer
Multidisciplinary approach to social, economic, and technical
problems of feeding world’s growing population. Principles
from social and economic sciences and from plant, animal, and
food sciences for application to world food problems.

FScN 8101. Research Seminar. (1 cr; prereq #;
S-N only)
Discussion with faculty member(s) on research progress
within the group, or review and discussion of current
research literature related to food science and nutrition.

FScN 8603. Advanced Topics in Nutrition.
(1-4 cr; prereq #)
Review of recent research or presentation of special topics.

(1-9 cr; prereq #)
Independent study and written reports in nutrition.

Nutr 8745. Seminar. (1 cr [may be repeated for cr];
prereq #)
Current topics in human nutrition.

Nutr 8990. Graduate Research. (2-5 cr; prereq #)
Research in various areas in nutrition represented by
staff interests.

PubH 5330. Epidemiology I. (4 cr; prereq public
hith or pharmacy or med school or nursing or dentistry
or grad student or #) Luepker, Sellers
Basic epidemiologic principles applicable to infectious
and noninfectious disease; host-agent-environment
complex; factors underlying spread of infectious disease;
lab applications of statistical and epidemiologic methods.

PubH 5386. Public Health Aspects of
Cardiovascular Diseases. (3 cr; prereq 5330, 5450
or equiv) Elmer
Evaluating population studies and trials on cardiovascular
diseases; modifiable risk factors for coronary heart
disease; preventing other types of heart disease.

PubH 5387. Cancer Epidemiology. (3 cr; prereq
5330, 5340 or #) Potter, Robison
Epidemiologic aspects of cancer, including theories of
carcinogenesis, incidence, site specific risk factors, and
issues of cancer control and prevention.

(3 cr; prereq 3xxx nutrition course or equiv or #) Brown
Nutritional needs of childbearing women and infants,
how to meet these through programs and services.

PubH 5914. Nutrition Intervention. (3 cr; prereq
grad student or #) Jeffery, Kushi
Selecting appropriate nutrition intervention strategies for health
programs, applying them to specific target audiences, and
evaluating their usefulness in relation to program objectives.

(3 cr; prereq grad student or #) Krinke
Review of current literature and research on nutrient
needs and factors affecting nutritional status of adults
and the elderly.

Occupational Therapy (PMed)

Associate Professor: Judith Reisman, director and
director of graduate studies; James Carey; Virgil
Mathiowetz; Erica Stern

Assistant Clinical Specialist: Diane Anderson; Cheryl
Meyers

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

Degree Offered—M.S. (Plan A or Plan B).

Curriculum—This new graduate program,
available beginning fall 1997, offers academic
study and clinical education to prepare
occupational therapy clinicians and researchers.
Emphasis is on application of the critical
thinking model to diverse areas of practice and
to diagnostic groups in both clinic and
community settings. Clinical education is
available in such areas as physical disabilities,
psychosocial dysfunction, and developmental
disabilities. Research emphasizes investigation of treatment effectiveness.

In addition to the courses listed below are several that are under development and will be added to those required in the curriculum. These courses will cover research, adult education, documentation, anatomy, healthcare management, neurorehabilitation, and clinical education.

**Prerequisites for Admission**—Individuals with a bachelor’s degree in any field may apply.

**Special Application Requirements**—Applicants must submit a program application, including one to three letters of reference, Graduate Record Examination General Test scores (no minimum required for consideration), and evidence of work or volunteer experience in occupational therapy. International students must also submit TOEFL scores (550 minimum) and TSE (Test of Spoken English) scores (50 minimum). Prerequisite coursework in statistics, the biological sciences, developmental and abnormal psychology, and related areas is also required. Contact the program office for specific information.

**Degree Requirements**—Students take 84 credits of predetermined academic coursework, 16 credits of clinical education, and 16 thesis credits (Plan A) or 6 project credits (Plan B). Both plans require a final oral examination by committee.

**Language Requirement**—None.

**For Further Information and Applications**—Contact the Program in Occupational Therapy, University of Minnesota, Box 388 Mayo, 420 Delaware Street S.E., 426 Church Street S.E., Minneapolis, MN 55455 (mailing address) (612/626-5887; fax 612/625-7192; e-mail schmi039@tc.umn.edu). Program office is located at 271 Children’s Rehabilitation Center, 426 Church Street S.E., Minneapolis campus.

**OT 8777. Thesis Credits: Master’s.** (16 cr required; Plan A only)

**Required Courses**

- **PMed 5161. Theory of Physical Medicine and Rehabilitation Applied to Medical Sciences.** (5 cr; prereq regis in OT or PT)
  Lectures focus on fields of surgery, orthopedics, pediatrics, dermatology, medicine, neurology and speech. Correlation clinic includes presentation of patients and discussion of treatment problems.

- **PMed 5182. Functional Neuroanatomy and Neurophysiology.** (5 cr; prereq regis in OT or PT)
  Neuroanatomic structures as functional systems; basic neurophysiologic concepts, emphasizing applications for understanding and treating physical dysfunctions.

- **PMed 5300. Concepts for Occupational Therapy Practice.** (5 cr; prereq regis in OT)
  Critical thinking, ethics, professional resources/organizations, patient-therapist relationship. Fieldwork experience.

- **PMed 5311. Therapeutic Occupation: Individual Focus.** (3 cr; prereq regis in OT)
  Foundation for therapeutic occupation, activity analysis, application to performance deficits.

- **PMed 5312. Therapeutic Occupation: Group Focus.** (2 cr; prereq regis in OT)
  Development, practical application, and analysis of activity groups as therapeutic occupation.

- **PMed 5341. Introduction To Assessment and Intervention Processes.** (5 cr; prereq regis in OT)
  Assessment concepts, techniques and application to populations with psychosocial and/or physical disabilities component deficits. Treatment planning and documentation.

- **PMed 5342. Compensatory Rehabilitation: Assessment and Intervention.** (6 cr; prereq regis in OT)
  Assessment of daily-living performance areas; adaptations/techniques to compensate for performance deficits. Fieldwork experience.

- **PMed 5370. Theory of Occupation.** (3 cr; prereq regis in OT)
  Occupational therapy frames of reference, role of activity, and historical development of profession.

- **PMed 5393. Kinesiology.** (3 cr; prereq regis in OT)
  The analysis of body mechanics and coordinated movement.

- **PMed 5394. Orthotics.** (4 cr; prereq regis in OT)
  Analysis, design, and construction of orthotic devices.

- **Neur 5121. Descriptive Neurology.** (2 cr; prereq regis in OT or PT)
  Central and peripheral nervous system. Correlation of neuroanatomy, neurophysiology, clinical neurology, and pathology of the nervous system.
Oral Biology (OBio)

Professor: Edward C. Combe (oral sciences); William H. Douglas (oral sciences); Gregory R. Germaine (oral sciences); Mark C. Herzberg (preventive sciences); William F. Liljemark (diagnostic/surgical sciences); Charles F. Schachtele (oral sciences); Burton L. Shapiro (oral sciences)

Associate Professor: Robert H. Ophaug (oral sciences), director of graduate studies; Ralph DeLong (restorative sciences); Kenneth M. Hargreaves (restorative sciences); Keith C. Kajander (oral sciences); Ambika Mathur (oral sciences); Joel D. Rudney (oral sciences); Larry F. Wolff (preventive sciences)

Assistant Professor: Pamela R. Erickson (preventive sciences); Tom W. Korioth (oral sciences)

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

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

Curriculum—Students are provided with a broad understanding of the orofacial region, its development (including aging), structure, function, and pathology. More specialized areas of interest, such as salivary glands and secretions, development of oral structures, mineral metabolism and nutrition, pulp biology, oral microbial ecology and physiology, mechanisms of microbial infection and immunity, and development and evaluation of dental materials are emphasized in advanced coursework and research. Individual programs are planned according to the student’s specific areas of interest and may include courses from other disciplines as part of the major. A minor in a related nonclinical discipline is also required.

Prerequisites for Admission—Programs are designed for individuals who have completed requirements for graduation with high standing from dental or medical schools and desire to undertake advanced studies in oral biology. In some cases individuals who have not yet obtained the D.D.S. (D.M.D.) or M.D. degree, but who have demonstrated exceptional potential for graduate study, may be admitted for a combined program. Individuals with a bachelor’s or master’s degree who can demonstrate an appropriate background and an interest in oral biology are considered for admission.

Special Application Requirements—Applicants must submit three letters of recommendation from persons familiar with their academic and research experience and a statement describing how training in oral biology will help them attain their professional objectives. Students may enter the program in any quarter, but fall quarter is recommended.

Master’s Degree Requirements—The M.S. degree program generally requires two years or more. For Plan A (with thesis), the student must complete a minimum of 20 credits in the major, including the survey course in oral biology (8010), 4 credits of oral biology topics courses, and participate each quarter in the student seminar. Students must also complete a minor in a related nonclinical discipline (minimum 9 credits). Plan B does not include a research thesis, but involves additional coursework (minimum 44 credits, including a minor of at least 9 credits) and three papers, at least one of which includes a laboratory study. A final oral examination is required for both plans.

Doctoral Degree Requirements—Coursework for the Ph.D. degree is selected to give the student a broad background in oral biology plus advanced coursework more directly related to the student’s research interests. Though there are no minimum credit requirements for the Ph.D. degree, all students register for the survey oral biology course (8010) and 8 credits of oral biology topics courses and participate each quarter in the student seminar. Depending on their research interests, most students are expected to take additional credits in biochemistry; molecular, cellular, developmental biology and genetics; neuroscience; and public health and a course (3 to 5 credits) in statistics or biostatistics to complete a core curriculum of 35-37 credits. A minor in a relevant nonclinical discipline is required. A cumulative GPA of at least 3.00 in both the major and minor is required. Only grades of A or B are acceptable in the core courses designated above. The preliminary written examination is taken before the end of the second year in residence. It consists of two research proposals, one representing the student’s anticipated thesis research, and the other on a topic assigned by the graduate faculty. The preliminary oral examination consists primarily of a defense of the
two proposals described above. Students must present a research seminar (which is attended by the final examination committee) no later than six months before defense of the thesis.

**Language Requirements**—None.

**Minor Requirements for Students Majoring in Other Fields**—A minor in oral biology consists of 9 credits for the M.S. degree and 20 credits for the Ph.D. degree. The minor must include OBio 8101, at least two advanced courses in oral biology, and other coursework in consultation with the director of graduate studies.

**For Further Information and Applications**—Contact the Oral Biology Graduate Program, University of Minnesota, 17-252 Moos Health Sciences Tower, 515 Delaware Street S.E., Minneapolis, MN 55455 (612/624-9123).

**OBio 8666. Doctoral Pre-Thesis Credits.** (max 18 cr per qtr; doctoral student who has not passed oral prelims)

**OBio 8777. Thesis Credits: Master’s.** (16 cr required; Plan A only)

**OBio 8888. Thesis Credits: Doctoral.** (36 cr required)

**OBio 5001f. Methods in Research and Writing.** (2 cr; prereq grad student) Kajander

**OBio 8001. Research in Oral Biology.** (Cr ar)

**OBio 8002. Tutorial in Oral Biology.** (Cr ar [2 hrs per wk=1 cr; may be repeated for cr])

Quarter-long apprenticeship with faculty members to familiarize students with faculty research interests.

**OBio 8010w. Oral Biology.** (3 cr; prereq dental specialist and/or oral research trainee)

Oral aspects of inflammation, wound healing, and immunology; plaque composition, formation, and metabolism; saliva glands, composition, and function; biochemistry of connective and mineralized tissues; neurobiology and pathophysiology of orofacial pain and sensations.

**OBio 8021f, 8022, 8023, 8024. Topics in Oral Biology.** (1-3 cr per qtr [may be repeated for cr]; prereq #)

Individual courses address specialized topic relevant to biology of orofacial region. Specific offerings for at least the next two years are listed below.

**OBio 8021f. Salivary Glands and Secretions.** (2 cr; offered even yrs) Germaine, Herzberg, Rudney, Shapiro

Structure, development, and evolution of salivary glands; mechanisms and control of secretion of electrolytes and macromolecules; structure and function of mucins, antimicrobial and mineral binding proteins, and exocrinopathy of salivary glands.

**OBio 8021f. Oral Microbiology.** (1-2 cr; offered odd yrs) Liljemark, Schachtele, Wolff

Lectures, assigned readings, and discussions on acquisition, distribution, and interactions of oral flora; mechanisms of dental plaque formation; etiology of dental caries and periodontal diseases; other oral bacterial infections; microbiology in dental specialty areas.

**OBio 8022w. Molecular Mechanisms of Cellular and Microbial Adhesion.** (2 cr; offered even yrs) Germaine, Herzberg, Liljemark, guest lecturers

Biochemical basis of adhesion phenomena, focusing on cells of immune system, development and tissue formation, and bacterial colonization of the human.

**OBio 8022w. Physical Biology of the Oral Cavity.** (1-2 cr; offered odd yrs) DeLong, Douglas

Structure and function of human masticatory system discussed from biophysical point of view. Mandibular form, movement, and infrastructure of hard tissues as related to occlusal wear and masticatory efficiency; role of saliva and salivary pellicle in reduction of interocclusal friction. Physical methods (artificial mouth), computational methods of stimulation, digitization and graphic representation of anatomical surfaces, and methods of clinical measurements.

**OBio 8023s. The Secretory Immune System.** (1-2 cr; offered odd yrs) Mathur

Lectures and discussions of secretory immunoglobulin A system. Origin, structure, and synthesis of sIgA; induction and biological activity of sIgA; role of sIgA in oral health.

**OBio 8024su. Genetics of Oral Diseases.** (2 cr; offered SSI of even yrs) Shapiro

Principles of medical genetics with emphasis on oral diseases. Twins, chromosomes, recombinant DNA, major gene traits, genes in populations, chromosomal abnormalities, complex traits, facial clefts, dental caries, periodontal diseases.

**OBio 8024su. Biology of the Chemical Senses.** (1-2 cr; offered SSI of odd yrs) Rudney, staff

Review of topical areas in biology of taste and smell. Histology, physiology, receptor recognition of tastant and odorant molecules, clinical measurement, and pathobiology.

**OBio 8030f, w, s. Seminar.** (1 cr [may be repeated for cr])

Faculty and student discussion of current topics in oral biology.

**OBio 8101, 8102, 8103. Topics in Cariology.** (1-2 cr; prereq #) Ophaug, staff

Different topics or subject areas each quarter, announced in advance. Includes etiology, pathogenesis, diagnosis, epidemiology, contributing factors, and prevention of dental caries.

Additional major coursework may be drawn from basic medical sciences and other areas appropriate to the individual program.
Otolaryngology (Otol)

Professor: George L. Adams, head; Frank M. Lassman (emeritus), director of graduate studies; Arndt J. Duvall III; S. K. Juhn; Robert H. Maisel; Robert H. Margolis; David A. Nelson; Peter A. Santi

Clinical Professor: Michael M. Paparella

Associate Professor: John H. Anderson; Lawrence R. Boies, Jr.; Peter A. Hilger; David B. Hom; Eric Javel; Samuel C. Levine

Clinical Associate Professor: Marcos V. Goycoolea; Stephen L. Liston

Assistant Professor: Kathleen A. Daly; Markus Gapany; George S. Goding, Jr.; David D. Hamlar, Jr.; Lisa L. Hunter; Mario J. Imola; Rick M. Odland; Franklin L. Rimell; Edward H. Szachowicz II

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

Degrees Offered—M.S., M.S.Otol. (Plan A only) and Ph.D.Otol.

Curriculum—The graduate degree programs prepare students in both clinical and experimental aspects of otolaryngology. Rotations at the University of Minnesota Hospital and Clinic, Minneapolis Veterans Administration Medical Center, St. Paul-Ramsey Medical Center, and Hennepin County Medical Center provide a wide range of material for clinical education and surgical experience. Opportunities for independent research are provided by the research laboratories of audiology, auditory electrophysiology, auditory neurophysiology, biochemistry, electronmicroscopy, electrophysiology, histochemistry, morphometry, psychoacoustics, temporal bone pathology, tumor immunology, skin-flap physiology, laryngeal physiology, mandibular bone physiology, microvascular tissue transfer, and vestibular physiology. Graduates of the program have careers in teaching, research, and the professional practice of otolaryngology.

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

Degree Requirements—All graduate students in the program spend one year in general surgery and four years in otolaryngology. During the last four years, each fellow is required to spend six months in basic research directed toward preparation of an acceptable thesis for a master’s or doctoral degree. Most Ph.D. candidates require time beyond the four years to complete their research.

Language Requirements—None.

For Further Information and Applications—Contact the Department of Otolaryngology, University of Minnesota, Box 396 Mayo, 420 Delaware Street S.E., Minneapolis, MN 55455 (mailing address) (612/625-3200; fax 612/625-2101).

Otol 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

Otol 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

Otol 8888. Thesis Credits: Doctoral. (36 cr required)

Otol 5101f. Introduction to the Basic Sciences in Otolaryngology I: Ear. (3 cr; prereq #) Anderson, Daly, Duvall, Javel, Juhn, Lassman, Liston, Margolis, Santi
Acoustics and psychoacoustics, temporal bone anatomy, external and middle ear mechanisms, cochlear physiology, auditory neurophysiology, ear embryology, ear biochemistry, fine structures, vestibular mechanisms and measurement.

Otol 5102s. Introduction to the Basic Sciences in Otolaryngology II: Head and Neck. (3 cr; prereq #) Adams, Daly, Gapany, Goding, Hilger, Hom, Imola, Liston, Santi, Szachowicz
Laryngeal anatomy and physiology, nasal anatomy and physiology, immune biology, embryology of head and neck.

Otol 5970. Directed Studies. (Cr ar [may be repeated for cr]; prereq #)
Directed readings and preparation of reports on selected topics.

Diagnostic and management instruction and experience in all phases of clinical otorhinolaryngology. Both inpatient and outpatient services are provided at University of Minnesota Hospital and Clinic, St. Paul-Ramsey Medical Center, Veterans Administration Medical Center, and Hennepin County Medical Center.

Surgical training and experience with a broad scope of surgical problems encountered in otorhinolaryngology provided at University of Minnesota Hospital and Clinic, St. Paul-Ramsey Medical Center, Veterans Administration Medical Center, and Hennepin County Medical Center.
Otol 8232. Maxillofacial Surgery. (1 cr) Adams, Boies, Duvall, Hamler, Hilger, Imola, Maisel, Szachowicz
Basic science principles and management principles of maxillofacial diseases. Problems of maxillofacial trauma. Experience with these problems in the hospitals of the training program, especially the county hospitals.

Teaching and practical training for otolaryngologic cosmetic surgery with emphasis on rhinoplasty and otoplasty.

Head and neck anatomy is studied from cadaver material through programmed learning. Temporal bones are dissected to learn anatomy and to practice all otologic surgical procedures.

Otol 8235. Roentgenology of the Head and Neck. (2 cr) Adams, Boies, Gapany, Levine, Goding, Javel, Maisel
Experience in X-ray diagnostic procedures for otolaryngologic problems.

Otol 8236. Pharmacology in Otolaryngology. (2 cr)
General principles of pharmacology as they relate to otolaryngology.

Otol 8237. Endoscopy. (2 cr) Adams, Duvall, Goding, Maisel
Instruction, didactic and practical, in laryngoscopy, esophagoscopy, bronchoscopy, and mediastinoscopy. General management principles emphasized.

Otol 8238. Pathology of the Ear, Nose, and Throat. (2 cr) Adams, Duvall, Gapany, Goding, Maisel
Gross pathology and histopathology of diseases of the ear, nose, throat, and related regions.

Otol 8239. Otoneurology. (2 cr) Anderson, Levine
Instruction and experience in diagnosis and management of otoneurologic problems including training in electroneystagmographic analysis of vestibular function.

Otol 8240. Allergy. (2 cr)
Concepts and management of otolaryngologic allergy.

Otol 8241. Tumor Clinic. (1 cr) Adams, Gapany, Goding, Hamler, Imola, Maisel
Clinical head and neck oncology including consideration of etiology, treatment (both surgical and nonsurgical), and other principles of management.

Otol 8242. Audiology and Speech Pathology. (2 cr) Hunter, Margolis, staff

Otol 8243. Introduction to Research Methodology. (2 cr) Daly, Odland, staff
Basic introduction to such topics as statistical methods, experimental design, and execution of otolaryngologic research. Required for all first-year otolaryngology residents.

Otol 8244. Seminar: Current Literature. (1 cr) Adams, Gapany
Presentation and discussion of selected articles required for all residents.

Otol 8245. Master’s Thesis Research. (Cr ar)

Otol 8246. Ph.D. Thesis Research. (Cr ar)

Otol 8247. Physiology of Hearing. (3 cr, §NSc 8247; prereq #; offered alt yrs) Anderson, Javel, Santi
Basic functional mechanisms of the auditory system, peripheral and central.

Otol 8248. Readings in Auditory Physiology. (1-3 cr; prereq #) Santi
Current research on biophysics and physiology of auditory system; specific topics selected for each student. Written reviews prepared and discussed.

Otol 8249. Seminar: Current Topics in Cochlear Anatomy. (1 cr; prereq #) Santi
Review of current research papers concerning cochlear anatomy and pathology.

Otol 8250. Advanced Biochemistry of the Auditory System. (2 cr; prereq MdBc 5100, MdBc 5101 or equiv or #) Juhn
Review of recent progress in biochemical aspects of auditory end organs.

Otol 8262. Advanced Clinical Audiology. (3 cr; prereq Otol grad major, 8242 or #) Margolis
Comprehensive reading and practicum experience in auditory evaluation of patients. Assumes basic knowledge of clinical audiology. Each session devoted to aspect of auditory evaluation or aural rehabilitation, including behavioral audiometry, electrophysiologic evaluation, hearing aid selection, and cochlear implants.

Parasitology
See Veterinary Pathobiology under Veterinary Medicine.
Pharmaceutics (Phm)

Professor: David J. W. Grant; Yueh-Erh Rahman; Edward G. Rippie; Ronald J. Sawchuk
Adjunct Professor: Michael J. Pikal; Aldo Rescigno
Associate Professor: Cheryl L. Zimmerman, interim head; Raj G. Suryanarayanan, director of graduate studies; Timothy S. Wiedmann
Adjunct Associate Professor: Walid M. Awni; Keith K. Chan; Lawrence J. Felice
Assistant Professor: Pei-Fan Bai
Adjunct Assistant Professor: George A. Ayilirah; Robert K. Schultz

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

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

Curriculum—Emphases are available in physical pharmacy, biopharmaceutics and pharmacokinetics. Coursework in supporting fields typically include chemistry, chemical engineering, mechanical engineering, physiology, biochemistry, cell biology, biometry, and pharmacology.

Prerequisites for Admission—A degree from a recognized college of pharmacy and an exceptional scholastic record are required. However, individuals from other academic fields (such as chemistry, engineering, biochemistry, and biology) may be admitted if their undergraduate coursework satisfies the prerequisites for graduate coursework in pharmaceutics. The degree program adviser may recommend additional background pharmacy coursework for such individuals.

Special Application Requirements—For applicants to both the M.S. and Ph.D. programs, recent Graduate Record Examination scores, a statement of career goals, and three letters of recommendation are required. Fall quarter admission is preferred; under exceptional circumstances other quarters may be considered.

Master’s Degree Requirements—Required components of the program include advanced courses in pharmaceutics and chemistry. A complete list of degree program requirements may be obtained from the director of graduate studies. An oral final examination is required.

Doctoral Degree Requirements—Required components of the program include advanced courses in pharmaceutics, chemistry, mathematics, statistics, and pharmacology. A complete list of degree program requirements may be obtained from the director of graduate studies.

Language Requirements—For the master’s degree, none. For the doctoral degree, one foreign language or a collateral field of knowledge chosen with the consent of the director of graduate studies is required. The choice of option must have the approval of the major adviser.

For Further Information and Applications—Contact the Department of Pharmaceutics, College of Pharmacy, University of Minnesota, 9-177 Weaver-Densford Hall, 308 Harvard Street S.E., Minneapolis, MN 55455 (612/624-5151; fax 612/626-2125).

Phm 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

Phm 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

Phm 8888. Thesis Credits: Doctoral. (36 cr required)

Phm 8100.* Seminar: Pharmaceutics. (1 cr; required of pharmaceutics majors)

Phm 8101. Readings in Pharmaceutics. (1 cr)

Phm 8105. Pharmacokinetics Research Seminar. (2 cr; prereq Phm grad specializing in pharmacokinetics) Sawchuk, Zimmerman

Phm 8200.* Research Problems. (Cr ar)

Phm 8410. Stabilization of Pharmaceuticals. (3 cr; prereq physical chem survey course) Wiedmann

Phm 8420. Modeling Approaches in Pharmacokinetics. (3 cr; prereq Phmc 5680, Math 3211 or # offered alt yrs) Sawchuk
Phm 8425. Advanced Topics in Pharmacokinetics. (3 cr; prereq 8420; offered alt yrs) Zimmerman
Nonlinear pharmacokinetics (concentration- and time-dependent), drug metabolic kinetics, kinetics of pharmacological response, population kinetics.

Phm 8430. Drug Transport and Absorption. (3 cr; prereq 5630, survey course in physical chem and in differential equations; offered alt yrs) Bai
Correlation of drug absorption with physiology and properties of drugs; fundamental problems of peptide drug delivery; chemical and physical approaches to improving bioavailability; use of animal and theoretical models to evaluate and predict drug absorption.

Phm 8440. Physical Pharmacy. (4 cr; prereq Phmc 5680, physical chem survey course or #; 4 hrs per wk; offered alt yrs) Rippie
Application of physical-chemical relationships between drugs and their formulations for optimization of bioavailability.

Phm 8441. Solid-State Properties of Drugs. (3 cr; prereq Phmc 5680, physical chem survey course or #; offered alt yrs) Suryanarayanan
Physical and physicochemical properties of drugs in solid state as related to their bioavailability.

Phm 8450. Industrial Pharmacy. (3 cr; prereq Phm 5605 or equiv or #; offered alt yrs) Schultz
Design, manufacture, and evaluation of modern pharmaceutical dosage forms and delivery. Preformulation studies, oral liquid and solid pharmaceutical dosage forms and optimization. Pulmonary, transdermal, and parenteral deliveries, including veterinary drug delivery systems.

Phm 8460. Solubility Behavior of Drugs and Other Organic Compounds. (4 cr; prereq physical chem survey course or #; offered alt yrs) Grant

Phm 8470. Biological Approaches to Drug Targeting. (3 cr; prereq biochem survey course; offered alt yrs) Rahman

Phmc 5460. Pharmacokinetics. (4 cr; prereq 5452, Math 1221 or #) Zimmerman
Physiological basis for drug absorption, distribution, metabolism, and excretion; using mathematical principles for designing dosage forms for individual patients.

Phmc 5681. Basic Pharmacokinetic Modeling. (2 cr; prereq 5680 with minimum grade of B; A-F only) Sawchuk
Computer simulation of compartmental and physiologic modeling.
Special Application Requirements—At least three letters of recommendation from former instructors or employers and scores from the General (Aptitude) Test of the Graduate Record Examination are required.

Master’s Degree Requirements—Completion of a core curriculum consisting of 19 course credits in pharmacology is required, along with prerequisite courses in biochemistry, physiology, and statistics and 16 thesis credits. A list of degree program requirements may be obtained from the director of graduate studies. An oral final examination is required.

Doctoral Degree Requirements—Students must complete Phcl 5110, 5111 (or an acceptable alternative), 8110, 8111, 8112, 8204, 8217, and 8888. Prerequisite courses include physiology and biochemistry. Additional requirements are courses in statistics, biochemistry, physiology, and any others that may be specified by the major adviser.

Language Requirements—None.

Minor and Supporting Program Requirements for Students Majoring in Other Fields—Students must complete 18 credits of coursework. At least 15 credits must be completed in Phcl 5110 and 5111, or the equivalent, 8110, 8111, 8112, 8204, and 8217. The remaining credits can be completed in other advanced pharmacology courses.

For Further Information and Applications—Contact the Department of Pharmacology, University of Minnesota, 3-249 Millard Hall, 435 Delaware Street S.E., Minneapolis, MN 55455 (612/625-9997).

Phcl 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

Phcl 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

Phcl 8888. Thesis Credits: Doctoral. (36 cr required)

Phcl 5110. Pharmacology. (2 cr; prereq regis med or #) Hunninghake, staff
Lectures and small groups on general principles of pharmacology and major classes of drugs.

Phcl 5111f,w1. Pharmacology. (3 cr fall, 4 cr wtr; prereq 5110 or #) Hunninghake, staff
Continuation of 5110.

Phcl 5462. Neuroscience Principles of Drug Abuse. (2 cr; prereq # offered alt yrs) Law, Wilcox
Current research on drugs of abuse: their mechanisms of action, characteristics shared by various agents, and cellular and neural systems affected by them.

Phcl 8110f. Advanced Pharmacology I. (2 cr; prereq biochem and physiol bkgrnd, 5111 or 5110 or #) Loh, staff
Supplement to 5110. Contemporary research concepts and experimental approaches in different areas of investigative pharmacology. Emphasis on mechanisms of action of drugs on systems (whole animal), organ, and cellular levels.

Phcl 8111w. Advanced Pharmacology II. (3 cr; prereq biochem and physiol bkgrnd, 5111 or 5111 or #) Loh, staff
Supplement to 5111. Contemporary research concepts and experimental approaches in different areas of investigative pharmacology. Emphasis on mechanisms of action on drugs on cellular and molecular levels.

Phcl 8112s. Advanced Pharmacology III. (3 cr; prereq biochem and physiol bkgrnd, 5111 or #) Loh, staff
Supplement to 5111. Contemporary research concepts and experimental approaches in different areas of investigative pharmacology. Emphasis on mechanisms of action on drugs on cellular and molecular levels.

Phcl 8204. Seminar: Selected Topics in Pharmacology. (1 cr per qtr; prereq 5111 or #) Walseth, staff

Phcl 8207. Seminar: Psychopharmacology. (1 cr; prereq #) Sparber, staff
Selected topics on behavioral aspects of drug action.

Phcl 8208s. Neuropsychopharmacology. (3 cr, 5Nsc 8208; prereq 5111, Psy 5018, Psy 5062 or #; offered alt yrs) Sparber, staff
Lectures on methodologies currently used to study relationships between drugs and biochemical, behavioral, and neurophysiological consequences. Discussions of functional biogenic amine, peptidergic, and other pathways; how specific manipulations result in altered neuronal function and behavior; and theories of feedback mechanisms, induction, and inhibition. Theories of tolerance to and/or dependence on stimulants, hallucinogens, depressants, and opiates.

Phcl 8214s. Toxicology. (2 cr; prereq MdBc 5101 or #) Holtzman, Loh
Lectures on biochemical and molecular mechanisms of action by which drugs and other chemicals adversely alter human health.

Phcl 8216s. Immunopharmacology. (2 cr; prereq MicB 5216 or equiv or #; offered alt yrs) Regal
Purported mediators of inflammatory process with reference to their actions on components of immune system and physiological response. Models for development of drugs useful in inflammatory disease as well as mechanisms of drugs currently in use. Lectures, assigned readings, discussion.
Phcl 8217f. Problems in Investigative Pharmacology. (2 cr; prereq #) Loh, staff
Contemporary research problems, investigative approaches and methodologies in experimental pharmacology. Related to cardiovascular, renal, endocrine, and autonomic pharmacology; neuropharmacology; psychopharmacology; chemotherapy; toxicology; and molecular pharmacology.

Phcl 8219s. Advanced Toxicology. (1 cr; prereq 8214 or #; offered alt yrs) Holtzman, staff
Lectures on the biochemical mechanisms of intoxication by selected compounds.

Phcl 8261. Molecular Toxicology. (3 cr; prereq 5262, Biol 5001, #PubH 8261, # Holtzman, staff
Toxic actions and mechanisms of environmental chemicals at molecular level; emphasis on current research in selective toxicity.

Phcl 8269. Toxicology Seminar. (1 cr; prereq 8261, #PubH 8269, # Holtzman, staff
Evaluation of toxicological studies. Students present data from literature or their own research.

Philosophy (Phil)

Professor: Marcia M. Eaton, chair; Elizabeth S. Belfiore; Norman E. Bowie; Norman O. Dahl; Ronald N. Giese; Jeanette K. Gundel; Keith Gunderson; William H. Hanson; Geoffrey P. Hellman; Jasper Hopkins; Michael B. Kac; Douglas E. Lewis; Helen E. Longino; H. E. Mason; Joseph I. Owens; C. Wade Savage; Naomi B. Scheman; John R. Wallace

Associate Professor: C. Kenneth Waters, director of graduate studies; John H. Beatty; John M. Dolan; Sandra L. Peterson; Michael D. Root

Assistant Professor: Sarah W. Holtman

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

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

Prerequisites for Admission—Recognizing that evidence of ability to pursue graduate study in philosophy is diverse, the department does not specify prerequisites for admission. Normally, those admitted have a broad undergraduate background that includes some courses in philosophy.

Special Application Requirements—Students must submit a completed application, scores from the General (Aptitude) Test of the Graduate Record Examination, and two or three letters of recommendation—normally by January 7. Decisions can be expected in March. Entry is usually in fall quarter, but may be permitted in other quarters in exceptional cases.

Master’s Degree Requirements—Students must exhibit competence, through coursework or examination, in the history of philosophy. Students must pass a final oral examination on their work.

Doctoral Degree Requirements—Students must exhibit competence in the history of philosophy and logic and in the ability to pursue work on a range of philosophical topics in such areas as epistemology, metaphysics, and ethics or political philosophy.

Language Requirements—There is no general language requirement for the M.A. or Ph.D. degree.

For Further Information and Applications—Further details about the program are presented in two publications: Graduate Studies: Philosophy and Department Degree Programs: M.A. and Ph.D., available from the Department of Philosophy, University of Minnesota, 355 Ford Hall, 224 Church Street S.E., Minneapolis, MN 55455 (612/625-6563; fax 612/626-8380; e-mail umphil@tc.umn.edu).

Phil 8666. Doctoral Pre-Thesis Credits. (max 18 cr per qtr; doctoral student who has not passed oral prelims)

Phil 8777. Thesis Credits: Master’s. (16 cr required; Plan A only)

Phil 8888. Thesis Credits: Doctoral. (36 cr required)

Phil 5004. Socratic Dialogues. (4 cr; prereq 3001 or #; offered when feasible) Dahl, Hopkins, Lewis, Peterson

Phil 5005. Plato. (4 cr; prereq 3001 or #; offered alt yrs) Hopkins, Peterson

Philo 5006. Aristotle. (4 cr; prereq 1 qtr hist of phil or #; offered alt yrs) Dahl, Peterson

Phil 5008. Aristotelianism. (4 cr; prereq 3003 or #) Philosophies of Descartes, Spinoza, and Leibniz.

Phil 5034. Descartes. (4 cr; prereq 3003 or #; offered alt yrs) Lewis, Root

Philosophical works.
Phil 5035. Spinoza. (4 cr; prereq 3003 or #; offered when feasible) Lewis

Phil 5041. Locke. (4 cr; prereq 3003 or #; offered alt yrs) Gunderson, Lewis
The Essay Concerning Human Understanding.

Phil 5042. Berkeley. (4 cr; prereq 3003 or #; offered when feasible) Lewis

Phil 5043. Hume. (4 cr; prereq 3003 or #; offered alt yrs) Lewis
Hume’s Treatise and Inquiry.

Phil 5046. Kant. (4 cr; prereq 3003 or 3004 or #; offered alt yrs) Dahl, Holtman
Selected passages from major works.

Phil 5054. Kierkegaard. (4 cr; prereq 1 qtr hist of phil or #; offered when feasible) Mason

Phil 5068. Later Philosophy of Wittgenstein. (4 cr; prereq 5231 or 3003 or #; offered alt yrs) Mason, Scherman
Philosophical Investigations.

Phil 5101. Metaphysics. (4 cr; prereq 1 qtr hist of phil or #; offered alt yrs) Dolan, Owens, Root
Philosophical theories concerning nature of reality.

Phil 5105. Epistemology. (4 cr; prereq 1001 or #; offered alt yrs) Dolan, Root, Savage, Wallace, Waters
Theories of origin, development, reliability, justification, and scope of knowledge.

Phil 5201. Symbolic Logic I. (5 cr; prereq 1001 or #) Dahl, Dolan, Hanson, Kac
Development of a formalized language. Syntax and semantics of sentential and first-order predicate logic. Deductive systems.

Phil 5202. Symbolic Logic II. (5 cr; prereq 5201 or #) Dolan, Hanson, Hellman, Kac, Wallace
Introduction to metatheoretic proofs and methods, including proof by mathematical induction; elements of set theory; metatheorems on soundness, consistency, completeness; extensions of elementary logic.

Phil 5203. Symbolic Logic III. (4 cr; prereq 5202; offered alt yrs) Dolan, Hanson, Hellman, Wallace
Elementary theory of Turing machines and recursive functions, proofs of limitative results, undecidability of first-order predicate logic, incompleteness of number theory and undefinability of truth therein. Philosophical significance of these results.

Phil 5211. Modal Logic. (4 cr; prereq 5202 or Math 5162 or #; offered alt yrs) Hanson
Axiomatic and semantic treatment of propositional and predicate logics; problems of interpreting modal languages.

Phil 5221. Philosophy of Logic. (4 cr; prereq 5202 or Math 5162 or #; offered alt yrs) Hanson, Hellman
Attempts to answer the question, “What is logic?” Scope of logic; disputes about alternative logics; various theories on nature of logical truth (e.g., conventionalism, the view that logical truths are contingent).

Phil 5222. Philosophy of Mathematics. (4 cr; prereq 5202 or 5xxx math course; offered alt yrs) Hanson, Hellman
Study of major philosophical questions arising in connection with mathematics: What (if anything) is mathematics about? How do we know the mathematics we do? What is the relation between mathematics and the natural sciences?

Phil 5231. Philosophy of Language. (4 cr; prereq 1001, 5201 or #; offered alt yrs) Dolan, Kac, Mason, Owens, Peterson, Root, Wallace
Central topics in the philosophy of language, theories of reference, linguistic truth, relation of language and thought, translation and synonymy.

Phil 5232. Topics in the Philosophy of Language. (4 cr; prereq 3231 or 5231 or #; offered when feasible) Dolan, Hellman, Kac, Mason, Owens, Peterson, Root, Wallace

Phil 5233. Philosophy of Science. (4 cr; prereq 3231 or 5231 or #; offered when feasible) Dolan, Lewis

Phil 5234. Ethics and Education. (4 cr; prereq 8 cr phil or educ or #; offered when feasible) Scherman, Wallace

Phil 5302. History of Ethics: Selected Classical Moralists. (4 cr; prereq 1003 or 1 qtr hist of phil or #; offered alt yrs) Dahl, Peterson
Moral philosophy outside of British tradition (see 5301). Specific topics announced in Class Schedule.

Phil 5311. Ethical Theory. (4 cr; prereq 1003 or #; offered alt yrs) Bowie, Dahl, Holmahn, Mason
Investigation of representative theories on the nature and justification of moral judgments.

Phil 5312. Foundations of Ethics. (4 cr; prereq 1003 or #; offered alt yrs) Dahl, Holmahn, Mason
Discussion of the view that evaluative judgments cannot be based on factual considerations alone, and the relation of this view to the objectivity of ethics.

Phil 5315. Ethical Theory of Bioethics. (4 cr)
Survey of normative ethical theories, focusing on key ethical notions relevant to bioethics, e.g., autonomy, utility, beneficence, paternalism, rights, justice, principilist and virtue ethics, and “ethics of care.”

Phil 5321. Theories of Justice. (4 cr; prereq 1003 or 1004 or 5311 or #; offered alt yrs) Bowie, Holmahn, Mason
Philosophical accounts of the concept and principles of justice.

Phil 5324. Ethics and Education. (4 cr; prereq 8 cr phil or educ or #; offered when feasible) Scherman, Wallace

Phil 5325. Biomedical Ethics. (4 cr; prereq # for undergrads)
Survey of topics and issues, including patients’ rights and duties, informed consent, confidentiality, ethical issues in medical research, initiation and termination of medical treatment, euthanasia, abortion, maternal/fetal conflicts, allocation of medical resources.

Phil 5414. Political Philosophy. (4 cr; prereq 1004 or #; offered alt yrs) Bowie, Dolan, Hellman, Holmahn, Root, Wallace
Central concepts and principal theories of political philosophy.
Phil 5415. Philosophy of Law. (4 cr; prereq 1003 or 1004 or 3302 or social sci major or #) Holtman
Analytical accounts of law and legal obligation.

Phil 5501. Principles of Aesthetics. (4 cr; prereq 3502 or #, offered alt yrs) Eaton, Gunderson
Standards of evaluation; aesthetic experience; representation, meaning.

Phil 5504. Applied Aesthetics. (4 cr, § 3504; prereq 3502 or 5501 or #)
Application of concepts and theories in philosophy of art and aesthetics to practical problems in contemporary society, e.g., assessment of environmental values, artists’ responsibilities, censorship.

Phil 5512. Philosophy and Literary Criticism. (4 cr; prereq 4 cr phil or #, offered alt yrs) Eaton,
Gunderson
Goals and aims of literary criticism and the problems which arise in attempting to justify various principles of criticism.

Phil 5514. Art and Language. (4 cr; prereq 3231, 3502, 5231, 5501 or #, offered alt yrs) Eaton,
Gunderson, Mason, Root, Scheman
Similarities and differences between verbal and nonverbal symbols; questions concerning extent to which art can be called a “language.”

Phil 5521. Philosophy of Religion. (4 cr, §RelS 5521; prereq 8 cr phil; offered alt yrs) Hopkins, Owens
Conceptual problems arising from attempts to provide rational justification for religious belief.

Phil 5601. The Evaluation of Scientific Hypotheses. (4 cr; prereq 3601 or #) Giere, Hanson,
Hellman, Savage, Waters
Philosophical theories of the nature of scientific methods for evaluating scientific hypotheses, of role of experimentation in science, and of how hypotheses come to be accepted within a scientific community.

Phil 5602. The Nature of Scientific Theories. (4 cr; prereq 3601 or #) Giere, Hellman, Savage,
Waters
Contemporary issues concerning the nature and role of theories in science: their structure and their relations with models and laws, other forms of representation, experiment, and the world in general.

Phil 5603. Scientific Explanation. (4 cr; prereq 3601 or #, offered when feasible) Giere, Hellman,
Savage, Waters

Phil 5604. Determinism and Causation. (4 cr; prereq courses in phil of sci or natural sci; offered when feasible) Hellman

Phil 5605. Time and Space. (4 cr; prereq courses in phil of sci or natural sci; offered when feasible) Savage

Phil 5606. Philosophy of Quantum Mechanics. (4 cr; prereq 3601 or Phys 3501 or Math 3142 or #) Hellman
Introduction to problems of interpretation of ordinary (nonrelativistic) quantum mechanics: two-slit experiment, Schrödinger cat paradox (measurement problem), Einstein-Podolsky-Rosen paradox; leading approaches to interpretation (Copenhagen, hidden variables, universal wave function) and their connections with philosophical issues.

Phil 5607. Philosophy of the Biological Sciences. (4 cr; prereq courses in phil of sci or biol; offered when feasible) Beatty, Waters

Phil 5608. Theory and Measurement. (4 cr; prereq 5201 or #)
Theory of measurement and its applications in philosophy of science, metaphysics, and epistemology.

Phil 5611. Philosophy of the Social Sciences I. (4 cr; prereq 12 cr phil or soc sci or #, offered when feasible) Root

Phil 5612. Philosophy of the Social Sciences II. (4 cr; 5611 recommended; offered when feasible) Root

Phil 5614. Philosophy of Psychology. (4 cr; prereq 3607 or 5601 or Psy 3051 or Psy 5011 or #) Savage
Problems of and prospects in recent developments in psychology, cognitive science, and philosophy of mind.

Phil 5615. Minds, Bodies, and Machines. (4 cr; prereq 4 cr phil or #, offered alt yrs) Gunderson,
Owens
Philosophical relevance of cybernetics, artificial intelligence, and computer simulation.

Phil 5617. Twentieth-Century Philosophy of Science: Logical Empiricism. (4 cr; prereq phil major or phil grad student or #) Giere, Savage
Historical development of logical empiricism from its European origins in first half of 20th century to its emergence as nearly universal account of science in post-war Anglo-American philosophy.

Phil 5618. Twentieth-Century Philosophy of Science: The Historical School. (4 cr; prereq phil major or phil grad student or #) Giere, Savage, Waters
Historical turn in Anglo-American philosophy of science beginning in 1960s with writings of Stephen Toulmin, Russell Hanson, Paul Feyrerabend, and Thomas Kuhn and continuing with works of Imre Lakatos, Larry Laudan, and Dudley Shapere.

Phil 5622. Philosophy and Feminist Theory. (4 cr; prereq 8 cr phil or women’s studies or #) Scheman
Critical examination of encounters between philosophy and feminism; e.g., how has gender figured in traditional philosophical problems and methods, and how do theorizing and social role of theorist relate to politics of feminism?
Phil 5701. Survey of Contemporary Philosophy. (4 cr; prereq 3003 or #; offered alt yrs)
Lewis
Current systematic and critical philosophies as represented by their principal exponents.

Phil 5720, 5730. Studies in Contemporary Philosophers. (4 cr per qtr; prereq 3003 or #)
Specific topics announced in Class Schedule.

Phil 5760, 5770. Selected Topics in Philosophy. (4 cr per qtr; prereq 4 upper div cr in phil or #)
Philosophical problems of contemporary interest. Specific topics announced in Class Schedule.

Phil 5781. Existentialism. (4 cr; prereq 3003 or 3004 or 5054 or #; offered alt yrs) Hopkins, Lewis, Mason
Writings of existentialist philosophers since Kierkegaard.

Phil 5970, 5990. Directed Study and Research. (1-5 cr per qtr; prereq #, Δ, CLA approval)

Phil 8090. Seminar in History of Philosophy. (4 cr [may be repeated for cr])

Phil 8110, 8120. Seminar: Metaphysics. (4 cr per qtr [may be repeated for cr]; prereq 5101 or #)
Topics in metaphysics. Specific topics announced in Class Schedule.

Phil 8130, 8140. Seminar: Epistemology. (4 cr per qtr [may be repeated for cr]; prereq 5105 or #)
Problems in the theory of knowledge. Specific topics announced in Class Schedule.

Phil 8131. Epistemology Survey. (4 cr)
Problems in epistemology.

Phil 8180. Seminar: Philosophy of Language. (4 cr [may be repeated for cr])

Phil 8210. Seminar: Logical Theory. (4 cr [may be repeated for cr]; prereq 5201, 5202 or #)
Selected topics in the philosophy of logic.

Phil 8220. Seminar: Philosophy of Mathematics. (4 cr; prereq 5203 or Math 5164 or 8xxx math course or #) Hanson, Hellman
Topics such as significance of limitative theorems (Gödel, et al.), assessment of major foundational programs (set theoretic, modern Hilbertian, constructivist), modal and structuralist alternatives to standard platonism.

Phil 8315. Ethical Issues in Human Experimentation. (4 cr; prereq 5xxx ethics course)
Evolution of ethical protections for human subjects, definition of research, informed consent, competency, and ethics of research on vulnerable subjects such as children, prisoners, and the mentally ill.

Phil 8321. Ethics Survey. (4 cr) Holtman, staff
Problems in ethics.

Phil 8420. Seminar: Political Philosophy. (4 cr) Holtman
Systematic study of selected problems in political philosophy.

Phil 8510. Seminar: Studies in Aesthetics. (4 cr [may be repeated for cr]) Eaton, Gunderson, Hellman
Problems in aesthetics. Specific topics announced in Class Schedule.

Phil 8550. Seminar: Philosophy of Religion. (4 cr [may be repeated for cr]; prereq 5521 or #; offered when feasible) Hopkins

Phil 8600. Seminar: Philosophy of Science. (4 cr [may be repeated for credit]) Giere, Hellman, Savage, Waters

Phil 8605. Issues and Approaches in Philosophy of Science. (4 cr)
Major contemporary approaches to philosophical study of general nature of science.

Phil 8606. Philosophy of Medicine and the Biomedical Sciences. (4 cr; prereq 5xxx ethics course)
Aims and goals of medicine; concepts of health, illness, and disease; nature of reasoning in clinical medicine, theoretical evolution in medicine, and role of values in practice of medicine and healthcare.

Phil 8610. Seminar: Philosophy of the Physical Sciences. (4 cr [may be repeated for cr]; offered when feasible)

Phil 8620. Seminar: Philosophy of Biology. (4 cr [may be repeated for credit]) Beatty, Waters

Phil 8640. Seminar: Philosophy of Psychology. (4 cr, §CgSc 8000; prereq phil or psych grad student or #) Owens, Savage

Phil 8970, 8990. Directed Study and Research. (1-4 cr per qtr; prereq passing grade on written prelim exam for phil PhD, #)