UNIVERSITY OF NEW HAMPSHIRE
Graduate Catalog
1985–1987
The Graduate School 1985–1987

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Graduate Programs

Master of Arts
Counseling
Economics
English
   Literature
   Language and Linguistics
   Writing
History
Music
Political Science
Psychology
Sociology
Spanish

Master of Science
Animal and Nutritional Sciences
Biochemistry
Biology
Botany
Chemical Engineering
Chemistry
Civil Engineering
Communication Disorders
Computer Science
Earth Sciences
   Geology
   Oceanography
Electrical Engineering
Entomology
Family and Consumer Studies
Forest Resources
Genetics
Hydrology
Mathematics
Mechanical Engineering
Microbiology
Music Education
Nursing
Ocean Engineering
Physical Education
Physics
Plant Science
Resource Administration and Management
Resource Economics
Soil Science
Wildlife
Zoology

Master of Arts in Teaching
Elementary Education
Secondary Education

Master of Science for Teachers
Chemistry
English
Mathematics
Physics

Master of Education
Administration and Supervision
Counseling
Developmental Disabilities
Early Childhood Education
Special Needs
Elementary Education
Reading
Secondary Education

Master of Occupational Education

Master of Business Administration

Master of Public Administration
Certificate of Advanced Graduate Study
Counseling
   Educational Administration and Supervision

Doctor of Philosophy
Animal and Nutritional Sciences
Biochemistry
Botany
Chemistry
Earth Sciences
   Geology
   Oceanography
Economics
   Organizational Behavior/Labor
Engineering
English
Genetics
History
Mathematics
   Mathematics Education
Microbiology
Physics
   Plant Science
   Psychology
Reading and Writing Instruction
Sociology
Zoology
Graduate Education and the University of New Hampshire

The University

The home of the University is Durham—one of the oldest towns in northern New England. The town is semirural and still retains traces of its colonial past. Easy accessibility to Boston's cultural opportunities (65 miles to the south); the unsurpassed skiing, hiking, and scenery of the White Mountains (60 miles north); and the sandy beaches and rocky coast of New Hampshire and Maine (10 miles east) make it an ideal location.

The 188-acre campus is surrounded by more than 3,000 acres of fields, farms, and woodlands owned by the University. A 15-acre wooded tract, known as the Ravine, graces the center of the campus, allowing members of the University community some natural quiet midst the 35 classroom, research, and service buildings and 29 residential buildings of the campus.

The University is composed of the College of Liberal Arts, College of Life Sciences and Agriculture, College of Engineering and Physical Sciences, Whittier School of Business and Economics, School of Health Studies, Thompson School of Applied Science, Division of Continuing Education, and the Graduate School. In addition to these colleges and schools located on the University campus, the University System of New Hampshire also includes Keene State College, Plymouth State College, and the School for Lifelong Learning.

The University enrolls more than 10,000 students, has a full-time faculty of more than 500, and offers 94 undergraduate and 75 graduate programs. The student body includes 1,000 graduate students.

The University of New Hampshire is a land-grant institution made possible by the Morrill Act of 1862, which aided states in developing institutions to serve all the people. The institution was founded as New Hampshire College of Agriculture and the Mechanic Arts in 1866 to train young men and women for service to the state through agriculture and technology. In 1893, New Hampshire College (as it was called at that time) moved from Hanover to Durham, as the result of a bequest of lands and funds by Benjamin Thompson, and began to develop more rapidly. University status was conferred in 1923. In 1980, UNH and the University of Maine were designated jointly as a Sea Grant College by the National Oceanographic and Atmospheric Administration (NOAA).

Graduate Education

The University awarded its first Ph.D. in 1896, placing it among the early American universities to award that degree. Doctoral programs in their present form began in the 1950s.

Graduate education is supervised by a graduate faculty of 450. The Graduate School is led by the dean, who implements the policies of the graduate faculty. The Graduate Council is composed of elected faculty and student representatives and serves in an advisory capacity to the dean.

Quality graduate education requires development of new knowledge and communication of existing knowledge. The faculty, while dedicated to teaching, carry on an active research program, which supports graduate education by developing new knowledge and providing training opportunities for graduate students in residence. As a land-grant and Sea Grant institution, the University is responsible for conducting research and disseminating information to the public in areas affecting the nation's welfare.

The University of New Hampshire is the only university in the state and is the primary institution within the University System of New Hampshire responsible for providing graduate programs that meet state and regional needs. Doctoral programs are offered exclusively on the University campus although other units of the University System offer some master's programs.

Master's Programs

The University offers master's degree programs in a wide variety of disciplines. The master's degree can serve either as a professional terminal degree or as an intermediate degree for those intending to pursue further graduate study. Master's programs at the University of New Hampshire have been carefully developed and are reviewed by the graduate dean and faculty to ensure their continuing quality. In most programs, students can elect options that will permit them either to study one aspect of a discipline in depth by preparing a thesis or to gain a broader mastery of a discipline by electing to take course work in lieu of a thesis.

Doctoral Programs

The University offers programs leading to the doctor of philosophy in those disciplines that have both faculty and facilities to support advanced graduate education of high quality. Care has also been taken to ensure that the
programs will make a significant contribution to the opportunities for doctoral education in the New England region. Doctoral education properly focuses upon preparing the student to contribute to the growth of knowledge through research. However, since a large percentage of doctoral students find employment in higher education, most doctoral programs provide opportunities for students to work as teaching assistants and to participate in seminars on teaching led by experienced faculty members. This preparation for the student’s future role as both developer and communicator of knowledge has enabled recipients of the doctoral degree from the University of New Hampshire to obtain attractive teaching and research positions.

Interdisciplinary Programs
The Graduate School encourages interdisciplinary study within its existing programs and has adopted procedures for faculty to develop interdisciplinary options within established doctoral programs. However, independent, self-designed graduate programs are not available at the University. Formal interdisciplinary degrees are offered in the Genetics Program, which involves geneticists from many departments in both master’s and doctoral programs; the Engineering Ph.D. Program and the Ocean Engineering M.S. Program, which are cooperative, interdisciplinary efforts of the electrical and computer engineering, civil engineering, mechanical engineering, and chemical engineering departments; and the Biology Program, which makes the resources of the biological science departments available to students interested in a general master’s program.

Graduate programs with interdisciplinary marine concentrations are offered in the departments of botany and plant pathology, chemical engineering, chemistry, civil engineering, earth sciences, electrical and computer engineering, mechanical engineering, microbiology, and zoology. Other departments offering marine-related study are animal and nutritional sciences, biochemistry, computer science, mathematics, physical education, political science, resource economics, and sociology and anthropology. The Whittemore School of Business and Economics and the Complex Systems Research Center also provide marine study opportunities.

Additional interdisciplinary opportunities are listed with the individual program descriptions.

The Graduate School
The staff of the Graduate School is available to assist students in both academic and personal matters affecting their study at the University. Students are urged to contact the office with questions about academic policy, financial assistance, and University services available to graduate students. The offices of the Graduate School are located in the Horton Social Science Center.

Graduate Student Life
Graduate students play an active role in the life of the University community. In most departments, students are consulted concerning issues affecting their programs and serve as full voting members on important departmental committees. Three graduate students are elected by the graduate student organization as full voting members of the Graduate Council, the body that advises the graduate dean on all matters concerning Graduate School policy. Graduate students are also represented in the Academic Council of the Student Senate and Academic Senate and serve on such University-wide committees as the Research Council and the Teaching-Learning Council.

Recreational and Cultural Activities
The University offers students a variety of recreational, social, and cultural opportunities. With two theaters and two art galleries in the Paul Creative Arts Center, the University is a major cultural resource for the entire state. The Sidore Lecture Series presents provocative, well-known speakers each year, while the University’s Celebrity Series brings leading concert artists and professional talent to the campus. University students and faculty also perform in public concerts, recitals, and theater productions.

Approximately 100 student clubs and organizations are recognized on campus, and membership in many of these is open to graduate students. Since graduate students are not required to pay the student activities fee, a nominal charge for admission to some events may be required.

The Memorial Union Building houses many of the student organizations and also provides lounges, eating facilities, and recreation areas for student use. New Hampshire’s public television station, WENH-TV, also housed in the Memorial Union, broadcasts in-school programs for 110,000 young people and, during evening hours, cultural and educational programs.
Recreational facilities are also available at the field house for students who purchase recreation passes. The pass entitles the holder to use the athletic-recreation facilities during open recreation periods and to participate in certain club sports, noncredit instructional programs at reduced rates, and the faculty/staff/graduate student intramural program.

The University competes in 14 men’s and 12 women’s varsity athletic programs.

**Graduate Student Residences**

**Babcock House** provides on-campus housing and a sense of community for full-time graduate students. Babcock lies within easy walking distance of all major classroom buildings as well as the University library, University theaters, computer clusters, and the Memorial Union Building. Babcock itself is a center for both academic and nonacademic graduate student activities. Events in the past have included job opportunity seminars, art exhibits, film series, and evening gatherings; whale watches and hiking trips have also been organized.

Six-story Babcock can accommodate 180 persons on co-ed or single-sex wings. The general atmosphere is quiet but sociable. A common T.V. and study lounge with tables and comfortable seating is located on each floor. On the ground floor, you can relax in front of the fireplace in the main lounge, unwind with a game of ping-pong in the recreation room, or check out sports equipment for use outside. Other facilities in the hall include a photography darkroom, piano, locked bicycle storeroom, coin-operated laundry, vending machines, luggage storage areas, and individual mailboxes. All student rooms are single occupancy. Each room is furnished with a bed, easy chair, desk and chair, wardrobe, clothing drawers, medicine cabinet, mirror, and lights.

A full-time hall director lives in a ground-floor apartment. Five resident assistants, one on each floor, assist in administration and programming and can provide information on University policies and personal services available to graduate students. Babcock also has a house council with representatives elected from each wing. The council acts as an advocate for residents and, traditionally, supplies papers, magazines, television, recreational equipment, and other services and programs for residents.

Following acceptance to the Graduate School, each student will be contacted by the Office of Residential Life, Pettee House, University of New Hampshire, Durham, N.H. 03824.

**Forest Park Apartments:** The University owns and operates Forest Park, a complex of 154 studio (efficiency), one- and two-bedroom apartments for married students, students with families, and for new faculty. The community is composed of two- and three-story buildings located on the southern edge of campus, within walking distance of all UNH facilities and Durham’s shopping area and schools.

To be eligible for housing, all graduate students must be admitted to the University and be considered full time as defined in this catalog. Students may apply for Forest Park before fulfilling the above requirements, as long as the requirements are met at the time of assignment. Before an apartment can be offered, all interested individuals must fill out an application form available at the Forest Park Office. Generally, most applicants are offered an apartment within 4 to 6 months of application. A brochure and application can be requested by writing to: Forest Park Resident Manager, 160 Forest Park, University of New Hampshire, Durham, N.H. 03824.

**Summer Housing:** Rooms in Babcock House are available to graduate students taking courses during the summer. Students interested in summer accommodations should contact the Summer Housing Office, Pettee House, University of New Hampshire, Durham, N.H. 03824 or complete and return the Summer Housing Application Form in the Summer Session Bulletin.

**Off-Campus Housing:** The Dean for Student Affairs office operates the Commuter/Transfer Center, which assists students in obtaining off-campus housing. As in most university communities, rents in the Durham area can be high and the supply limited. The office has listings of off-campus rentals in Durham and the surrounding area that are updated weekly.

Students are encouraged to make every effort to come to campus so that the Commuter/Transfer Center staff will be able to assist in finding accommodations. The office is located in the Memorial Union Building and is open Monday through Friday.

**Dining Services:**

Graduate students may elect to take their meals on a contractual basis with the University dining halls whether or not they live on campus. There are limited cooking facilities in Babcock House, but none in individual rooms. Information concerning meal plans is available from the Office of Dining Services, Pettee House, University of New Hampshire, Durham, N.H. 03824.
Health Services
This service, located in Hood House, has a well-equipped clinic for diagnosis and treatment of student health problems. Services include: out- and in-patient care, laboratory tests, x-rays, limited mental health care, and routine medications. For serious medical problems, students are generally referred to consultants and/or a local hospital. An emergency ambulance service is available.

During the regular academic year, the Health Service is staffed by full-time physicians, nurses, and part-time consultants. Regular clinic hours are held, and appointments may be made upon request. Nurses are available 24 hours a day, and a doctor is always on call.

The Health Service operates on a limited basis during holidays, semester breaks, and summer session.

Full-time graduate students must pay the mandatory health fee. Part-time graduate students may be required to pay the health fee or pay a fee for services used. The Health Service also offers a group accident and sickness insurance policy that is mandatory for international students and optional for all others.

Counseling
The Counseling and Testing Center offers students, without charge, professional assistance in meeting a variety of personal, educational, and vocational problems. Services include individual and group counseling, vocational testing, and information on national testing programs such as the Graduate Record Examination and the Miller Analogies Test. Individual clinical testing is available.

The center sponsors a variety of student-oriented activities, e.g., personal skills groups on such topics as communication, values clarification, and life planning.

All information about students’ visits to the Counseling and Testing Center is confidential and cannot be released without the permission of the student.

Career Planning and Placement Service
The Career Planning and Placement Service assists students in planning for professional careers following completion of their degree work. The assistance available to students includes an on-campus interview program, which brings recruiting personnel to the campus between November and May, a library of information on employers and career opportunities, career and life counseling, placement techniques workshops, and aid in finding summer employment.

The service will also update students’ records and provide assistance to alumni.

International Students Office
The International Students Office, located in Huddleston Hall, advises on all immigration matters for international students, as well as serving as a general resource and referral center for them. The I.S.O. runs orientation programs for new international students before the fall and spring semesters. It also helps to plan activities for the Smith Hall International Center, which is open to all UNH students: graduate and undergraduate, foreign and American. All foreign students are required to maintain contact with the I.S.O., especially to report any change of address, finances, or academic program.

Handicapped Services
The Office of Handicapped Services assists disabled students with meeting their educational, cultural, and recreational needs while at UNH. The coordinator invites questions from students who are thinking of coming to UNH. For information, write to: Handicapped Services, Memorial Union Building, University of New Hampshire, Durham, N.H. 03824.

Campus Minister and Churches
A full-time, on-campus minister is funded by the Ecumenical Ministry to the University of New Hampshire. In addition, several denominations have designated chaplains. Places of worship for many faiths are convenient to the campus area. In Dover are a synagogue, Greek Orthodox Church, and a Friends Meeting; Protestant, Catholic, Episcopal, and Latter-day Saints churches are located in Durham.

The Alumni Association
All recipients of a graduate degree from the University are considered members of the Alumni Association. It organizes alumni activities including educational, cultural, and social programs, both on and off campus. The alumni magazine publishes news of alumni, the University, students, staff, and faculty.
The New England Center for Continuing Education

The New England Center for Continuing Education is adjacent to campus. This architecturally striking complex was built with a gift from the Kellogg Foundation and is sponsored by the six New England state universities. The center provides residence and conference facilities for a wide variety of adult education programs. A closed-circuit TV system permits conference programs to be reviewed in participants' rooms. The center's restaurant, lounge, and hotel are open to the public on a space-available basis.
Research and Support Services

Research is an essential part of graduate education. It sustains a continuing infusion of knowledge, enhances the level of instruction, extends the frontiers of understanding, and makes human progress possible. It provides an opportunity for graduate students to learn by working with instructors on independent projects or as part of research teams. Ultimately, the goal is to share discoveries and applications with others in the state, region, and world.

Research Programs and Facilities

The University has many diversified research projects, ranging from highly specialized investigations in the physical and biological sciences to broad interdisciplinary marine studies. Graduate students are involved in research as project assistants working on research leading to master's theses and doctoral dissertations.

Research projects are conducted not only in individual departments but also in multidisciplinary research centers. The major University research centers include the following:

The Space Science Center is a research unit within the physics department. The center, which is funded by grants from the National Aeronautics and Space Administration and the National Science Foundation, is currently involved in ten ongoing satellite projects, is a Center of Excellence in solar-terrestrial research, and has an active balloon and rocket program. Graduate students do advanced degree work in all aspects of center programs.

The Marine Systems Engineering Laboratory develops high technology systems involving microcomputers, for Arctic and oceanographic research both in ice-covered and open ocean areas, emphasizing robotics and intelligent systems. A major goal of the laboratory is to make use of the skills and enthusiasm of students by employing their talents in project roles, at times with private industry, to provide practical experience in engineering.

The Ocean Process Analysis Laboratory is a multidisciplinary research organization that is affiliated with several academic departments and houses investigators from research groups studying ocean-related problems concerning biogeochemistry, environmental engineering, chemical oceanography, hydrodynamic modeling, isotope geochemistry, geotechnology, glaciology, physical oceanography, sedimentology, and electrical engineering. Funding for the laboratory has come from the National Science Foundation, National Oceanic and Atmospheric Administration, the Environmental Protection Agency, the U.S. Geological Survey, and the North Atlantic Treaty Organization. The staff includes faculty, research scientists, technical support, and graduate and undergraduate students.

The Water Resource Research Center, supported by the United States Department of the Interior and the University, implements basic and applied research in freshwater resources. It is also involved in information dissemination activities and technology transfer programs that will contribute to the solution of national water resource problems. Both undergraduate and graduate students are involved in the research projects conducted in individual departments and other facilities provided by the University.

The Complex Systems Research Center investigates, using computer modeling and policy analysis, the earth's biogeochemical cycles and human effects on them. The center's research cuts across the boundaries of traditional scientific disciplines and embraces the social sciences and humanities as well. Research projects are related to resource use, have a strong natural science component, and yield results that can be immediately useful to decision-makers. Although center staff members have no formal teaching duties, they occasionally teach advanced courses and frequently sponsor seminars on topics related to their research.

The Human Nutrition Center conducts research into the mechanisms underlying the role that diet and nutrition play in the modulation of disease processes common in western civilization, such as obesity, cancer, and heart disease. This research requires the efforts of biochemists, chemists, immunologists, mathematicians, and behaviorists, as well as nutritionists. Graduate students are involved not only in research teams but also in the nutritional assessment and counseling service the center provides.

The Family Research Laboratory is internationally recognized for its extensive and pioneering research on intrafamily violence and sexual abuse of children. The laboratory also conducts studies on many other aspects of the family, including communication patterns, the balance of power in marriage, and methods of measuring key aspects of the family. Laboratory work is supported by grants from the National Science Foundation, National Center on Child Abuse and Neglect, National Institute of Justice, and the National Institute of
Mental Health, the latter providing fellowships for research and training on family violence. Postdoctoral fellowships are open to persons with a Ph.D. in any of the social sciences. Graduate study fellowships are available only for persons admitted to the Ph.D. program in sociology.

The Writing Process Laboratory provides unique opportunities for graduate students in education and English to acquire hands-on experience in writing research. The laboratory, staffed by internationally known faculty, is currently conducting research on the relationship between reading and writing by introducing new methodology to local elementary school systems. The National Endowment for the Humanities, the United States Department of Education, and the Ford Foundation have all been supporters of the laboratory's pioneering work.

The larger research service units on campus include the following:

The Research Computer Center consists of a set of PRIME computers dedicated to the support of academic research.

The University Instrumentation Center operates and maintains various types of scientific instrumentation for the benefit of the University research community. The center provides direct and easy access for all researchers to instruments such as electron microscopes, nuclear magnetic resonance spectrometers, mass spectrometers, amino acid analyzers, elemental analyzers, and various spectrophotometers. Repair services on most research instrumentation are also provided by the center.

Agricultural Experiment Station

The Agricultural Experiment Station (AES), one of the largest research and service units at the University, is supported by United States Department of Agriculture and state of New Hampshire appropriations. Scientists associated with the AES are legally mandated to solve important problems affecting the economic and social well-being of the people of New Hampshire, the region, and the nation and to add to the store of knowledge. Projects are designed to optimize a realistic blend between basic and applied research in areas concerned with improving the quality of life. These projects vary from fundamental studies of cancer cells to community planning, resource management to genetic engineering, consumer advocacy to production agriculture, and career teaching to molecular biology and biotechnology. Scientists and graduate students from fourteen different programs in the College of Life Sciences and Agriculture are involved in research through the AES.

Marine Program

The University's central location on the northeastern New England coast near a variety of estuarine, coastal, insular, and continental-shelf environments has fostered a broad range of marine educational and research activities for many years. These varied activities, which occur within all of the University's colleges, are coordinated and supported by the Marine Program.

Research Marine research by faculty and students is conducted on disciplinary and multi/interdisciplinary bases and is supported by University, state, and private funds as well as by organizations such as the National Science Foundation, the Office of Naval Research, the National Institutes of Health, the U.S. Coast Guard, the Woods Hole Oceanographic Institution, and the National Sea Grant Program. UNH and the University of Maine together are a Sea Grant College.

An important emphasis of marine research activities at UNH is understanding the neighboring environments of the Great Bay estuarine system, the coastal zone, the near-shore coastal zone, the Isles of Shoals, and the Gulf of Maine. There are new and growing research interests in other regions of the world's oceans including the Mediterranean, North Sea, Arctic, Antarctic, Atlantic, and Pacific oceans. Some examples of research studies include those relating to marine food chains; marine biotoxins; oil-spill containment; trace metals; biological and thermal pollution; marine mineral resources; marine geology and geophysics; mariculture; marine resource management; marine law; continental shelf circulation; arctic under-ice systems; diving systems; submarines; and buoy systems and breakwaters.

Facilities The Marine Program building houses work spaces for ocean engineering, physical sciences, and other marine activities, as well as the Marine Program Office. The Marine Systems Engineering Laboratory and Ocean Process Analysis Laboratory provide opportunities for applied research in the marine environment. The Jackson Estuarine Laboratory, located on Great Bay about five miles from the campus and fourteen miles from the ocean via the Piscataqua River, supports the research of the marine life sciences and earth sciences departments. A running-seawater facility at Fort Constitution in Newcastle, near
Portsmouth, is nearing completion. A running-freshwater facility near campus supports fishery research. The Diamond Island Ocean Engineering Station, located about 40 miles from Durham on Diamond Island in Lake Winnipesaukee, furnishes an excellent freshwater testing site for ocean systems. The Shoals Marine Laboratory, located about seven miles off the New Hampshire coast on Appledore Island of the Isles of Shoals, is a joint facility of UNH and Cornell, is principally concerned with marine-life sciences educational and research activities. A near-coast pier facility, situated about ten miles from Durham in Portsmouth, New Hampshire, and two miles from the ocean on the Piscataqua River, serves research vessels up to approximately 50 feet in length and commercial fishing boats of the area. The R/V Jere Chase is a 45-foot research vessel equipped for a wide variety of marine research activities in the estuarine and near-coast waters.

Central University Research Fund

The Central University Research Fund (CURF) provides financial support to UNH graduate students for meritorious research projects. Projects can include a pilot study for a thesis, a master's thesis, or a doctoral dissertation. Competitive CURF proposals are solicited and reviewed each semester by the Research Council, which consists of elected faculty representatives from each college and school, the Coordinator for Research Development, the Dean of the Graduate School, and two graduate student representatives. The CURF program is administered by the Research Administration Office staff, Horton Social Science Center.

Library

The University library houses more than 860,000 volumes, more than 6,000 periodicals, and substantial microfilm and audio-tape and record collections. Specialized subject collections are housed in four branches: chemistry in Parsons Hall, engineering and mathematics in Kingsbury Hall, biological sciences in Kendall Hall, and physics in DeMeritt Hall. The branches are administered by a physical sciences librarian and a biological sciences librarian.

Special services offered to graduate students include graduate study areas, with assignable locked book trucks. Graduate students may use the Interlibrary Loan System to supplement material available in the University library. The library is a U.S. government document depository, and a full-time documents librarian is available. On-line, data-base search services are offered at cost through the reference and branch departments.

The library serves the University and the town of Durham. A graduate student's spouse and children may use the facilities, which include a professionally staffed children's room.

During the regular academic year, the library is open seven days a week. On vacations and during the summer, a more limited schedule is in effect.

Computer Services

The University of New Hampshire has one of the largest and most accessible computer installations of its type in the country. UNH Computer Services operates several large computers (two DEC 10s, three VAX 11/780s, five PRIMES) in support of the combined instructional, research, and administrative data processing needs of the University.

More than 300 terminals are tied into the UNH computers, with four major clusters in classroom buildings and one in a residence hall. Other terminals are located in Dimond Library and dormitories. In addition, many departments have their own mini- and micro-computer labs. For example, computer science has a VAX 11/780 and a Data General MV10000, and electrical and computer engineering has two VAX 11/730s. There are more than 500 microcomputers in use on campus, including a cluster maintained by Computer Services.

A Research Computing Group channels its collective energies and expertise into the support and promotion of research activities on the Durham campus. In addition to providing high-level consulting to researchers, the group also engages in program investigation and acquisition, and exploration and evaluation of network links; members are familiar with mini- and micro-computer systems as they relate to the needs of researchers on campus.

Short, noncredit courses are regularly offered, at nominal charge, to users of the facilities. Extensive on-line system documentation is supplemented by a physical library with assorted manuals and trade journals.

Publications of Computer Services include a newsletter, ON-LINE, and other specialized instructional materials.
Admission and Registration

Admission

General Requirements
Persons holding the baccalaureate degree from a college or university of approved standing and wishing to take graduate-level courses at the University as part of a graduate degree program must apply for admission to the Graduate School. Admission to the Graduate School is both limited and competitive and is based solely upon academic qualifications and potential.

Application procedures are outlined below and are included with the application materials available at the Graduate School. Specific program information and requirements are outlined in the program descriptions of this catalog. The completed application for admission to graduate study also serves as the application for new students for assistantships, and full-time scholarships supported by the Graduate School.

Applicants to programs leading to the master of science for teachers degree must meet, in addition to the normal requirements, one of the following admission requirements: 1) completion of education courses sufficient for certification, 2) three years of teaching experience, or 3) a current full-time teaching position.

Applicants may apply to only one specific degree program.

Application Procedures
Application materials may be requested from the Graduate School, University of New Hampshire, Horton Social Science Center, Durham, N.H. 03824.

Applicants for admission must:
1. Submit the official application form in duplicate. An application file is not started until the application form is received.
2. Submit a $15 nonrefundable application fee.
3. Request that two official transcripts from each college/university attended be sent directly to the Graduate School.
4. Request that three recommendations using official recommendation forms be sent directly to the Graduate School. Letters of recommendation more than 12 months old are not acceptable. (Placement credentials more than one year old may be accepted as one letter of recommendation.)
5. Request the official test scores (GRE, GMAT), if required, be sent by the Educational Testing Service directly to the Graduate School. Test scores more than five years old may not be acceptable.
6. Submit any additional material required by individual programs.
7. Submit the Statement of Residence Form (New Hampshire residents only).

Applications will not be reviewed until they are complete. It is the applicant’s responsibility to make sure that the required application materials have been submitted by the appropriate deadline.

All application material becomes part of the permanent records of the University of New Hampshire and will not be returned. Access to this material is limited under the Family Rights and Privacy Act of 1974. Applicants who are not admitted, or who are admitted and do not register in the Graduate School, do not have access to their application file. Material received as part of the application process will not be duplicated for personal use by the applicant nor forwarded to a third party. Materials received from applicants who do not complete their application, who are not admitted, or who are admitted and do not register are held for one year before being destroyed.

Applicants from Foreign Countries
All applicants from non-English speaking countries must, in addition to all of the above, provide TOEFL (Test of English as a Foreign Language) scores. A minimum TOEFL score of 550 is required. TOEFL test scores are valid for only two years. A financial statement on official University forms is also required.

Applications from residents of foreign countries will be considered only for regular admission.

Application Deadlines
Applications must be completed by December 1, for the spring session; by April 1, for the summer session; and July 1, for the fall session. There is no guarantee that applications completed after these deadlines can be acted upon in time to permit registration in the desired session.

Applicants for financial assistance (assistantships and scholarships) should complete their application prior to February 15, to ensure consideration for the following academic year.

Foreign applicants who are not currently residing in the United States will be considered only for admission for the fall session and must have their application completed by April 1. Foreign applicants currently residing in the United States should have their application completed at least four months prior to the session for which they are applying.
Programs that consider applications only for a specific session are noted on the “Instructions for Application for Admission to Graduate Study,” included with the application materials.

**Incomplete Applications:** Applications that remain incomplete after the first day of classes of the semester for which admission was desired will be placed in an inactive status. A written request is required to reactivate an application.

**Application Review**

Once an application is complete, it is reviewed by faculty members of the appropriate program. All material that is submitted as part of the application receives careful consideration. The review is normally conducted by an admissions committee of graduate faculty members, which makes recommendations to the Graduate School concerning the admission of applicants to the program. Upon receipt of the committee’s recommendation, the Graduate School carefully reviews the applicant’s file. After making the final decision, the Graduate School will inform all applicants of the action taken. While applicants with bachelor’s degrees may apply directly to certain doctoral programs, the Graduate School reserves the right to offer these applicants admission at the master’s degree level.

**Admission Categories**

Official offers of admission from the Graduate School are made for a specific term and year in one of the following categories:

**Regular Admission:** Regular admission may be offered to those applicants whose academic records and supporting documents indicate that they are fully qualified to undertake graduate study in their chosen field.

**Provisional Admission:** Provisional admission may be offered to applicants whose academic records and supporting documents indicate that they are qualified to undertake graduate study, but whose undergraduate preparation was not in the intended field of graduate study. Applicants offered provisional admission must meet the specific criteria, usually undergraduate coursework, stated at the time of their admission before being admitted to regular graduate-student status.

**Conditional Admission:** Conditional admission may be offered to those applicants whose academic records indicate deficiencies but suggest some promise of success in graduate study. Students offered conditional admission must meet the specific requirements stated at the time of their admission in order to remain in the Graduate School. Conditionally admitted students are not eligible for assistantships and scholarships offered through the Graduate School until the conditional status is removed.

Offers of admission, regular, provisional, or conditional, to applicants who are in the final year of an undergraduate, or, in some cases, a graduate, degree program are contingent upon the successful completion of that degree program. An official final transcript showing grades and the awarding of the degree must be received by the Graduate School prior to enrolling for the graduate program.

Applicants who cannot enroll in the term for which admission was offered may request to have their admission deferred for up to one year. Such requests must be in writing and will be considered only once. Because enrollments are limited and competition for admission may vary from year to year, such requests may not be granted.

**Additional Information**

**Early Admission—University of New Hampshire Seniors:** Qualified senior students at the University of New Hampshire may be admitted to the Graduate School provided they have followed normal application procedures; they must have been admitted for the semester in which they wish to enroll in courses for graduate credit. A 3.2 cumulative grade-point average is normally required to be considered for early admission. Such seniors are normally admitted prior to the start of their last undergraduate semester. Seniors who have been admitted under early admission may register for a maximum of two courses for graduate credit (see also dual credit on page 23).

**Admission to the 3/2 Program:** Undergraduate UNH students may be admitted to one of the approved five-year combined bachelor’s degree/Master of Business Administration (see the Undergraduate Catalog) programs, which normally commence during the fall semester of their senior year. Application to the Graduate School is made during the second semester of the junior year. Interested students should contact the assistant dean in the Whittemore School for information.

**Special Students:** Individuals holding baccalaureate degrees may register for graduate courses on campus through the Division of Continuing Education in Verrette House, or for graduate courses off campus through the School for Lifelong Learning. These individuals are designated as “special students,” and
are not required to file an application for admission to the Graduate School and are not candidates for a graduate degree. Special students are not normally permitted to register as full-time students (see special-credit rule on page 23).

**University of New Hampshire Employees:** Members of the University of New Hampshire faculty with the rank of assistant professor or above will not be admitted to the graduate programs. Full-time staff employees of the University who do not hold academic rank will not ordinarily be admitted to doctoral programs in the department in which they are employed. The above regulations pertain even to individuals who resign their positions.

**Honorary Fellows:** Qualified scholars who may temporarily desire the privilege of using the library and research facilities of the University and who are not candidates for a degree may, upon recommendation of the Dean of the Graduate School and the approval of the President of the University, be appointed honorary fellows without stipend. Honorary fellows shall not be required to pay any charges except the cost of unusually expensive supplies or equipment.

**Applicants Not Admitted:** Applicants who are denied admission may have their applications reconsidered only if they furnish significant additional material that was not available at the time of the original decision, such as evidence of further academic achievement, or more recent and significantly improved GRE or GMAT scores. Reapplication is not encouraged.

**Registration**

**Academic Year**

Students admitted to the Graduate School must have their programs approved by their adviser or the chairperson of their guidance committee. Registration is usually held the first Monday after classes begin each semester for day students and Monday through Thursday of that week for evening students. All tuition and fees are payable at the time of registration. Registration information and the *Time and Room Schedule* may be obtained from the Registrar's Office, Thompson Hall. Students who register after the registration period will pay a late registration fee.

**Continuous Registration:** Students who are in residence and using University facilities are required to register each semester. Master's students who have completed all course requirements and have previously registered for the maximum number of thesis or project credits and are on campus completing their master's program must register for Master's Continuing Enrollment. Doctoral students who are in residence and have completed all course requirements must register for Doctoral Research 999 each semester even if the minimum requirement (two semesters) has been met.

**Full-time Students:** Graduate students registered for nine or more credits, Master's Continuing Enrollment, or Doctoral Research 999 are classified as full-time students. Students holding appointments as graduate assistants or project assistants are also considered full-time and must register for a minimum of six credits, Master's Continuing Enrollment, or doctoral research each semester.

**Half-time Students:** Graduate students not on an assistantship and registered for 5 or 6 credits are classified as half-time students.

**Three-quarter time Students:** Graduate students not on an assistantship and registered for 7 or 8 credits are classified as three-quarter time students.

**Maximum Load:** The maximum graduate load allowed is 16 credits (12 credits for a student on an assistantship). Only under unusual circumstances will a student be allowed to exceed these limits, and then only with the recommendation of the student's adviser, graduate program coordinator, and the approval of the Dean of the Graduate School.

**Dropping and Adding Courses:** Graduate students may add or drop courses in accordance with the procedures and deadlines published by the Registrar's Office in the *Time and Room Schedule*. Deadlines are also published in the Graduate School calendar.

**Auditing Courses:** A graduate student may, with the approval of his or her adviser and the faculty member concerned, audit courses. The deadline for requesting an audit is Friday of the third week of classes. Subsequent requests for change to audit must be petitioned and be approved by the course faculty member, the student's adviser and graduate program coordinator, and the Dean of the Graduate School.

**Change of Name or Address:** It is the responsibility of the student to complete a change of name or address form in the Registrar's Office whenever a change is made.
Summer Session

Although many graduate level courses are offered during the Summer Session, the University does not guarantee that any particular course will be offered. The availability of individual faculty members to supervise research or to participate in qualifying examinations and final examinations or defenses during the Summer Session varies from year to year.

Course information and registration materials may be obtained from the Division of Continuing Education, Verrette House.

Deadlines for completion of degree requirements for the Summer Session are published in the Graduate School calendar.

Maximum Load: The maximum graduate load allowed is four credits for a four-week summer session and eight credits for an eight-week summer session. Only under unusual circumstances will a student be allowed to exceed these limits, and then only with the recommendation of the student's adviser, graduate program coordinator, and the approval of the Dean of the Graduate School.

Nonregistration

Leave of Absence: Students who find it necessary to interrupt their graduate programs may request a leave of absence by writing to the Dean of the Graduate School stating the reasons for, and the anticipated length of, the interruption. Leaves are granted for a specific time, usually not to exceed one calendar year. Students who are on approved leaves of absence must notify the Graduate School at least four weeks prior to the start of classes for the term in which graduate work is to be resumed. Students who do not return from a leave of absence as approved will have their degree status discontinued and will be required to apply for readmission.

Withdrawal: A student may withdraw from the Graduate School during any semester by obtaining a withdrawal form from the registrar or the Graduate School. This form should be signed by the student's adviser, the Dean of the Graduate School, and other appropriate University officials. When completed, the form should be filed with the registrar. Students who formally withdraw are required to apply for readmission if they subsequently desire to resume their academic program.

Degree Status Discontinued: Students who do not formally withdraw and do not register during a twelve-month period or do not return from an approved leave of absence are considered inactive and will have their degree status discontinued. Students are notified by the Graduate School when this administrative action is taken and are required to apply for readmission if they subsequently desire to resume their academic program.
Administrative Withdrawal for Reasons of Health and Procedures for Readmission: The Dean of the Graduate School, in consultation with professional University Health Service officials, may temporarily suspend a graduate student from the University without prejudice for reasons of seriously impaired physical or mental health and/or in consideration of the physical health, safety, and well-being of members of the University community. Such action shall be taken only for bona fide health and safety emergencies and should not be used as a means of excluding qualified handicapped students.

The dean or designee shall provide the student with a written statement of the reasons for the temporary suspension. The student may request a hearing with the dean or designee to dispute the reasons. The student may be represented at the hearing by a member of the University community. If the student fails to request such a hearing within ten days of beginning the temporary suspension, or if the temporary suspension is upheld at the hearing, the temporary suspension shall be changed to an administrative withdrawal.

Readmission is contingent upon receipt by the directors of counseling and/or health services, or their agents, of a medical release from a licensed attending medical authority; an evaluation by the University Health Service; and a personal interview with the Dean of the Graduate School, who, on the basis of the information received, will either approve or disapprove the application.

Readmission: Students who withdraw or who have their degree status discontinued are required to apply for readmission. Readmission forms are available at the Graduate School and must be processed at least by December 1 for the spring semester, April 1 for Summer Session, and July 1 for the fall semester. Students are not guaranteed readmission.

Change of Degree
An enrolled student who wishes to pursue a degree program other than the one for which admission was granted originally should file an application for a change in degree with the Graduate School. Change of degree requests should be filed by the regular admission deadlines. The Dean of the Graduate School will notify the student of the decision after consulting with the appropriate departments.

Students enrolled in UNH master’s programs who intend to pursue the Ph.D. in the same department in which they were admitted for the master’s degree should submit to the Dean of the Graduate School an application for a change in degree program. This application will be reviewed by the Graduate School, which will notify the student of the decision. If such students do not file a change-in-degree application before receiving the master’s degree, they will be required to submit a new application for admission to study for the Ph.D. degree.
Fees and Financial Assistance

Fees
Tuition and fees vary according to whether or not the student is a legal resident of the state of New Hampshire and/or is enrolled full or part time. All charges are payable at the time of registration.

New Hampshire Residents
Each graduate student is classified as a resident or nonresident for tuition purposes at the time of admission to the University. The decision, made by the Graduate School, is based upon information furnished by the student’s application and any other relevant information.

All applicants living in New Hampshire are required to submit a notarized statement to the effect that they have been legally domiciled in New Hampshire continuously for at least 12 months immediately prior to registering for the term for which in-state status is claimed.

Students admitted from states other than New Hampshire or from foreign countries are considered nonresident throughout their entire attendance at the University unless they shall have acquired bona fide domicile in New Hampshire. Changes in residency for enrolled students are reviewed by the registrar’s office and will only occur if the student can clearly establish that his or her residence in New Hampshire is for some purpose other than the temporary one of obtaining an education at the University.

The burden of proof in all cases is upon the applicant. In all cases, the University reserves the right to make the final decision as to resident status for tuition purposes. The University Rules Governing Tuition Rates are fully set forth in the application for admission package; all students are bound by them.

New England Regional Program
The University of New Hampshire participates in the New England Regional Student Program administered by the New England Board of Higher Education. Under this program, admitted graduate students from New England may qualify for regional tuition rates (New Hampshire resident tuition, plus 25 percent) if the program to which they are admitted is one which is not available at their home state university. Inquiries and requests for further information may be directed to the Dean of the Graduate School, Horton Social Science Center, UNH, Durham, N.H. 03824 or to the New England Board of Higher Education, 45 Temple Place, Boston, MA, 02111.

Sub-Degree Exchange Program
The Graduate School of the University of New Hampshire participates in a Sub-Degree Exchange Program sponsored by the New England Land-Grant Universities. The program is designed to provide any admitted student at one of the six land-grant universities access to the full range of talent and resources available in the region. Under the agreement, graduate students may, with the approval of the Dean of the Graduate School at UNH and the graduate dean of the host university, take advantage of courses or other special resources not available at UNH. Specific information about the program may be obtained from the Dean of the Graduate School, Horton Social Science Center, UNH, Durham, N.H. 03824.

Schedule of Fees
The following schedule of fees is in effect each semester of the 1985–86 academic year, and is subject to change for 1986–87. Required, nonrefundable fees for all students include a Memorial Union fee, which funds the personnel, programs, and maintenance of this building; a Student Services fee, which partially funds the programs and services available in the Division of Student Affairs, including Handicapped Services and the Commuter/Transfer Center; and a health fee, which funds the Health Service. The services and facilities are available to all—the extent to which each student uses them cannot be the factor by which assessment is determined.

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<tr>
<th>Graduate Tuition Rates 1985–86</th>
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<td>Tuition: (per semester) (9–16 credits)</td>
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<td>N.H. Resident</td>
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<td>Doctoral Research</td>
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<td>Master’s Continuing Enrollment</td>
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<td>Mandatory Fees*:</td>
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<td>N.H. Resident</td>
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<td>Nonresident</td>
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<td>Late Registration Fee:</td>
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*Students on assistantships, fellowships, or full-time tuition scholarships, students registered for doctoral research (999), and students registered for Master’s Continuing Enrollment are considered full-time and are required to pay full mandatory fees.

The University reserves the right to revise its schedule of tuition and fees without notice.
Master's Continuing Enrollment: Master's students in residence and registered for Master's Continuing Enrollment will pay $150 tuition plus full mandatory fees per semester during the academic year and $75 plus fees for the Summer Session.

Doctoral Research: Doctoral students in residence and registered for Doctoral Research 999 will pay $300 plus full mandatory fees per semester during the academic year and $150 plus fees for the Summer Session. Students who register for coursework in addition to doctoral research will pay the appropriate additional tuition charges up to the appropriate maximum tuition rate for full-time students.

Differential Tuition: Full-time resident and nonresident students majoring in engineering or computer science will be charged a tuition differential of $87.50 per semester. Students in these programs who are registered for doctoral research (999) or Master's Continuing Enrollment are considered full time and pay the full tuition differential. Students in these programs (both resident and nonresident) who register for fewer than 9 credits pay a differential tuition of $5 per credit hour.

Tuition and fees are payable at registration, and a student is not considered registered until they have been paid.

The above charges will apply to admitted graduate students enrolling for courses at the University during the academic year. Admitted graduate students planning to enroll for courses through the School for Lifelong Learning or during the Summer Session should consult the relevant catalogs for information regarding tuition and fees.

Tuition Waiver for Senior Citizens
Any New Hampshire resident senior citizen who submits evidence of being 65 years of age or over, and whose participation is not intended for economic improvement, will be allowed to take courses at UNH with the tuition waived. Such waivers shall cover the cost of tuition only and are limited to a maximum of eight academic credits per semester for each eligible individual. Admission into particular courses will be granted on a space-available basis, at the discretion of the graduate dean. All other costs of attendance are to be borne by the student.

Other Charges and Fees
More than 16 Credits per Semester: Graduate students are charged full tuition at the appropriate rate plus the appropriate course charge for each credit beyond 16 if registered for more than 16 credits 30 days after the semester has begun. (No refund will be made if a student subsequently drops a course, reducing his or her course load to 16 or fewer credits.)

Zero-Credit Seminars: Seminars for zero credit are assessed as if they were for one credit.

Audit: Charges for auditing a course are the same as those for taking it for credit.

In-Absentia Fees: Students who are not registered at the time they complete their degree requirements (examinations, submission of thesis, dissertation, etc.) will be assessed an in-absentia charge one month prior to the conferred of their degrees. The in-absentia charge is $25 for master's candidates; $25 for C.A.G.S. candidates; and $100 for doctoral candidates.

Late Fees: A $25 late registration fee is charged to students who register after the second Friday of classes. Late fees are also charged for changes in registration as follows:
A $25 fee is charged for each course dropped after the third Friday of classes; a $25 fee is charged for each course added after the third Friday of classes. The late-add fee is charged in addition to the late-registration fee when students register after the third week of classes. A change of section (within the same course) is accomplished by a "drop" of one section and an "add" of another section. The fee will not be assessed for the add portion of a late section change; but the $25 drop fee will still apply for the drop portion of the late section change.

Student Accident and Sickness Insurance: All graduate degree students registered for five (5) credits or more per semester are required to purchase the student accident and sickness insurance coverage. This coverage may be refused and the fee waived if the student completes a refusal of insurance form available at Hood House. (This coverage is required of all international students.) There is no partial fee payment for part-time students. Inquiries on this coverage should be sent directly to Hood House.

Refunds
Tuition during the academic year is refundable in accordance with the calendar published in the Time and Room Schedule and the Graduate School calendar. The mandatory health fee may be refunded upon petition to the
Health Service. (Students must petition for refund no later than two weeks after graduate registration. Forms are available in the Health Service Office at Hood House. Refund requests should be sent directly to the Health Service, Hood House.) The Memorial Union and Student Services fees are nonrefundable.

Financial Assistance

General Information

There are several forms of financial assistance available to graduate students, most of which are awarded for an academic year commencing in September. To be eligible for any assistance, the student must first be admitted to the Graduate School. The Graduate School normally administers and awards the fellowship and scholarship programs. Assistantships and associateships are normally awarded by the individual graduate programs. Loans and work-study programs are administered by the Financial Aid Office. The application for admission with supporting documents serves as the application for new graduate students for the scholarship and assistantship programs available to them and should be completed by February 15 for awards for the following academic year. Separate application forms are required for the loan and work-study programs administered by the Financial Aid Office and are available at that office in Thompson Hall. The deadline for receipt of these applications is May 1.

Scholarships and Fellowships

Graduate Scholarships for Merit: A recipient of a graduate assistantship or a project assistantship who is newly admitted to a Ph.D. program and has outstanding qualifications may be awarded a Graduate Scholarship for Merit. The scholarship supplements the academic year stipend by $600. Continuation of a Graduate Scholarship for Merit into succeeding years will be contingent upon the student's demonstration of superior performance in a doctoral program.

Full Tuition Scholarships: Up to 60 students may be granted academic-year tuition scholarships. These awards provide for waiver of tuition and are subject to the maintenance of a high scholastic record in the Graduate School. Application is made to the student's program.

Part-time Tuition Scholarships: Up to 35 students may be granted part-time tuition scholarships. These awards provide a partial waiver of tuition charges and are awarded each semester. Applications are available at the Graduate School Office. University employees or family members who are eligible for staff benefits are not eligible to receive part-time tuition scholarships.

Dissertation Fellowships: Dissertation Fellowships for a maximum tenure of one academic year are available on a competitive basis to doctoral students who have been advanced to candidacy. These awards include a stipend of $5,300 and a waiver of the doctoral research registration fee for the period of the award. Application is made to the Dean of the Graduate School.

Summer Fellowships for Teaching Assistants: A limited number of Summer Fellowships are awarded to students who have held graduate assistantships involving teaching during a previous academic year. The stipend for summer study is $1,000. Application is made to the Dean of the Graduate School.

Assistantships

Approximately 380 assistantships are awarded annually to superior students. Appointments are for one academic year. An appointment may be renewed provided that funds are available and that the student's academic performance, as well as performance in carrying out the responsibilities of the assistantship, is satisfactory. Students normally are involved in assistantship activities for 20 hours a week. All graduate students holding appointments as assistants must be admitted on a regular or provisional basis to the Graduate School and must register for a minimum of six credits (maximum of 12 credits), or Master's Continuing Enrollment, or doctoral research during each semester in which they hold their appointments. Such students are considered full-time students. A limited number of newly admitted doctoral students who are awarded assistantships may also receive a Graduate Scholarship for Merit as explained above.

The 1985–86 academic year stipend levels for assistantships are $5,000 ($5,300 in biochemistry, chemistry, computer science, engineering, and physics). Doctoral students who have held an assistantship for two years may qualify for an advanced academic year stipend of $5,300 ($5,400 in biochemistry, chemistry, engineering, and physics).

Inquiries regarding assistantships should be addressed to the chairperson or director of graduate studies of the appropriate department or program.

Appointments are made in the following categories:
**Graduate Assistants:** Students supported by University funds are appointed as graduate assistants and are normally involved in assisting faculty members in instructional activities. Graduate assistants receiving the full academic-year stipend are exempt from the payment of tuition during the academic year of their appointment and may be exempt the following summer session. Graduate assistants receiving less than the normal academic-year stipend may be exempt from a prorated portion of their tuition during the period of their appointment and the following summer session.

**Graduate Research Assistants:** Students in the College of Life Sciences and Agriculture may be appointed as graduate research assistants and are normally involved in the research activities of the Agricultural Experiment Station. Graduate research assistants receiving the full academic-year stipend are exempt from the payment of tuition during the academic year of their appointment. Graduate research assistants receiving less than the normal academic-year stipend may be exempt from the payment of a prorated portion of their tuition during the period of their appointment.

**Project Assistants:** Students supported by externally funded research projects are appointed as project assistants and are involved in the research activities of the project. Project assistants receiving the full academic-year stipend are exempt from the payment of tuition during the academic year of their appointment. Project assistants receiving less than the normal academic-year stipend may be exempt from the payment of a prorated portion of their tuition during the period of their appointment.

**Graduate Associates:** A very limited number of highly qualified graduate students may be appointed to teaching or research positions as graduate associates. The academic load for students appointed to these positions will not exceed two full courses or doctoral research registration per semester. Stipends are negotiable up to $8,000 per academic year according to the qualifications and duties of the student. Graduate associates receiving a stipend of more than $4,000 per academic year may be exempt from the payment of tuition during the academic year of their appointment. Graduate associates receiving $4,000 or less per academic year may be exempt from the payment of half of their tuition during the academic year of their appointment.

**Summer Assistantships:** Full-time and part-time summer appointments may be available. Students are normally appointed for a maximum of two months and are not normally permitted to register for summer session courses if on a full-time appointment.

**Loan and Work-Study Programs**

**National Direct Student Loans:** To be eligible for consideration, a student must be an admitted degree candidate carrying at least one-half the full-time academic load as defined by the University, be a U.S. citizen or a permanent resident of the U.S., and establish need for a loan that is to be used for educational purposes only.

**UNH Loans:** To be eligible for consideration, a student must be a registered degree candidate. Financial need must be clearly established, and if approved, the loan may be used for educational purposes only. The maximum amount granted to a student is $1,000 during his or her undergraduate and/or graduate work.

**College Work-Study Program:** With the aid of federal funds, the University is able to provide employment opportunities on campus or in various off-campus agencies. To be eligible for consideration, a student must be an admitted degree candidate carrying at least one-half the full-time academic load as defined by the University and demonstrate financial need as determined by the Financial Aid Office. Work during the academic year is usually on campus.

Satisfactory progress in a course of study must be maintained by all students who receive federal financial aid. The current standards for satisfactory academic progress are available upon request from the Financial Aid Office, Thompson Hall. Application material and additional information for the above programs may also be obtained from the Financial Aid Office. A May 1 priority deadline is in effect.

**Guaranteed Student Loan Programs:** Students may apply for as much as $5,000 per year from a bank or other financial institution participating in the Guaranteed Student Loan Program. Qualified borrowers pay no interest while attending college. Repayment of principal and interest begins nine months after the student ceases a full-time course of study. Check with your local bank for further details and current interest charges.
Academic Regulations and Degree Requirements

It is the responsibility of the student to become familiar with the academic regulations and degree requirements of the Graduate School as well as the special requirements of his or her own academic program.

Academic Regulations

Graduate credits may be earned in courses numbered from 700 through 898 and in Master's Thesis 899 and Doctoral Research 999. The faculty of each graduate program prescribes the courses that make up the degree program. In addition, the Graduate School has general requirements for master's and doctoral degree programs.

800-level courses: are offered for graduate credit only and therefore are only open to admitted or special graduate students.

700-level courses: are advanced-level undergraduate courses and may be taken for graduate credit.

600-level courses: are advanced-level undergraduate courses, which may be taken for graduate credit under limited conditions by degree candidates only, provided the courses are given in a department other than the one in which the degree is earned and are approved by the Dean of the Graduate School. Courses taken off campus at the 600 level will not be approved for graduate credit.

Graduate credits will not be given for any 600- or 700-level courses that are open to or have freshmen or sophomores enrolled.

Grades

The following grades are used at the University: A, A–, B+, B, B–, C+, C, C–, D+, D, D–, F. Graduate credit is normally granted only for coursework completed with a grade of B– or higher. Individual programs may have stricter requirements for major courses. Grade points and averages are not calculated for graduate students.

AF Grades: An “AF” grade, Administrative F, is assigned for failure either to drop or complete the course. An AF is considered a failing grade by the Graduate School.

C, C+ Grades: The Dean of the Graduate School may, under limited conditions, approve up to eight credits of C or C+ grades for graduate credit. When a student's advisory committee or a student's adviser, in conjunction with the appropriate departmental committee, wishes to recommend that credit be given for work completed with a C or C+, the advisory committee shall forward its recommendation, with appropriate justification, to the Dean of the Graduate School within one month after conclusion of the course. Normally these courses will be elective courses outside the student's major area.

Credit/Fail Grades: A “CR” grade is given for complete, approved theses and dissertations, as well as other approved courses and seminars.

With the permission of the instructor at the time of registration, a graduate student may elect to take independent study courses on a credit/fail basis. Students electing this option should ask the instructor to send written notification to the Graduate School and Registrar's Office that the graduate student is taking the course credit/fail. The undergraduate pass/fail option is not available to graduate students.

Audit Grades: An “AU” grade is assigned for completion of courses for which audit approval was granted. No credit is earned.

Incomplete Grades: An “IC” grade is assigned with the approval of the instructor only for excused unfinished work. The work must be completed and submitted to the instructor by the last day of classes of the semester immediately following the one in which the incomplete was granted (700- and 800-level courses only; midsemester for 400-, 500-, and 600-level courses). A petition requesting an extension of time, approved by the instructor, may be submitted to the Dean of the Graduate School by the last day of classes. An extension will be granted by the dean only under unusual circumstances. An incomplete grade automatically becomes an F if not removed or if a petition for an extension is not approved within the allowed time period. This policy also applies to students who withdraw from the University or who are not currently registered.

An “IA” grade is assigned for approved continuing courses such as thesis or doctoral research and remains on the record until the course requirements are completed.

W Grades: If a student withdraws from school or drops a course prior to the third Friday of classes, the course(s) will not appear on the student's permanent record. If a student withdraws from school or, for compelling nonacademic reasons, submits an approved petition to drop a course after the third Friday of classes, a notation of “W” will be shown on the student's academic record.
**Academic Standards**

Grades below the B− level, including grades of C or C+ which may have been approved for graduate credit, will, for the purposes of determining academic standing, be considered failing grades. Failing grades (below B−) received in undergraduate courses taken while the student is in the Graduate School are counted in the cumulative total of failing credits.

Graduate students receiving failing grades in nine or more credits will be dismissed from the Graduate School. Students are advised that this requirement is the minimum standard required by the Graduate School unless students are on a conditional status. Such students must meet the conditions as stated in their letter of admission in order to remain in the Graduate School.

In addition, each individual program may set and announce standards for coursework and research achievement that are more rigorous than this minimum standard. Thus, students may be dismissed if they accumulate less than nine credits of failing grades and/or fail to make adequate progress in other aspects of their graduate program.

**Dual Credit**

**UNH Seniors:** University of New Hampshire seniors who have been admitted to the Graduate School under early admission (see page 14) may, upon recommendation of the department and approval of the Graduate School, be allowed, for a maximum of two 800-level courses, to count credits toward both a bachelor's and master's degree. Dual credit forms must be completed and approved by the Dean of the Graduate School at the beginning of the semester for which dual credit is sought. Dual credit forms are available at the Graduate School.

**Transfer Credit**

Candidates for the master's degree and the Certificate of Advanced Graduate Study (C.A.G.S.) may request that up to six semester credit hours of resident courses completed on the campus of an accredited institution authorized to grant graduate degrees be transferred to count toward their graduate program. All courses presented for transfer must have been completed with a grade of B or better and must have been taken for graduate credit; courses cannot be transferred for credit if used in earning another degree; and will normally not be approved if taken more than two years prior to admission to the Graduate School. Transfer of credits must be recommended by the program faculty and approved by the Dean of the Graduate School. Students taking courses at another university for transfer after enrolling at UNH should obtain approval of their adviser and the graduate dean prior to enrolling for the course. Since the doctoral degree does not require a specific number of courses, credits are not normally transferred onto doctoral students' academic records.

**Special Student Credits**

**Special-Credit Rule:** A maximum of 12 credits earned in University of New Hampshire graduate courses by a special student may, upon recommendation of the program faculty and approval of the Dean of the Graduate School, be applied to a student's degree program. The 12-credit limitation applies to all courses completed or in process on the date when the official letter of admission is written.

**Off-Campus Courses**

Credits earned off campus will be applied toward a graduate degree only if recommended by the major department and approved by the Graduate School. UNH courses offered off campus that are not listed in the Graduate Catalog or specifically approved by the Dean of the Graduate School will not be approved for graduate credit.

**12-Credit Rule:** A maximum of 12 credits, not including thesis, may be earned in UNH courses taken off the Durham campus. Credits earned off campus by a special graduate student will be counted as part of the 12 credits. Credits transferred from another university will also count as a part of the 12 credits allowed.

**Exceptions to the 12-Credit Rule:** Students who are admitted to external graduate degree programs (a listing of approved UNH programs is available at the Graduate School) are exempt from the 12-credit rule. Students who are admitted to all other graduate degree programs are subject to the 12-credit rule. Exceptions for these students may be granted on a course-by-course basis. Courses taught by regular members of the graduate faculty of UNH may be approved for exception to the 12-credit rule. The Graduate School maintains a list of the approved courses. It is the responsibility of students who have reached the 12-credit maximum to check with their adviser to see if the desired course(s) can be applied toward their degree program, and with the Graduate School to see if the course has been approved for exception to the 12-credit rule.
Master's Degree Requirements

General

Credits: A minimum of 30 graduate credits is required for all master's degrees. Many programs require substantially more than the minimum 30 credits. Individual program requirements are outlined in the program descriptions of this catalog. Graduate credits are normally earned in courses numbered 700–899. Master's candidates must earn at least eight credits in courses numbered 800–898. (Thesis credits cannot be used to meet this requirement.) Up to four credits earned in courses numbered 600–699 may be taken for graduate credit by master's degree candidates provided the courses are approved by the Dean of the Graduate School and given in a department other than the one in which the degree is earned.

Residency: A student will normally spend at least one calendar year, or the equivalent, in satisfying the requirements for the degree.

Master's Continuing Enrollment: Master's students who have completed all course requirements and have previously registered for the maximum number of thesis or project credits and are on campus completing their master's program must register for Master's Continuing Enrollment.

Time Limit: All graduate work for any master's degree must be completed within six years of the time of registration for the first graduate work applied toward the degree (including special and transfer credits). Progress toward the degree will be carefully monitored by the adviser and the Graduate School to ensure that adequate advancement is made toward the completion of the program and that any deficiencies noted at the time of admission are removed.

Nonthesis Option

Students who are in a nonthesis program may be required to pass a final examination. This examination may be oral, written, or both. A candidate will be permitted only two opportunities to take the final examination for the master's degree. The time of final examinations will be at the convenience of the department concerned, except that all such examinations must be given at least two weeks before the Commencement date at which the degree is to be conferred. Further regulations governing the final written examination, when required, will be made by the department concerned, subject to the approval of the Dean of the Graduate School.

Examing Committee: Examining committees, when required, are appointed by the Dean of the Graduate School, upon recommendation of the department or program concerned. Normally three members are required. The Dean of the Graduate School is an ex officio member of all examining committees.

Thesis Option

Students who are in a thesis program are required to conduct independent research and prepare a scholarly paper for submission to the Graduate School. Each department will determine the date when the candidate must submit for approval a statement of the subject of the thesis and the date when the thesis must be completed. Students writing a thesis should obtain a copy of the Thesis and Dissertation Manual from the Graduate School. Students who are in a thesis program may also be required to pass a final examination. The regulations concerning this exam are the same as those in the nonthesis option above. The thesis committee will normally also serve as the examining committee.

Thesis Credits: A minimum of 6 and a maximum of 10 thesis credits may be applied toward a master's degree. The exact number of credits to be applied toward the degree will be determined by the faculty of the individual programs. No thesis credit shall be given until the completed thesis has been approved by the thesis committee. Satisfactory acceptance of the thesis will be recorded as a credit (Cr).

Thesis Committee: A master's thesis must be approved by a committee composed of the faculty member under whose direction it was written and two other members of the graduate faculty nominated by the department chairperson or graduate program coordinator and appointed by the Dean of the Graduate School.

Submission of Thesis: Two copies of the approved thesis, ready for binding, shall be submitted to the Graduate School Office as soon after approval as possible, but not less than two weeks before Commencement. Binding fees will be paid at the Graduate School. Most programs require one additional copy of the thesis.
Certificate of Advanced Graduate Study

Requirements
Requirements for completion of the Certificate of Advanced Graduate Study are found under the program descriptions of the education department.

Time Limit: All graduate work for the C.A.G.S. must be completed within six years of the time of registration for the first graduate work applied toward the degree (including special and transfer credits).

Doctoral Degree Requirements

General
The degree of doctor of philosophy is conferred on qualified candidates who have passed an oral or written examination on the subject matter of their field of study, who have completed an original investigation in this field and have embodied the results in an acceptable dissertation, and who have passed an oral examination in defense of the dissertation. The degree of doctor of philosophy is essentially a research degree. It is not given merely for the completion of course credits.

Credits: There is no specific number of courses required for the Ph.D.

Residency: All doctoral students must be registered each semester that they use University facilities. A minimum of three academic years of graduate study is required for the doctorate. Resident graduate work done at other universities may be counted toward the minimum requirement upon approval of the guidance committee and the Dean of the Graduate School, but one full academic year must be in residence at the University of New Hampshire. In individual cases, the major department and the Dean of the Graduate School may grant permission to pursue the research for the dissertation at another institution where access to special facilities would be advantageous.

Doctoral Research: A minimum of two semesters of registration in doctoral research is required. However, doctoral students using University facilities while engaging in dissertation research must register for 999 each semester, even if the minimum requirement has been met.

Guidance Committee: A guidance committee will be appointed by the Dean of the Graduate School upon the recommendation of the program faculty as soon as possible after a student has begun study for the doctoral degree. The committee will have the responsibility of assisting the student in outlining a program and preparing for the qualifying examination, and will administer the examination.

Qualifying Examination: The qualifying examination is required and may be written, oral, or both. This examination will test: 1) the student's general knowledge in the student's major and minor work and 2) the student's fitness for engaging in research, particularly in the subject proposed for the dissertation. The results of the examination will be communicated by the chairperson of the student's program to the Dean of the Graduate School.

Language/Research Tool Requirement: Each doctoral program has its own language and/or research tool requirements. These requirements can be found in the individual program descriptions.

Degree Candidacy: A doctoral student is advanced to candidacy for the degree by the Dean of the Graduate School after the student has passed the qualifying examination, met the language or proficiency requirements as are deemed desirable by the student's program, and declared a topic for dissertation research.

Doctoral Committee: After the student has been advanced to candidacy, a doctoral committee will be appointed to supervise and pass on the dissertation and administer the final examination. This committee will be nominated by the department of major concentration and appointed by the Dean of the Graduate School. It shall consist of a minimum of five members, usually three from the major department and two from related departments. The Dean of the Graduate School is an ex officio member of all doctoral committees.

Time Limit: All graduate work for the doctorate must be completed within eight years of the beginning of doctoral study, unless the student entered with a master's degree in the same field, in which case the doctorate must be completed within seven years. The beginning of doctoral study is defined as the beginning date of the earliest course applied to the
doctoral record. The student must be advanced to candidacy within five years of the beginning of doctoral study, or within four years if the student entered with a master's degree in the same field.

**Dissertation:** The dissertation must be a contribution to scholarship in the student's discipline, embodying the results of significant and original research, and a mature and competent piece of writing. Students writing dissertations should obtain a copy of the *Thesis and Dissertation Manual* from the Graduate School.

**Final Defense:** A copy of the completed dissertation must be made available to the members of the examining committee two weeks before the final examination date.

The final oral examination is conducted by the doctoral committee and is intended to give the candidate an opportunity to defend the dissertation. A written final examination, on subject matter not covered in the qualifying examination, may also be required. This written examination is conducted by the major department. These final examinations must be completed by the date listed in the Graduate School calendar. After consultation with the major department, the dean may appoint, for participation in the final oral examination, additional members of the faculty under whom the student has worked. The doctoral committee alone shall decide on the merits of the candidate’s performance by a majority vote.

**Submission of Dissertation:** As soon after the examination as possible, but not less than two weeks prior to Commencement, two copies of the approved dissertation, ready for binding, shall be turned in to the Graduate School Office. Binding, microfilming, and copyright fees will be paid at the Graduate School. Most departments require one additional copy of the dissertation. Students should consult their advisers concerning dissertation requirements.

Publication of the dissertation by University Microfilms will be required, and the cost will be assumed by the student. Students are urged to protect their research by copyrighting their dissertation at the time of microfilming. If the material presented in the dissertation is further published, it should be designated as having been accepted as a doctoral dissertation by the University of New Hampshire.

**Graduation**

Students are required to file an “Intent to Graduate Card” with the Registrar's Office at the beginning of the semester in which they intend to graduate. Specific information concerning graduation is available at the Graduate School or the Registrar's Office in Thompson Hall.

Students should be aware that all coursework taken prior to the official awarding of the degree will apply only to that degree program.

Deadlines for graduation are listed in the Graduate School calendar and each semester's *Time and Room Schedule*. 
Departmental Requirements and Course Descriptions

Key

When two course numbers precede a course title and are connected by a hyphen, the first semester of the course, or its equivalent, is a prerequisite to the second semester. If the course numbers are separated by a comma, qualified students may take the second semester without having had the first.

The notation "Lab" indicates that laboratory sessions are a part of the course.

Each prerequisite for a course is separated from the other prerequisites by a semicolon; e.g., Prereq: Educ 807; Psyc 841. If permission (of the instructor, department, adviser, or committee) is a prerequisite for all students, it is listed among the prerequisites: e.g., Prereq: Educ 807; Psyc 841; permission. If, on the other hand, permission may be substituted for one or more of the listed prerequisites, it follows the other prerequisites and is separated from them by a slash mark: e.g., Prereq: Educ 807; Psyc 841; /permission. If permission may be substituted for only one of the prerequisite courses, it is listed with the course for which it may be substituted: e.g., Prereq: Educ 807 or permission; Psyc 841.

Cr/F following the description indicates that no letter grade is given but that the course is graded credit/fail.

For up-to-date information about when a course is offered; who teaches the course; the number of recitations, lectures, labs, and such, students are referred to each semester's Time and Room Schedule, which carries a complete schedule of courses for the semester.

Program Abbreviations

The following program abbreviations are used. An asterisk indicates those disciplines in which graduate programs are offered.

**College of Liberal Arts**
- Anth Anthropology
- Arts Arts
- *Biol Biology
- Clas Classics
- *Educ Education
- Engl English
- Fren French
- Geog Geography
- Germ German
- Greek Greek
- *Hist History
- Hama Humanities
- Ital Italian
- Jap Japanese
- Just Justice Studies
- Latn Latin
- Ling Linguistics Program
- *Micr Microbiology
- *Musj Music
- *MuEd Music Education
- Phil Philosophy
- *Polt Political Science
- *Port Portuguese
- *Psyc Psychology
- R S Religious Studies
- Russ Russian
- ScSc Social Science
- S S Social Service
- *Soc Sociology
- *Span Spanish
- ThCo Theater and Communication
- W S Women's Studies
- *Zool Zoology

**College of Life Sciences and Agriculture**
- *AnSc Animal and Nutritional Sciences
- *Bchem Biochemistry
- *Bot Botany and Plant Pathology
- C D Community Development
- E C Environmental Conservation
- *Ento Entomology
- *FCS Family and Consumer Studies
- *FoRs Forest Resources
- Nutr Nutritional Sciences
- *PlSc Plant Science
- *RECo Resource Economics
- *Soil Soil Science
- *VTAE Vocational/Technical and Adult Education
- *Wild Wildlife Management

**College of Engineering and Physical Sciences**
- *Ch E Chemical Engineering
- *Chem Chemistry
- *Cl E Civil Engineering
- *C S Computer Science
- *Esci Earth Science
- *E E Electrical and Computer Engineering
- ET Engineering Technology
- *Math Mathematics
- *M E Mechanical Engineering
- *O E Ocean Engineering
- *Phys Physics
- *Engr Engineering Ph.D.
- *Tech Technology nondepartmental

**School of Health Studies**
- *Comm Communication Disorders
- HAP Health Administration and Planning
- MedT Medical Technology
- *Nurs Nursing
- O T Occupational Therapy
- *PhEd Physical Education
- RecP Recreation and Parks
- SHS School of Health Studies

**Whittier More School of Business and Economics**
- *Admn Administration
- *Econ Economics
- Hotl Hotel Administration
- Secr Secretarial Studies

**Separate Departments and Programs**
- Aero Aerospace Studies
- DCE Division of Continuing Education (all courses)
- *Gen Genetics Program
- Gero Gerontology
- Inco Intercollge
- Milt Military Science
- PIP Program for International Perspectives
- SLL School for Lifelong Learning
- TSAS Thompson School of Applied Science
Animal and Nutritional Sciences (ANSc)

Chairperson: William A. Condon

PROFESSORS: Thomas P. Fairchild; James B. Holter; Samuel C. Smith; Richard G. Strout; Henry J. Thompson; Willard E. Urban, Jr.

ASSOCIATE PROFESSORS: William E. Berndtson; William A. Condon; Walter E. Hylton; Charles G. Schwab; Anthony R. Tagliaferro

ASSISTANT PROFESSORS: Roger A. Cady; Richard W. Fite; Thomas L. Foxall; Colette H. Janson; Alan H. Parsons; Robert Taylor, Jr.; Roger E. Wells

GRADUATE PROGRAM COORDINATOR: William A. Condon

An applicant admitted to graduate study in animal and nutritional sciences is expected to have had sufficient undergraduate training in the basic biological sciences to qualify for special work in this field. All applicants must submit general test scores from the Graduate Record Examination.

Master of Science

Master of science degree candidates may specialize in animal nutrition, human nutrition, reproductive physiology, mammalian physiology, cell biology and immunology, animal breeding and quantitative genetics, animal diseases, or animal management. In addition to meeting the Graduate School’s requirements for the degree, the candidate must defend a thesis based on a research project. The program may include no more than six credits of thesis research and no more than four credits of investigations. Each candidate must present at least two seminars (exclusive of the thesis defense) and must serve as a teaching assistant for one semester.

Doctor of Philosophy

Doctor of philosophy degree candidates may specialize in animal nutrition, human nutrition, reproductive physiology, mammalian physiology, or cell biology and immunology. A minimum of 20 graduate credits (exclusive of dissertation research) beyond those required for an M.S. degree, or a minimum of 48 course credits without an M.S. degree, is required. However, it is expected that most students will accumulate additional course credits beyond these minimal requirements. A guidance committee, usually consisting of three graduate faculty members within the department and two from other departments, will be appointed during the first semester of enrollment and will assist the candidate in designing the program of study. Upon completion of graduate courses and demonstration of computer literacy, a doctoral student will be required to pass an oral qualifying examination conducted by the guidance committee. This examination may include a written component at the discretion of the committee. After the student’s advancement to candidacy for the Ph.D. degree, a doctoral committee will be appointed to supervise and approve the dissertation and to administer the final examination, which will be primarily an oral defense of the dissertation. During the tenure of the Ph.D. program, the candidate will be required to serve as a teaching assistant for two semesters or to teach a course for one semester.

700. CRITICAL ISSUES IN NUTRITION

Critical review and analysis of controversial topics in nutrition; emphasis on developing analytical writing skills. Prereq: basic nutrition courses. 3 cr. (Fall semester only.)

701. PHYSIOLOGY OF REPRODUCTION

Comparative aspects of embryology, anatomy, endocrinology, and physiology of reproduction. Lab. 4 cr.

702. EXPERIMENTAL ENDOCRINOLOGY OF REPRODUCTION

Discussions of current research literature plus application of laboratory techniques to the study of hormone relationships in the reproductive system. Prereq: ANSc 701 and permission. Lab. 4 cr.

704. PRINCIPLES OF PATHOBIOLOGY

Principles of disease processes; reactivity of the diseased cell, tissue, and organ. Prereq: animal anatomy, health, and disease courses; /or permission. 3 cr.

709. BIOCHEMISTRY OF NUTRITION

Intermediary metabolism of nutrients and energy; metabolic transport mechanisms; biological oxidation; interrelationships of carbohydrate, fat, and protein metabolism; obesity; control of hunger and appetite. Prereq: biochemistry. 4 cr.

710. RUMINANT NUTRITION

Feeding and related management of ruminant animals with special emphasis on dairy cattle; nutrients and their use, digestive anatomy and physiology, energy systems, forage systems, metabolic disorders, economical ration balancing. Prereq: prin of nutr 4 cr.

712. ANIMAL BREEDING AND IMPROVEMENT

Principles of genetic evaluation, selection, and breeding systems as they apply to the genetic improvement of farm animals. Prereq: prin of genetics or permission. Lab. 4 cr. (Not offered every year.)

714. INTRODUCTION TO ELECTRON MICROSCOPY

Principles, theory, and methods used in preparing and examining vertebrate tissues in the transmission and scanning electron microscopes; interpretation of electron micrographs. Prereq: chemistry or permission. 3 cr.

715. INTRODUCTION TO ELECTRON MICROSCOPY LAB


716. AVIAN DISEASES

Diagnosis, treatment, and control of the major bacterial, viral, and fungal diseases, parasite infestations, and nutritional deficiencies of birds. Diseases of commercial poultry are emphasized, but those occurring in pet and wild birds are also included. Labs will cover avian pathology and immunology. Prereq: permission. 4 cr.

717. MAMMALIAN PHYSIOLOGY

A systems-level course with emphasis on basic physiologic concepts and the functional principles of the nervous, muscular, skeletal, and cardiovascular systems. Prereq: one year of introductory an-
IMAL ANATOMY AND PHYSIOLOGY AND ONE SEMESTER OF BIOCHEMISTRY OR PERMISSION. 4 CR.

718. MAMMALIAN PHYSIOLOGY
A systems-level course with emphasis on the respiratory, gastrointestinal, excretory, reproductive, and endocrine systems. Prereq: one year of introductory animal anatomy and physiology and one semester of biochemistry or permission. 4 CR.

722. IMMUNOBIOLOGY
Study of the molecules, cells, and tissues of the immune system. Experimental foundations of immune ontogeny and phylogeny, cellular interactions, regulatory mechanisms, and immunogenetics. Analysis of the immune response using cellular and humoral techniques. Prereq: Micr 705 or permission. Lab. 4 CR.

750. HUMAN NUTRITION
Human nutrient requirements throughout the life cycle. Nutrient needs are evaluated in the context of their physiological and biochemical functions. Prereq: basic nutrition. Coreq: ANSc 751. 3 CR. (Fall semester only.)

751. LABORATORY TECHNIQUES IN NUTRITION
Standard procedures of nutrient analysis. Use of laboratory instruments and techniques to develop quantitative skills. Prereq: organic chemistry or permission. Coreq: ANSc 750. 2 CR. (Fall semester only.)

774. CLINICAL NUTRITION
Application of principles of normal nutrition and physiology to clinical problems; altered nutrient requirements in human disease. Prereq: basic nutrition in biochemistry or permission. Coreq: ANSc 775. 3 CR. (Spring semester only.)

775. NUTRITIONAL ASSESSMENT LABORATORY
Experimental techniques in anthropometric and biochemical assessment of nutritional status emphasizing principles of normal nutrition and changes induced by disease. Prereq: basic nutrition or permission. Coreq: ANSc 774. 2 CR. (Spring semester only.)

780. PRACTICAL APPLICATIONS IN CLINICAL NUTRITION
Supervised practical experience in dietetics in one of several cooperating New Hampshire hospitals. Emphasis on patient interviewing, evaluation, counseling, and instruction. Coreq: ANSc 774 and 775. 5 CR. (Spring semester only.)

795. INVESTIGATIONS IN THE ANIMAL SCIENCES
A) Genetics; B) Nutrition; C) Management; D) Diseases; E) Products; F) Light Horses; G) Physiology; H) Cell Biology. The student may select a special problem in any of the fields listed under the guidance of the instructor. Prereq: permission. May be repeated. 1–4 CR.

798. CONTEMPORARY TOPICS IN BIOMEDICAL SCIENCE AND NUTRITION
A lecture-discussion series on contemporary topics in animal biology, nutrition, and medicine including: production and applications of monoclonal antibodies, oncogenesis, sports nutrition, nutrition and cancer, toxicology, atherogenesis, etc. 2 CR. Cr/F.

801. ADVANCED STUDIES IN ANIMAL BREEDING
Independent study and research on modern breeding methods and newer systems of selection for quantitative traits. Prereq: ANSc 712. 3 CR.

803. ENERGY METABOLISM AND NUTRITION
Incidental lectures, assigned reading, and laboratory practice in methods of research with major emphasis on protein and energy metabolism. 3 CR. (Not offered every year.)

804. PROTEIN METABOLISM AND NUTRITION
Metabolism of dietary amino acids in the mammalian system with emphasis on various aspects of protein nutrition. Prereq: permission. 4 CR. (Not offered every year.)

805-806. AVIAN MICROBIOLOGY
The disease process (acute or chronic) in the intact host at cellular levels when invaded by viruses or virus-like agents, fungi, and protozoans. Physiological and cytopathological changes in tissue culture. 3 CR.

810. MINERALS AND VITAMINS IN NUTRITION
Metabolism and function of mineral elements and vitamins in higher animals. Prereq: permission. 4 CR. (Not offered every year.)

812. QUANTITATIVE GENETICS AND SELECTION
Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, correlated characters. Prereq: one course each in genetics and statistics. 3 CR. (Not offered every year.)

851. CELL CULTURE
Theory and principles fundamental to the culture of cells in vitro. Introduction to techniques of preparation and maintenance of animal, plant, insect, and fish cell cultures. Application of cell culture to contemporary research in biological sciences. Prereq: gen micro; permission. (Also offered as Micr 851 and Bot 851.) Lab. 4 CR.

853. ADVANCED CELL BIOLOGY
A study of the ultrastructure and function of cell organelles followed by an analysis of various specialized animal cells to show how differences in form and location of various organelles lead to differences in function. Prereq: biochemistry; physiology; vertebrate anatomy; (or permission. 4 CR. (Not offered every year.)

895, 896. RESEARCH IN ANIMAL SCIENCES
Advanced investigations in a research project, exclusive of thesis project. Elective only after consultation with the instructor. May be repeated. 1–4 CR.

897, 898. ANIMAL SCIENCE SEMINAR
A survey of recent literature and research in the animal sciences. Staff. (May be repeated.) 1 CR. Cr/F.

899. MASTER'S THESIS
6–10 CR.

999. DOCTORAL RESEARCH
Biochemistry (Bchm)

Chairperson: James A. Stewart

PROFESSORS: Donald M. Green; Edward J. Herbst; Miyoshi Ikawa; Samuel C. Smith; James A. Stewart

ASSISTANT PROFESSORS: Clyde L. Denis; Anita S. Klein; Thomas M. Laue

GRADUATE PROGRAM COORDINATOR: Edward J. Herbst

An applicant who gains admission to graduate study in biochemistry is expected to have completed basic courses in chemistry, biological sciences, mathematics, and physics. Otherwise well-qualified applicants will be permitted to correct deficiencies in undergraduate education by enrollment in the appropriate courses or by independent study. All applicants must submit general test scores from the Graduate Record Examination.

The department offers opportunities for specialization in developmental biochemistry, biochemistry of natural products, physical biochemistry, biochemical genetics, and structure and metabolism of macromolecules. Opportunities also exist for interdisciplinary research specialization in marine biochemistry, biochemical nutrition, and cell biology in adjacent facilities on campus. In addition to the graduate courses in biochemistry, courses in advanced organic chemistry, radiochemistry, advanced microbiology, and genetics are usually recommended.

Participation of all graduate students will be required in the instructional activities of the department, either in the laboratory, in lectures, or in an individual instruction format. These teaching assignments are an essential part of the graduate academic programs of the department and are designed to give graduate students practical teaching experience. Normally one year of part-time teaching will be required of each student.

Master of Science

Degree candidates will be expected to develop a thesis on a basic research problem or to prepare a report or publication based on an applied project in biochemistry. All candidates for the M.S. degree will be required to pass an oral examination based on the thesis or project report and on the graduate courses completed in the degree program.

Doctor of Philosophy

Degree candidates will be required to complete a dissertation on original research in biochemistry. At the end of the first year of graduate study, a preliminary examination on organic chemistry, physical chemistry, and general biochemistry will be presented to students in the doctoral program. The results of this examination and the student's academic record will be evaluated at this time to ascertain eligibility to proceed to candidacy in the doctoral program. Upon completion of graduate courses recommended by a guidance committee and demonstration of proficiency in the translation of biochemical literature in either German, French, or Russian, a doctoral student will be required to pass an oral qualifying examination conducted by the guidance committee. The successful completion of these requirements and advancement to candidacy for the Ph.D. degree must occur at least six months prior to the final oral defense of the Ph.D. dissertation administered by the student's doctoral committee.

702. COMPARATIVE MARINE BIOCHEMISTRY

Nutrition, metabolism, and composition of marine organisms and relation to phylogeny; marine natural products. Prereq: Bchm 752; or permission. 3 cr. (Not offered every year.)

721. NEUROCHEMISTRY

Biochemistry of the nervous system; metabolism and alterations of normal brain chemistry by drugs, chemicals, nutrition, memory, and learning; pathological changes. Prereq: a biochemistry course. 3 cr.

751-752. PRINCIPLES OF BIOCHEMISTRY

Fundamental biochemistry; chemistry, metabolism, and biological function of nucleic acids, proteins, carbohydrates, and lipids. Prereq: organic chemistry; or permission. 3 cr.

753-754. BIOCHEMISTRY LABORATORY

Must be taken concurrently with Bchm 751-752. Lab fee: $30.00. 3 cr.

760/860. ENZYME CHEMISTRY

Proteins, physical chemistry, enzyme structure, and enzyme kinetics; physical properties of enzymes and enzyme solutions in vitro and in vivo; methods of purification, structural analysis, and kinetic mechanisms emphasized. Demonstration of a thorough understanding of the theory and the use of one of the techniques is required in 860. Prereq: calculus; Bchm 752; or permission. 3 cr.

765. ADVANCED PLANT BIOCHEMISTRY

Structure, metabolism, synthesis, and regulation of cellular constituents of plants. Prereq: Bchm 752 or PISC 762 or permission of instructor. 3 cr.

771. BIOCHEMICAL GENETICS

Mechanisms of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Prereq: Bchm 752; or permission. (Also offered as Gen 771.) 3 cr.

772. INTRODUCTORY LABORATORY IN MOLECULAR GENETIC TECHNIQUES

Modern biochemical gene manipulation techniques including the genetic, physical, and enzymatic characterization of gene vectors, gene cloning, construction of genetic probes, and sequencing of nucleic acids. Prereq: Bchm 752; and either Bchm 771, Bchm 781, or Micr 704. (Also offered as Gen 772.) 3 cr.

781/881. THE NUCLEIC ACIDS

Chemistry and metabolism of nucleic acids: molecular structures, purification and separation, biosynthesis, and biological functions. Research paper based on current literature required in 881. Prereq: Bchm 752; or permission. 3 cr.

795. INVESTIGATIONS IN BIOCHEMISTRY

Subject matter and hours to be arranged. Prereq: permission. Not more than 4 total credit hours can be applied to biochemistry or major electives. 1–4 cr.

811. BIOCHEMISTRY OF LIPIDS

Chemistry, metabolism, and function of lipids. Prereq: Bchm 752; or permission. 3 cr. (Not offered every year.)
832. BIOCHEMISTRY OF CARBOHYDRATES
Chemistry, metabolism, and functions of carbohydrates. Polysaccharides, glycoproteins, and the nature of cell surfaces. Prereq: Bchm 752; /or permission. 3 cr. (Not offered every year.)

842. BIOCHEMICAL REGULATORY MECHANISMS
Nonreplicative functions of DNA; transcription and translational control of protein synthesis; quantitative regulation of proteins; regulation of metabolism by hormones, allosteric regulation and repression; regulatory mechanisms operating during development and differentiation. Prereq: Bchm 752; /or permission. 3 cr.

850. PHYSICAL BIOCHEMISTRY
Structure, interactions, and physical properties of biomolecules. Thermodynamic, hydrodynamic, and spectroscopic methods for study of proteins and nucleic acids. Prereq: physical chemistry; Bchm 752 or permission. 3 cr.

897, 898. BIOCHEMISTRY SEMINAR
Prereq: permission. 1 cr.

899. MASTER'S THESIS
6–10 cr.

999. DOCTORAL RESEARCH

Biochemistry, Biology, Botany and Plant Pathology

Biology: Intercollege Biological Sciences Organization

Chairperson: Richard G. Strout
Chairperson of Graduate Advising Committee: Frank K. Hoornbeck

The master of science program in biology is administered by the Intercollege Biological Sciences Organization, which is composed of faculty members involved in teaching and research in various biological sciences. Students in the program consult with the Graduate Advising Committee in planning their individual programs. At present, participating faculty are drawn from the following areas: molecular, cellular, and developmental biology; systematics, ecology, and evolution; physiology, anatomy, and nutrition; genetics, pathobiology.

Master of Science
This is a general, nonthesis program that is applicable to interests which may not be met in a formal department. Curricula may be individually designed for persons working for agencies that require advanced, broad training in the biological sciences, or for those who wish to prepare for junior or community college teaching. Applicants should have a bachelor's degree in biology, zoology, botany, microbiology, or a strong background in biological and physical sciences including physics, college mathematics, and organic chemistry. Requirements for the degree include a four-credit research project and successful completion of a final written comprehensive examination on completed coursework.

Persons interested in the biology program should contact the chairperson, Graduate Advising Committee, for further information.

The biology program is currently undergoing a major review; admission to the master of science program has therefore been temporarily suspended.

Botany and Plant Pathology (Bot)

Chairperson: Subhash C. Minocha

PROFESSORS: Robert O. Blanchard; A. Linn Bogle; William E. MacHardy; Arthur C. Mathieson; Subhash C. Minocha
ASSOCIATE PROFESSORS: Alan L. Baker; Garret E. Crow; Leland S. Jahne
ASSISTANT PROFESSORS: Wayne R. Fagerberg; Thomas C. Harrington; Thomas D. Lee

ADJUNCT PROFESSOR: Alex L. Shigo
ADJUNCT ASSISTANT PROFESSORS: Kathleen K. Baker; Antoinette P. Hartergink; Frederick T. Short; Walter C. Shortle; Janet R. Sullivan

GRADUATE PROGRAM COORDINATOR: Alan L. Baker

Students admitted to graduate study in botany and plant pathology are expected to have adequate preparation in basic botany courses and in the physical sciences. All applicants must submit scores on the general and subject biology portions of the Graduate Record Examination.

The candidate for the master of science degree will meet the Graduate School's requirements for the degree and, in addition, will be required to defend a thesis based on field or laboratory research, after passing a comprehensive examination. A student who is working toward the doctor of philosophy degree will be advanced to candidacy for the Ph.D. after a successful comprehensive examination and completion of the following language requirement: a reading knowledge of at least one foreign language. The guidance committee may request a reading knowledge of two foreign languages, or a reading knowledge of one foreign language and proficiency in a cognate field such as statistics or computer techniques. The student will be required to defend a dissertation that is to be a substantial contribution to botanical knowledge.

All botany and plant pathology graduate students without professional teaching experience will satisfy the following departmental teaching requirements: each student will assist a faculty member for one semester in teaching one botany course; a Ph.D. candidate will assist in teaching an introductory course and an additional semester in an advanced botany course.

The department's areas for graduate study include plant physiology, Leland Jahne, Subhash Minocha; plant ecology, Thomas Lee; systematic botany, Garrett Crow; physiology, marine-freshwater, Arthur Mathieson, Alan Baker; plant pathology, Robert Blanchard, Thomas Harrington, William MacHardy; plant morphology and anatomy, Linn Bogle; mycology, Thomas Harrington; developmental botany, Subhash Minocha; cell biology, Wayne Fagerberg.

717. GENERAL LIMNOLOGY
Special relationships of freshwater organisms to the chemical, physical, and biological aspects of their environment; factors regulating their distribution; and the primary and secondary productivity of lakes. Individual projects. Prereq: general ecology or equivalent. 4 cr.
719. FIELD LIMNOLOGY
Principles of freshwater ecology, examined in a variety of habitats; the application of field instruments and computer methods used to study lakes and interpret data. Occasional Saturday field trips. Coreq: Bot 717; permission. Lab. 4 cr.

721. THE MICROSCOPIC ALGAE
Survey of phytoplankton and periphyton in local marine and freshwater habitats. Identification, systematics, and evolution. Class and individual collection trips. Prereq: elem bot or survey of the plant kingdom. Lab. 4 cr. (Not offered every year.)

722. MARINE PHYCOLOGY
Identification, classification, ecology, and life history of marine algae, particularly the benthiic marine algae of New England. Periodic field trips. Prereq: elem bot or survey of the plant kingdom. Lab. 4 cr. (Not offered every year.)

723. MARINE ALGAL ECOLOGY
Distribution, abundance, and growth of marine plants in relation to their environment. Scheduled field trips and an independent research project are required. Prereq: Bot 722; or permission. Lab. 4 cr. (Not offered every year.)

724. FRESHWATER ALGAL ECOLOGY
Survey of freshwater algal habitats; physiological explanation of population models. Individual experimental projects. Prereq: Bot 717 or 721; or permission. 4 cr.

727. ALGAL PHYSIOLOGY
Survey of major topics in the physiology and biochemistry of marine and fresh water algae including: nutrition, metabolism of marine algae, reproductive physiology, storage and extracellular products, cell inclusion, growth and development. Prereq: plant physiology and introductory biochemistry or permission. 2 cr. (Not offered every year.)

729. ALGAL PHYSIOLOGY LABORATORY
Laboratory techniques useful in studying the physiology of freshwater and marine algae. Experiments in nutrition, metabolism, pigment and enzyme analysis. Small research project required. Prereq: permission. Coreq: Bot 727. 2 cr. (Not offered every year.)

732. CELL BIOLOGY
How cell structure relates to cell function, cell-to-cell communication, replication, and the factors controlling cell structure. Cell interaction with its environment. Major tools used by the cell biologist to study cells. Prereq: one year of biology and an introductory chemistry course. 4 cr.

742. PHYSIOLOGICAL ECOLOGY
Physiological responses of plants to the physical environment; energy exchange, light, and photosynthesis, water relations, and mineral nutrition. Prereq: plant physiology or permission. Lab. 4 cr.

747. AQUATIC HIGHER PLANTS
Flowering plants and fern relatives found in and about bodies of water in the northeastern United States; extensive field and herbarium work, preparation techniques, and collections. Prereq: plant taxonomy. Lab. 4 cr. (Not offered every year.)

752. MYCOLOGY
Classification, identification, culturing, life histories, and diseases of ascomycetes and basidiomycetes; their role in the environment and human affairs. Prereq: elementary botany. Lab. 4 cr.

755. PLANT VIROLOGY
Characterization and replication of plant viruses; diagnosis, epidemiology, and control of virus-caused diseases of plants. Prereq: plant pathology or permission. 2 cr. (Not offered every year.)

757. PLANT BACTERIOLOGY
Biology of beneficial and detrimental bacteria associated with higher plants. Prereq: plant pathology, microbiology, or permission. 2 cr. (Not offered every year.)

758. PLANT ANATOMY
Anatomy of vascular plants; structure and development of basic cell and tissue types and of major organs of woody plants. Prereq: intro bot or survey of the plant kingdom; permission. 3 cr.

761. PLANT GEOGRAPHY
Distribution of plants, a consideration of vegetative types and floras, and problems of endemism with emphasis on North America; major influential factors such as geologic, climatic, edaphic, and biotic. Major contributions from Humboldt to the present time. Prereq: survey of the plant kingdom. Lab. 4 cr. (Not offered every year.)

762. MORPHOLOGY OF THE SEED PLANTS
Comparative form and structure of the major living and extinct groups; evolutionary modifications of the vegetative and reproductive organs, and the basic life history pattern. Prereq: survey of the plant kingdom. Lab. 4 cr. (Not offered every year.)

764. MICROTÉCHNIQUE
Methods of preserving cell and tissue structure, embedding, sectioning, and staining plant tissues, and an introduction to microscopy. Prereq: permission. Lab. 4 cr. (Not offered every year.)

795, 796. INVESTIGATIONS IN:

803. TOPICS IN DEVELOPMENTAL PLANT PHYSIOLOGY
A) Fungal Physiology: physiology and biochemistry of nutrition, metabolism, and growth in the fungi; physiology of reproduction and sporulation, spore dormancy, and germination. B) Nitrogen Fixation: nomenclature and distribution of N2 fixing organisms; symbiotic relationships of Rhizobium; mechanisms of N2 fixation; genetic regulation of N2 fixation. C) Genetic Engineering in Plants: theory and techniques of genetic manipulation in plants; mechanisms of gene expression; gene vectors; somatic cell genetics; uses for agriculture. D) Photomorphogenesis: photoreceptors and response systems in plants; chemistry and biological action of phytochrome; biochemistry of photomorphogenesis. E) Plant Hormones: chemical nature, uptake, translocation, biosynthesis, and
metabolism of plant hormones; mechanism of hormone action. F) Stress Physiology: physiological effects of environmental stress (heat, cold, drought, air pollution, etc.) on plant growth and metabolism. G) Genetic Control of Plant Development: control of cell division and cell elongation; regulation of flowering and sex expression; mutants and plant productivity. H) Regulation of Gene Activity: transcription and processing of RNA in plants; regulation of protein synthesis; chromosomal differentiation; organization of chromosomes; chromosomal proteins and gene regulation. I) Metabolic Mechanisms in Plants: photosynthetic and catabolic carbon pathways, plant senescence, and nitrogen metabolism. A series of seven-week, two-credit, in-depth modules covering recent advances in plant physiology and development. Two to three modules per semester. Prereq: permission. (Also offered as MS 803.) 2 cr.

813. PHOTOSYNTHESIS
The physiology and biochemistry of photosynthesis in higher plants and microorganisms: light reactions, electron transport, membrane structure and function, carbon assimilation pathways, energy conservation, and metabolic regulation. Agronomic and ecological aspects of photosynthesis will also be examined. Prereq: plant physiology or biochemistry. 4 cr. (Not offered every year.)

822. ADVANCED MARINE PHYCOLOGY
Classification, ecology, and life histories of marine algae compiled at an advanced level. Seminars, discussion, assigned readings, and laboratory. Prereq: Bot 722 or equivalent. 4 cr.

845. PLANT COMMUNITY ECOLOGY
Methods for analysis of biological communities; ordination and classification of communities; theoretical and empirical investigation of factors controlling community structure; theory and modelling of succession. Occasional Saturday field trips. Prereq: intro. statistics and intro. ecology. Lab. 4 cr. (Not offered every year.)

850. MORPHOGENESIS
Principles of differentiation at molecular, cellular, and organismic levels; internal and external factors regulating gene activity and differentiation. Prereq: plant physiology or permission. 4 cr. (Not offered every year.)

851. CELL CULTURE
Theory and principles fundamental to the culture of cells in vitro. Introduction to techniques of preparation and maintenance of animal, plant, insect, and fish cell cultures. Application of cell culture to contemporary research in biological sciences. Prereq: gen micro; permission. (Also offered as Micr 851 and ANSc 851.) Lab. 4 cr.

854. PRINCIPLES OF PLANT DISEASE CONTROL
Epidemiology of plant diseases and relationship to cultural practices, resistant varieties, biological control, and chemical control; crop loss assessment, disease forecasting, and disease management. Prereq: plant pathology or forest and shade tree pathology. Lab. 4 cr. (Not offered every year.)

859. ADVANCED MYCOLOGY
Biological, isolation, and identification of fungi treated at an advanced level. Assigned readings and a collection required. Prereq: Bot 752 or equivalent. Lab. 4 cr. (Not offered every year.)

867. ADVANCED SYSTEMATIC BOTANY
Principles and rules of plant classification and nomenclature; plant families; field and herbarium work. Prereq: plant taxonomy. 4 cr.

871. COMPUTER APPLICATIONS IN BIOLOGY
A set of 2-credit modules. Module A, first half of semester. Module B, second half of semester. Module A prerequisite to Module B.

871A. Computer Application Techniques
Methods of problem solving in biology with computer aid. Introduction to file structure and manipulation. Use of available software packages to process field or laboratory data including acquisition, storage retrieval, statistical analysis, plotting, and report generation. Individual project. 2 cr.

871B. Biological Programming in FORTRAN
Fundamentals of FORTRAN programming including statements, arguments, functions, subroutines, encode/decode useful in scientific programming. Design and application of FORTRAN programs for experimentation and modeling. Individual project. 2 cr.

885, 886. RECENT ADVANCES
A) Systematic Botany; B) Plant Physiology; C) Plant Pathology; D) Plant Anatomy; E) Plant Ecology; F) Mycology; G) Cell Biology; H) Physiology; I) Botanical Teaching; J) Morphology; K) Cell Physiology. Prereq: permission. 2 cr.

895, 896. INVESTIGATIONS IN BOTANY

899. MASTER'S THESIS
6–10 cr.

999. DOCTORAL RESEARCH

Business Administration (Adm)

Program Director: James O. Horrigan
Director of Executive Programs: Linda G. Sprague

PROFESSORS: Robert F. Barlow; Stephen L. Fink; Russell I. Haley; James O. Horrigan; Manley R. Irwin; Fred R. Kaen; Melvin J. Karson; Dwight R. Ladd; Barry Shore; Linda G. Sprague; William E. Wetzel, Jr.; Robin D. Willits; Dwayne E. Wrightsman
ASSOCIATE PROFESSORS: John H. Barnett; John A. Freear; Francine S. Hall; Michael J. Merenda; Richard L. Mills; Melvin Sandler; Starr Schlobohm; Rita Weathersby
ASSISTANT PROFESSORS: Gene Bocialetti; Ahmad Ehrari; James L. Grant; Allen Kaufman; Duncan G. LaBay; Jeffrey E. Sohl
ADJUNCT ASSOCIATE PROFESSOR: Dale G. Broderick

Botany and Plant Pathology, Business Administration
The Whittomore School offers a program leading to the M.B.A. in formats designed for day students and practicing executives. The program is designed to prepare students for business, reference, and administration in both profit and nonprofit organizations in a rapidly changing world. The M.B.A. program is directed toward a broad preparation in general administration through the study of: 1) the increasing body of relevant knowledge drawn from the behavioral sciences, mathematics, and economics; 2) the existing and emerging processes and institutions of the functional fields of administration; and 3) the role of business and other organizations in a complex and turbulent society.

There is a consistent emphasis on developing basic analytical skills rather than on developing extensive technical expertise. Also, the program fosters the ability to utilize conceptual and theoretical material in the analysis and solution of practical problems.

Candidates for admission must possess a bachelor's degree from an accredited college or university. In addition, all candidates are expected to take the Graduate Management Admission Test (GMAT) given by the Educational Testing Service. Details concerning admission prerequisites and locations for these examinations may be obtained from Educational Testing Service, Box 955, Princeton, New Jersey 08540.

The Whittomore School welcomes applicants with an above-average academic record in any undergraduate specialty other than business or commerce. No previous exposure to business courses is expected. However, previous work in mathematics, economics, the behavioral sciences, and the branches of engineering is particularly useful for graduate study in administration. Because of the increasing use of mathematical concepts, models, and notation in the practice and study of administration, applicants should normally have successfully completed one year of college mathematics, preferably including an introduction to calculus. Students lacking this background may still enroll in the program provided they obtain adequate substitute preparation prior to beginning the program.

In all cases, the applicant's entire educational background, relevant work experience, references, and professional attainment will be considered in the admissions process. Exceptions may be made to any of the foregoing requirements by the committee on admissions.

**Day M.B.A. Program**

The Whittomore School curriculum for day students consists of an integrated sequence of 18 courses requiring two years of study, which can be started only in the fall semester. During the first year, 10 required courses in the basic disciplines (quantitative analysis, economics, and behavioral science) and the functional areas of management (accounting, marketing, operations management, and financial management) are integrated into an overall study of the process of administration. Special attention is also given to the study of the modern corporation as an economic, legal, and social organization by requiring all students to complete the course, The Organization and Its Environment.

The second year of the day curriculum continues the emphasis on overall management by requiring all students to complete Business Conditions and Economic Forecasting and Business Policy. The ten required courses in the first year and the two required courses in the second year are open only to full-time matriculated students. In addition, with the help of a faculty adviser, the student will select the equivalent of six four-credit elective courses with some concentration in an area of special interest. Students are encouraged to select appropriate graduate-level courses offered by other colleges of the University as well as by the Whittomore School, and to undertake field studies or internships.

**Executive M.B.A. Program**

The curriculum for practicing managers contains the same course requirements as the day M.B.A. program but is tailored to the context and scheduling needs of the working full-time at executive level jobs. The executive program begins each fall, and because of the cumulative nature of the program, participants are expected to stay on schedule with their class. The program is offered in Durham at the New England Center. The two-year program begins in the fall, with a full week of classes. Thereafter, classes are held twice each month in all-day Friday and Saturday sessions.

712. **MANAGING ORGANIZATIONAL CHANGE**

Conceptual and technical tools to manage the challenge of change, both unpredictable and predictable. Topics include the process of change; change strategies; change agent roles—internal and external; bases of resistance to change; coping with resistance. Prereq: organizational behavior or equivalent desirable. 4 cr.

713. **INTERPERSONAL SKILLS FOR MANAGERS**

Focuses on student awareness of interpersonal style and its effectiveness in gaining personal and organizational rewards. Also considered is the process by which groups develop and the management of that development. Lab fee may be charged. 4 cr.

714. **MANAGING ORGANIZATIONAL CONFLICT**

Conflict among individuals, small groups, and organizations. Analysis of cases, readings, simulations, and role-plays (often using video tape) develops useful concepts and skills for dealing with conflict. Students examine their own behavior in coping with conflicts within the class. Field project required. Prereq: permission. 4 cr.

715. **TRAINING THEORY AND PRACTICE**

Design and implementation of management training programs and experiential education. Leadership of training groups and self-development processes. Prereq: Admn 713 or equivalent experience is desirable. 4 cr.

718. **COST AND MANAGEMENT**

Effective use of cost accounting, cost analysis, and budgeting in planning and controlling operations. Analysis of cost behavior, direct and absorption costing, cost-price-volume relationships, distribution costs, transfer pricing, and capital budgeting analysis. Prereq: permission. 4 cr.

720. **AUDITING**

The attest function and the responsibility and professional ethics of the independent auditor in our society. Audit concepts, procedures, objectives, and reports. Operational audits, social audits, and management services. Prereq: financial and management accounting, or permission. 4 cr.
722. **TOPICS IN ACCOUNTING**
Special topics. Prereq: permission. 4 cr.

723. **TOPICS IN FINANCE**
Prereq: financial management. 4 cr.

724. **ADVANCED TOPICS IN OPERATIONS MANAGEMENT**
Analysis and development of planning and control systems for the operations within an organization. Prereq: permission. 4 cr.

726. **DECISION-SUPPORT SYSTEMS**
Exploration of computer usage in support of the problem-solving and decision-making process. Topics include conceptual foundations of decision-support systems, design of decision-support systems, spreadsheets, data base, and expert systems. Use of main frame and microcomputers, cases, projects; guest speakers. Prereq: permission. 4 cr.

728. **STATISTICAL DECISION MAKING**
Probability and statistics applied to decision problems. Bayesian approach to decisions under uncertainty, which explicitly injects prior judgments of decision makers and the consequences of alternative actions. Prereq: basic statistics; permission. 4 cr.

732. **EXPLORATION IN ENTREPRENEURIAL MANAGEMENT**
Examination of the management of change and innovation with particular attention to the role of the entrepreneur in the management of new ventures. Characteristic behavioral, organizational, financial, and marketing problems of entrepreneurs and new enterprises. Prereq: permission. 4 cr.

742. **MANAGEMENT INFORMATION SYSTEMS**
Concepts, design, and implementation of systems to provide information and support for managerial decision making. Use of computers, models, and behavioral factors from the manager's perspective. 4 cr.

745. **INTERNATIONAL BUSINESS**
Issues and problems confronting managers in the international economy. Emphasis on problems of working across national borders rather than on those encountered within the framework of different national economies, cultures, and institutions. For managers working in a multinational enterprise. Prereq: permission. 4 cr.

746. **INTERNATIONAL FINANCIAL MANAGEMENT**
Financial management problems facing multinational firms. Focus on effects of currency denominations on financial decisions. Prereq: financial management. 4 cr.

747. **BUSINESS TAXATION**
Taxation factors relevant to business decisions. Emphasis upon federal income taxation from the viewpoint of the firm. Prereq: financial and managerial accounting. 4 cr.

751. **ADVERTISING AND PROMOTION**
Advertising, personal selling, and other promotional tools to help solve marketing problems; advertising as a medium of communication and as a social-cultural force in the Western world. Prereq: marketing; permission. 4 cr.

756. **MANAGEMENT OF FINANCIAL INSTITUTIONS**
How financial institutions manage their sources and uses of funds; effect of external environmental factors upon the operation and performance of financial institutions. Optimal portfolio strategies for commercial banks, savings and loan associations, mutual savings banks, insurance companies, and pension funds. Implications of monetary theory for individual financial institution policies; credit analysis; competition among financial institutions; regulation of financial institutions. Prereq: financial management. 4 cr.

761. **SALES MANAGEMENT**
Principles and methods of successful salesmanship and management of the sales function. Selling experiences in fields of student interest; case studies, sales presentations; oral and written analyses of sales management issues. Prereq: marketing; permission. 4 cr.

762. **MARKETING WORKSHOP**
Integrative study of a real marketing situation in a business, nonprofit institution, or government agency. Activities include diagnosis of problems or collect data, suggest alternate solutions, and submit a recommended course of action. Prereq: one advanced marketing course; permission. 4 cr.

770. **PERSONNEL ADMINISTRATION**
Role of personnel administration and human resource management in achieving goals in "for-profit" and "not-for-profit" organizations. Functions of management; scope, technique, and current issues of personnel administration; organization of personnel activities and staff. How managers relate to personnel administration and interact with personnel administration staff and services. Prereq: permission. 4 cr.

775. **LABOR-MANAGEMENT RELATIONS**
Study of the legal, economic, and institutional environment within which labor-management relations occur and a study of the processes and goals that determine the rules governing labor-management relations. Focus on relations in the U.S., covering union and non-union and private and public enterprises. Issues considered include employee discipline, seniority, and performance appraisal, and job rights versus management rights. Grievance administration, arbitration, and contract negotiations are examined. Prereq: permission. 4 cr.

780. **WOMEN IN MANAGEMENT**
Issues faced by women managers; problems associated with role expectations of women as they move into managerial positions traditionally filled by men. Prereq: permission. 4 cr.

785. **CAREER MANAGEMENT**
Develops individual career management skills. Topics include concepts of career development and issues pertaining to career management in organizations. Helpful for students interested in human resource management. 4 cr.

795. **INTERNSHIP**
On-the-job skill development through fieldwork in an organization (business, industry, health, public service, etc.). Normally, supervision provided by a qualified individual in the organization, with frequent consultation by a faculty sponsor. Written report required. Internships may be part- or full-time, with course credits assigned accordingly. 1–16 cr.
800. INTEGRATIVE MANAGEMENT SEMINAR
This course extends throughout the Executive MBA Program. Material and topics not offered in regular courses are offered here, as are distinguished speakers from business and government, field trips, issues of immediate concern, etc. 1 cr. To be repeated up to 4 cr. Cr/F.

801. QUANTITATIVE METHODS
Basic mathematical and statistical concepts applied to managerial decision making. Probability, statistics, decision trees, and mathematical models. 3 cr.

803. HUMAN BEHAVIOR IN ORGANIZATIONS
Understanding of behavioral science concepts and their use in the analysis of individual, group, and leadership relationships in organizations; skills in dealing with others at work. 3 cr.

804. MANAGEMENT ORGANIZATION
Theories of organization and analysis of contemporary forms and structure. Concern is with development of rational management processes in a dynamic society. 3 cr.

806. FINANCIAL MANAGEMENT
Concepts and techniques for determining the need for, the acquisition of, and the management of, financial resources of the business. 3 cr.

808. MARKETING
Identification, development, and retention of markets for the goods and services offered by the firm. Attention is given to the dynamics of demand and to the blending of the marketing mix. 3 cr.

810. OPERATIONS MANAGEMENT
Analysis of operational problems in the product and service sectors, focusing on production system design and development; emphasis on standards, capacity, inventory, scheduling, and control. 3 cr.

811. THE ORGANIZATION AND ITS ENVIRONMENT
Study of the modern corporation as a partly economic, legal, and social organization, including examination of widely held views of business and views of business people about themselves. 4 cr.

815. FINANCIAL ACCOUNTING
Introduction to the accounting methods employed in organizations to determine and communicate their financial positions to interested parties outside the organizations. 3 cr.

816. MANAGERIAL ACCOUNTING
Introduction to various models employed by organizations in the financial planning and control processes. 3 cr.

817. BUSINESS CONDITIONS AND ECONOMIC FORECASTING
The effect on management decisions of historical and forecasted movements in interest rates, national income, inflation, and unemployment. 3 cr.

818. MANAGERIAL ECONOMICS
An economics approach to the conceptualization, analysis, and management of revenues, costs, and profits. 3 cr.

820. BUSINESS POLICY
A "capstone" course, focused on industries, companies, and other organizations in operation, and studied through case examples, with emphasis on integration of materials covered in prior courses. 4 cr.

830. INVESTMENTS ANALYSIS
Security analysis, efficient market hypothesis, portfolio theory, and alternative investments. Prereq: Adm 806; permission. 4 cr.

837-839. ADVANCED FINANCIAL ACCOUNTING I-II
Theory and practice of income measurement and asset valuation; consolidations, partnerships, leases, pensions, price-level reporting, foreign currencies, and fund accounting. Prereq: Adm 815 and 816. 4 cr.

841. SURVEY OF MANAGEMENT SCIENCE
Survey of mathematical aspects of decision making and the use of the computer in the decision-making environment. Development and analysis of basic principles and methods of management science as applied to decision making in the public and private sector. Emphasis is on the methods and techniques that form the basis of management science, mathematical model formulation, real world applications, and computer solution of the model. Prereq: permission of the instructor. 4 cr.

842. TIME SERIES ANALYSIS
Modern techniques for time series analysis. Prereq: Adm 801. 4 cr.

848. LAW: USE AND APPLICATION IN BUSINESS
Use and understanding of law as it applies to business judgement and policy decision making; basic legal rules and their application. Contracts, corporations, agencies, partnerships, administrative agencies, commissions, and other related business matters. Case-method teaching with outside research. 4 cr.

850. MARKETING MANAGEMENT
Practical application of theories taught in marketing. Planning, organization, and control of marketing activities in large corporations and small businesses; new product development; pricing policies; selection of channels of distribution; interrelationships between marketing, production, and finance. Sound policy formulation and decision making established through analysis of cases and computer simulation. Prereq: a basic marketing course. 4 cr.

851. GOVERNMENT REGULATION OF BUSINESS
Government policy as it affects managerial decision making. Conspiracy, monopoly, mergers, unfair practices, discrimination, and recent social legislation. 4 cr.

852. MARKETING RESEARCH
Identification, collection, and analysis of data for the marketing process. Strengths, limitations, environment, and evaluation of research in the marketing process. Prereq: marketing and statistics; permission. 4 cr.

855. ADVANCED BUSINESS FINANCE
Analytical tools and practical skills for recognizing and solving complex problems of business finance.
Working-capital management; capital budgeting; cost of capital; capital structure; dividend policy. Prereq: Admn 806. 4 cr.

860. COMPUTER-BASED CORPORATE PLANNING TECHNIQUES
Computer-based techniques and models for planning: model construction, validation, and evaluation; data collection and analysis; system characteristics; evaluation of alternatives. Student projects required. 4 cr.

895. SPECIAL PROJECTS AND INDEPENDENT STUDY
Projects, research, and reading programs in areas required for concentration. Sixty days advance approval of the student's plan of study by adviser and by proposed instructor required. Maximum of 8 credits, except by special permission. Maximum of 4 credits if Admn 896 has been taken for 8 credits. Variable cr. (May be repeated.)

896. CONSULTING PRACTICUM
Field consulting experience as a member of MBA Associates. Development of client relationships, diagnoses and analyses of actual problems, written and oral reports to clients, and administrative participation in MBA Associates. Prereq: permission. 4 cr. (May be repeated.)

898. TOPICS IN ADMINISTRATION
Special topics; may be repeated. Prereq: consent of adviser and instructor. 1-4 cr.

Chemical Engineering (Ch E)

Chairperson: Stephen S. T. Fan

PROFESSORS: Stephen S. T. Fan; Virendra K. Mathur; Gae D. Ulrich
ASSOCIATE PROFESSORS: Ihab H. Farag; Donald C. Sundberg
ASSISTANT PROFESSORS: Russell T. Carr; Arun V. Someshwar
GRADUATE PROGRAM COORDINATOR: Stephen S. T. Fan

To be admitted to graduate study in chemical engineering, an applicant is expected to have completed a course of study substantially equivalent to that required for the degree of bachelor of science in chemical engineering in this University. However, students with good undergraduate records but with deficiencies in certain areas may be admitted on condition that they complete specified courses without credit to make up for their deficiencies. A minimum of 30 credits, which must include Ch E 813, 815, 816, 823, and 832, is required for the master of science in chemical engineering degree. The core-courses requirement can be waived only in special cases with permission from the department faculty. A candidate for the master of science degree must prepare a thesis, for which a minimum of six credits will be allowed, unless the candidate is specifically exempted by the faculty because of previous research experience. Students interested in graduation deferment beyond the master of science degree should refer to the section entitled Engineering Ph.D. Program. Permission of the instructor and consent of the student's adviser are required for enrollment in all chemical engineering courses.

701. INTRODUCTION TO POLYMER ENGINEERING
Principles of polymer chemistry, polymerization kinetics, polymer rheology, and material characteristics. Design and analysis of polymer reactors, extruders, and other forming operations. Lab. 4 cr.

705. NATURAL AND SYNTHETIC FOSSIL FUELS

712. INTRODUCTION TO NUCLEAR ENGINEERING
Development of nuclear reactors; binding-energy; radioactivity; elements of nuclear reactor theory; engineering problems of heat transfer, fluid flow, and shielding; environmental impacts. 4 cr.

751. PROCESS SIMULATION AND OPTIMIZATION
Techniques for computer-aided analysis of chemical processing systems. Development of mathematical models to describe process behavior. Application of optimization techniques. Prereq: a knowledge of FORTRAN programming. Lab. 4 cr.

752. PROCESS DYNAMICS AND CONTROL
Dynamic behavior of chemical engineering processes described by differential equations; feedback control concepts and techniques; stability and analysis. Lab. 4 cr.

754. GRAPHICAL, NUMERICAL, AND FINITE ELEMENT APPLICATIONS IN CHEMICAL ENGINEERING
Computational methods for solving differential equations resulting from the modeling of a process or physical phenomenon. Graphical display of results of data and of curve-fitted equations. Use of interactive graphics and the solution of boundary-value problems. Applications of finite element analysis and discussion of other software available. Prereq: permission; knowledge of FORTRAN programming. 4 cr.

772. PHYSICOCHEMICAL PROCESSES FOR WATER AND AIR QUALITY CONTROL
Origin and characterization of pollutants. Controls, including filtration, sedimentation, coagulation and flocculation, absorption and adsorption. Applied fluid mechanics, mass transfer, and kinetics. Thermal pollution, chemical treatment, oil spills on water, and aeration. Lab. 4 cr.

804. RADIATIVE HEAT TRANSFER
Heat transmission in high-temperature operations and interaction of radiative and other transport mechanisms; radiation geometry; application of matrix algebra to radiative transfer in enclosures; zoning methods of temperature measurements. Analytical and empirical approximations of engineering use. Quantitative design of several furnaces and high-temperature systems. 3 cr. (Not offered every year.)

813. ADVANCED FLUID MECHANICS
Basic equations describing behavior of static and dynamic fluid systems. The equations of motions and application to laminar and turbulent flow. Mo-
mentum and energy equations for advanced problems associated with flow inside conduits. Flow of compressible fluids and boundary layer phenomena. 3 cr.

814. FLUIDIZATION ENGINEERING
Fluidization regimes, fluid mechanics of particle suspensions, motion of single and multi-bubbles in fluidized beds. Heat and mass transfer and gas-solid reactions in fluidized beds. Applications in design of noncatalytic reactors and heat transfer equipment. 3 cr. (Not offered every year.)

815. HEAT TRANSFER
Steady-state and transient heat conduction in solids; heat convection; analytic solutions, similarity relations, boundary layer methods; radiation. 3 cr.

816. DIFFUSIVE MASS TRANSFER
Physical aspects of diffusion; theories of diffusion in dilute gases, dense gases, liquids, and solids; surface diffusion; mixing processes. Simultaneous heat and mass transfer. 3 cr.

823. ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS
The multicomponent open system; the volumetric and phase behavior of pure substances and of multi-component systems at physical and chemical equilibrium, fugacity and activity; thermal properties of equilibrium, chemically reacting systems; introduction to statistical thermodynamics. 3 cr.

826. DIFFUSION MASS TRANSFER
Simplified applied kinetics problems; catalysis; fast reaction and shock tubes; combustion and detonation processes; nonisothermal kinetics; heat and mass transfer in nonequilibrium, chemically reacting systems. 3 cr.

827. ADVANCED PROCESS DYNAMICS
Process dynamics for higher order processes and nonlinear processes. Modeling of complex process by differential equations, linearizing nonlinear elements, and adequately controlling the entire system. 4 cr. (Not offered every year.)

890. LITERATURE REPORT
Instruction in the use of the library for chemical engineering research, culminating in the preparation of a literature report on a topic of mutual interest to the student and the chemical engineering faculty. 1 cr.

896. GRADUATE INDEPENDENT STUDY
Directed reading or investigation at the advanced level on topics in chemical engineering. 2–4 cr.

898. GRADUATE SEMINAR
Discussion on topics of interest to graduate students and staff; reports of research progress; invited lectures by outside speakers. 0 cr.

899. MASTER'S THESIS
Variable credit; 6 credits required.

999. DOCTORAL RESEARCH

Chemistry (Chem)

Chairperson: Frank L. Pilar

PROFESSORS: Alexander R. Amell; Kenneth K. Andersen; N. Dennis Chasteen; Clarence L. Grant; Colin D. Hubbard; Paul R. Jones; James D. Morrison; Charles W. Owens; Frank L. Pilar; Albert K. Sawyer; W. Rudolf Seitz; James H. Weber

ASSOCIATE PROFESSORS: Gary R. Weisman; Edward Hou Sen Wong

ASSISTANT PROFESSORS: Christopher F. Bauer; Louise H. Foley; Catherine E. Housecroft; Richard P. Johnson; Howard R. Mayne; Sterling A. Tomellini

GRADUATE PROGRAM COORDINATOR: James H. Weber

The Department of Chemistry offers programs leading to three graduate degrees: doctor of philosophy, master of science, and master of science for teachers. Entering graduate students (except for those desiring the M.S.T. degree) are expected to take proficiency examinations in chemistry to assist in starting each new student's graduate work at the proper level. These examinations will be offered at the beginning of each semester on dates announced in the departmental graduate calendar.

The faculty of the chemistry department feels that the experience of teaching is a valuable part of the training of the graduate student. Therefore, all graduate students who are doctor of philosophy or master of science candidates will obtain some teaching experience during their tenure.

Doctor of Philosophy

Admission to this program is based upon superior work in the usual undergraduate courses in inorganic chemistry, analytical chemistry, organic chemistry, and physical chemistry, as well as the normal supporting courses in mathematics and physics. This degree requires the completion of a research problem presented in the form of a thesis.

Ph.D. candidates will be expected to demonstrate proficiency in reading chemical literature in one or two appropriate foreign languages; the analytical and physical divisions require German or Russian, the inorganic division requires German only, and the organic division requires German plus French or Russian. Candidates will also demonstrate to the doctoral committee that they have a broad basic knowledge of the field of chemistry: 1) by completing certain fundamental graduate courses; and 2) by means of a series of examinations in the major field. The principal emphasis of the last two years will be on the research project that will constitute the dissertation. During this time, doctoral candidates will present and defend an original research proposal before the doctoral committee.

Master of Science

Admission to this program is based upon a superior undergraduate average and requires satisfactory work in the usual undergraduate courses in inorganic chemistry, analytical chemistry, organic chemistry, and physical chemistry, as well as the normal supporting courses in mathematics and physics. This degree requires the completion of a research problem presented in the form of a thesis.
Master of Science for Teachers
This program is offered for candidates who hold secondary-school teacher certification in chemistry. This degree requires 30 semester hours in courses approved by the graduate coordinator. Persons interested in this degree should confer with the department’s graduate program coordinator.

Interdisciplinary Programs in Chemistry
Graduate students in chemistry may elect to enter one of the interdisciplinary programs offered jointly with the chemistry department and other departments. In these programs, the graduate student, with the advice of the guidance committee, elects courses in chemistry and in the related disciplines, and writes the dissertation on a research problem appropriate to interdisciplinary treatment. Students interested in these programs should write to the chairperson of the department for further information.

Analytical Chemistry
762. INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS
Theory, instrumentation, and application of methods such as atomic absorption, coulometry, emission spectrometry, gas and liquid chromatography, polarography, potentiometry, IR and UV-VIS absorption spectrophotometry, and mass spectrometry to chemical analysis. Prereq: quantitative analysis; physical chemistry II as a pre- or corequisite; or permission. Coreq: Chem 763. 3 cr.

763. INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS LABORATORY
Experimental parameters, error analysis, and applications of the methods covered in Chem 762. Coreq: Chem 762. 2 cr.

830. ADVANCED OPTICAL METHODS
Techniques of chemical identification and analysis utilizing optical instrumentation from the standpoint of theory and application. Topics include UV-visible absorption, luminescence, atomic spectroscopy, IR, NMR, x-ray methods and mass spectrometry. 3 cr. (Not offered every year.)

831. ADVANCED ELECTRICAL METHODS
Introductory electronics for chemists; theory and applications of important electrochemical techniques such as polarography and cyclic voltammetry. 3 cr. (Not offered every year.)

832. STATISTICS AND EXPERIMENTAL DESIGN
Confidence intervals, analysis of variance, regression analysis, sampling statistics, optimization procedures. Examples drawn primarily from the analytical chemistry literature. 2 cr. (Not offered every year.)

833. CHEMICAL SEPARATIONS
The use of various separation techniques prior to analysis; separations as methods of analysis. 3 cr. (Not offered every year.)

834. CHEMICAL EQUILIBRIA
Formulation and solution of chemical equilibrium problems of relevance to analytical chemistry; calculation of equilibrium constants from experimental data. 2 cr. (Not offered every year.)

Inorganic Chemistry
774. INORGANIC CHEMISTRY
Basic theoretical concepts and their applications to inorganic reactions and compounds. Prereq: organic chem; physical chemistry; or permission. 3 cr.

775. INORGANIC CHEMISTRY LABORATORY
Synthesis and characterization of inorganic compounds with an emphasis on techniques not taught in other laboratory courses. 2 cr.

803. ADVANCED INORGANIC CHEMISTRY I
Survey of some concepts of modern inorganic chemistry, serving as general background material for all graduate students and as basic fundamentals for further courses in inorganic chemistry. 4 cr.

804. ADVANCED INORGANIC CHEMISTRY II
Special topics for the advanced student: transition metal reaction mechanisms; organometallic chemistry. Overview of current trends in inorganic research. 3 cr.

847. ADVANCED INORGANIC CHEMISTRY III
Advanced topics in metal complexes and chemistry of organometallic compounds. Prereq: Chem 803 or permission. 3 cr.

Organic Chemistry
755. ADVANCED ORGANIC CHEMISTRY
Methods of synthesis and determination of structure, including stereochemistry of complex organic compounds. 3 cr.

756. ADVANCED ORGANIC CHEMISTRY LABORATORY
Synthesis and structural determination of complex organic compounds, techniques for the separation, determination of purity, and identification of compounds by spectroscopic and chemical means. 2 cr.

801. THEORETICAL ORGANIC CHEMISTRY I
Discussion of theoretical and experimental methods used in study of reaction mechanisms and molecular stereochemistry. 4 cr.

802. THEORETICAL ORGANIC CHEMISTRY II
A continuation of Chem 801. 3 cr.

811. SYNTHETIC ORGANIC CHEMISTRY I
Advanced synthetic methods for preparing organic molecules. Prereq: permission. 3 cr.

812. SYNTHETIC ORGANIC CHEMISTRY II
A continuation of Chem 811. Prereq: permission. 3 cr.

817. 818. SPECIAL TOPICS IN ORGANIC CHEMISTRY
Specialized courses for the advanced student. Topics may include reaction mechanisms, stereochemistry, spectroscopy, molecular biochemistry, steroids, and organic sulfur compounds. 2 or 3 cr.
PHYSICAL CHEMISTRY

776. PHYSICAL CHEMISTRY III
Quantum theory; spectroscopy; chemical bonding; statistical thermodynamics. Prereq: physical chemistry. Lab. 4 cr.

778. CHEMISTRY OF LARGE MOLECULES
Basic chemistry of high-molecular-weight compounds, including synthetic polymers and substances occurring in living systems. Elementary aspects of the structures, syntheses, and properties of large molecules, and their roles in modern science, technology, and living systems. Prereq: one semester of organic chemistry. 4 cr.

805. ADVANCED PHYSICAL CHEMISTRY I
An introduction to topics in quantum mechanics and group theory, which form the background of all areas of modern chemistry. 4 cr.

806. ADVANCED PHYSICAL CHEMISTRY II
Wave mechanics and quantum chemistry, spectroscopy, molecular structure; statistical thermodynamics, kinetics, and mechanism. Prereq: one year of physical chemistry. 3 cr.

821. PHYSICAL CHEMISTRY—CHEMICAL KINETICS
The kinetics of homogeneous and heterogeneous reactions in gaseous and liquid systems, including an introduction to very rapid reactions. Prereq: one year of physical chemistry. 3 cr.

822. PHYSICAL CHEMISTRY—CHEMICAL THERMODYNAMICS
The foundations and interrelationships of the laws of thermodynamics. The methods by which the theoretical principles may be applied to practical problems. 3 cr.

826. NUCLEAR AND RADIOCHEMISTRY
Nuclear structure and reactions, particle accelerators, radioactive decay, detection of particles, and the interaction of particles with matter. Application of radiochemistry to chemical systems and research. May be offered as a tutorial. 3 cr. (Not offered every year.)

827, 828. THEORETICAL CHEMISTRY I, II
The modern concepts and mathematical formalism of quantum mechanics and applications to electronic structures of atoms and molecules, spectroscopy, and the solid state. May be offered as a tutorial. 3 cr. (Not offered every year.)

829. THEORETICAL CHEMISTRY III
Statistical mechanics with applications to thermodynamics of nonideal systems, intermolecular forces, and chemical kinetics. May be offered as a tutorial. Prereq: permission. 3 cr. (Not offered every year.)

General Offerings
Courses in which all areas of specialization participate.

708. RESEARCH TECHNIQUES
Use of nuclear magnetic resonance, infrared, ultraviolet, and mass spectroscopy in the study and identification of organic molecules. 1-4 cr.

807. INTRODUCTION TO RESEARCH
A course to introduce the Doctor of Philosophy student to the planning, experimental methods, and interpretation of a research problem. Student presents and defends an original research proposal before a faculty committee. Must be completed satisfactorily by all doctoral students. Cannot be used for credit by Master of Science candidates. 2 cr.

895, 896. COLLOQUIUM IN CHEMISTRY
A) Inorganic Chemistry; B) Organic Chemistry; C) Theoretical Organic Chemistry; D) Physical Chemistry; E) Analytical Chemistry. 1-4 cr. Sections of the course may be taken to a total of 12 cr.

897, 898. SEMINAR
Presentation and discussion of recent investigations in chemistry. 1 cr. Cr/F.

899. THESIS—PROBLEMS IN CHEMISTRY
Conferences, library, and experimental work in some field of chemistry. Variable credit; 6 credits required.

999. DOCTORAL RESEARCH

Civil Engineering (Ci E)

Chairperson: David L. Gress

PROFESSORS: Paul L. Bishop; Oris J. Sproul; Tung-Ming Wang
ASSOCIATE PROFESSORS: Pedro A. De Alba; Charles H. Goodspeed; David L. Gress; Louis H. Klotz; Paul J. Ossenbruggen
ASSISTANT PROFESSORS: Thomas P. Ballesteros; Jean Benoit; Robert M. Henry; Nancy E. Kinner

GRADUATE PROGRAM COORDINATOR: Pedro A. De Alba

The Department of Civil Engineering offers the master's degree in civil engineering with the following areas of specialization: structural, materials, and geotechnical engineering; environmental engineering; and ocean and coastal engineering.

A student admitted to graduate study in civil engineering must have completed a baccalaureate degree in engineering, mathematics, or science at an accredited college or university. If coursework or laboratory experience is deficient, the student will be required to fulfill, without graduate credit, all undergraduate prerequisites for graduate courses. In some cases the student's adviser may require additional undergraduate courses in order to achieve a well-integrated program of study.

Each entering graduate student is assigned an academic adviser who will assist the student in planning a program of study. The adviser will also assist the student in selecting a graduate advisory committee normally composed of at least two civil engineering faculty members and one non—civil engineering faculty member. The graduate advisory committee provides guidance to the student in course selection and thesis or project research, and evaluates the student's overall progress.

A student in the master's program has the option of electing either a thesis (minimum of 25 course credits and 6 thesis credits) or nonthesis (minimum of 31 course credits and a zero-credit research project) option. There are no course requirements for
either option; a minimum number of course credits is specified. A candidate electing the thesis option is required to submit a copy of the thesis, prepared in accordance with the Graduate School's Thesis and Dissertation Manual. A formal oral presentation/thesis defense is also required.

A candidate electing the nonthesis option is required to prepare a noncredit project paper and give a final oral presentation/project defense. In addition to the paper, the candidate must pass a departmental comprehensive examination on fundamental engineering concepts prepared and evaluated by the candidate's advisory committee. Project paper preparation guidelines are available in the departmental office.

For graduation, a B average must be achieved. All students are required to register for Civil Engineering Seminar (CI E 800) for a minimum of one semester.

An Engineering Ph.D. Program is also available. For general information, refer to the section entitled Engineering Ph.D. Program. Details of specific requirements for the civil engineering area of specialization are available from the graduate program coordinator.

Areas of Interest
The faculty of the civil engineering department has research interests in the following areas. Students in the M.S. in civil engineering or the Engineering Ph.D. Program may select courses and research topics in these areas.

Environmental Engineering: Recent and current research topics include aquaculture treatment of wastewaters in temperate climates; metal uptake by aquatic plants; treatment of wastewaters from island communities; the microbiology of rotating biological contactors; pathogen survival during composting of municipal wastewater sludges; innovative processes for treatment of metal plating wastes; nutrient cycling in a tidal estuary; removal of radon gas from drinking water supplies; the chemistry of aluminum in drinking water; optimization and dynamic control of the coagulation process in water treatment; regional solid waste management techniques; ocean disposal of wastewater; and the growth and development of biofilms.

Geotechnical Engineering: Currently under way are studies of in-situ stresses and consolidation characteristics of soils, using a self-boring pressuremeter; stress-strain behavior of frozen soils; offshore application of soil acoustics; and bearing capacity of piles under earthquake loading.

Structural/Materials Engineering: Topics of current research include the effect of super water reducers on the properties of concrete, the determination of water-cement ratio by microwave analysis, solidification of hazardous waste materials for structural use, the effects of precast cladding on the dynamic characteristics of frames, the use of network theory for structural optimization, and development of computer graphics software for engineering applications.

Systems Analysis: Examples of recently conducted projects are studies of renewable energy sources to determine the feasibility of wind power and small scale hydroelectric power generation, methods to better control water treatment operations, and risk analysis of decayed trees.

Water Resource Engineering: Studies currently ongoing include flood hazard mitigation, hydraulic physical modeling of river structures, sediment transport phenomena, multiphase use of lakes and ponds, groundwater geochemistry, fate of pollutants, and legal restrictions to water development.

The environmental engineering and water resources areas of specialization in the Department of Civil Engineering offer a joint program on hazardous waste management. The hazardous waste program stresses the latest treatment technologies and theories and concentrates research in new areas that offer promise as practical solutions to detection, monitoring, and disposal problems.

721. PAVEMENT DESIGN
Flexible and rigid pavements and bases for highways, airports, and city streets; pavement selection, construction methods, materials, specifications, and engineering cost estimates. Prereq: soil mechanics. 3 cr.

722. PROPERTIES AND PRODUCTION OF CONCRETE
Basic properties of hydraulic cements and mineral aggregates and their interactions in the properties of plastic and hardened concrete; modifications through admixtures; production handling and placement problems; specifications; quality control and acceptance testing; lightweight, heavyweight, and other special concretes. Prereq: engineering materials or permission. 3 cr.

723. BITUMINOUS MATERIALS AND MIXTURES
Considerations of major types of bituminous materials, asphalt cements, cutback asphalts, asphalt emulsions, and tars; influence of chemical composition on physical properties; desirable aggregate characteristics for bituminous mixtures; construction techniques; current practices for determining optimum asphalt contents. Prereq: engineering materials or permission. 3 cr.

731. NETWORK PLANNING AND SCHEDULING
Application of critical path methods (CPM) and project evaluation review technique (PERT) to the design and control of engineering projects. Lab. 2 cr.

733. SYSTEMS ANALYSIS
Quantitative and economic techniques for optimum allocation of resources in planning and design of engineering systems. Topics include engineering economics, principles of optimization, and statistical decision analysis. Prereq: permission. 3 cr.

734. OPTIMIZATION OF ENGINEERING SYSTEMS
Application of methods to the optimum design of structures, treatment plants, and other large-scale facilities. Topics include linear and nonlinear programming, numerical methods, and linear regression analysis. Prereq: permission. 3 cr.

740. RURAL WASTEWATER ENGINEERING
Methods for collecting and treating wastewater in small communities and rural areas. Biological and physicochemical treatment systems for small communities; land application; soil absorption; gray water treatment; and septic treatment. Prereq: intro environ pollution control. 3 cr.
741. OPEN CHANNEL FLOW
Energy and momentum principles in open channel flow; flow resistance; channel controls and transitions; unsteady open channel flows; convective and dispersive transportation of pollutants; and basic modeling techniques. Prereq: fluid mechanics. 3 cr.

742. HAZARDOUS WASTE MANAGEMENT
A thorough examination of the hazardous waste management problem in terms of the magnitude of the problem, the regulation of hazardous wastes, hazardous waste treatment and disposal technology, siting requirements, and remedial actions required at uncontrolled dump sites. Prereq: water and wastewater engineering. 3 cr.

743. ENVIRONMENTAL SAMPLING AND ANALYSIS
Laboratory exercises in the techniques of water, wastewater, and solid-waste sampling and analysis. Interpretation of results from pollution surveys and operation of pollution control facilities; statistics of sampling and statistical evaluation of analytical data. Prereq: gen chem. Lab. 3 cr.

744. ENVIRONMENTAL LIMNOLOGY
Biological, chemical, and physical processes that occur in lakes and impoundments are explored and interpreted with respect to the cultural activities of humans. Basic concepts of lake origin, morphometric and trophic status, water movement and stratification, nutrient cycling, etc. Current limnologically related problems are explored from the environmental engineering standpoint. Term projects involving laboratory field work and readings in the current scientific literature are required. Lab. 4 cr.

745. ENGINEERING HYDROLOGY
Hydrologic cycle, probability theory related to hydrology and the design of water resources structures, flood discharge prediction, hydrograph development, hydraulic and hydrologic river routing, reservoir routing, theory of storage, reservoir operation, hydropower development, multipurpose projects. Prereq: fluid mechanics or permission. 3 cr.

746. WASTEWATER TREATMENT PLANT DESIGN
Choice of treatment units. Design of the components; preparation of a plan for a particular city that includes a suitable combination of the units previously designed. Prereq: water and wastewater engineering. 3 cr.

747. INTRODUCTION TO MARINE POLLUTION AND CONTROL
Introduction to the sources, effects, and control of pollutants in the marine environment. Dynamic and kinetic modeling; ocean disposal of on-shore wastes, shipboard wastes, solid wastes, dredge spoils, and radioactive wastes; and oil spills. Prereq: water and wastewater engineering or permission. 3 cr.

748. SOLID WASTE MANAGEMENT
Basic methods and theories of solid waste management systems, including collection and disposal methods. Incineration, sanitary landfill design, etc.; resource recovery techniques; hazardous waste management. Prereq: intro environ. pollution control or permission. 3 cr.

749. WATER CHEMISTRY
Application of chemical principles to interpretation of water quality criteria and parameters; use of chemistry in water and wastewater treatment. Theory, applications, and calculations of ionic equilibrium stressed. Acid/base, hydrolysis, complexation, precipitation/dissolution, and redox equilibria; applicability of results and kinetic principles to natural water chemistry. Prereq: general chem or equivalent. 3 cr.

751. TRANSPORTATION PLANNING
Transportation demand forecasting techniques applied to regional and urban situations. Calibration and use of mathematical models for forecasting land use, trip generation, trip distribution, modal choice, and trip assignment. Prereq: probability and/or statistics. 3 cr.

755. DESIGN OF WATER TRANSMISSION SYSTEMS
Pressure, sewer, and open channel system design. Theory developed for individual components to large complex systems. Topics include: closed conduit flow, open channel flow, pressure surge, design of storage, valves and meters, pump selection, system planning and layout, and system operation and maintenance. Prereq: fluid mechanics or permission. 3 cr.

756. WASTEWATER MICROBIOLOGY
Concepts of wastewater treatment microbiology. Topics include taxonomy of wastewater species; cellular chemical composition and ultrastructure of sewage microorganisms; microbial metabolism, interaction, and growth kinetics in wastewater treatment; biogeochemical cycling in polluted water; and effects of environmental parameters on wastewater microbial processes. Laboratory projects will examine these concepts. Prereq: water and wastewater engineering or permission. Lab. 4 cr.

757. COASTAL ENGINEERING AND PROCESSES
Introduction to small amplitude and finite amplitude wave theories. Wave forecasting by significant wave method and wave spectrum method. Coastal processes and shoreline protection. Wave forces and wave structure interaction. Introduction to mathematical and physical modeling. Prereq: fluid dynamics or permission. (Also offered as M E 757 and O E 757.) 3 cr.

763. ADVANCED SOIL MECHANICS I
Current methods of determining soil strength and compressibility. Application to earth pressure, bearing capacity, slope stability, and settlement problems. Prereq: soil mechanics or permission. 3 cr.

765. FOUNDATION ENGINEERING
Subsurface investigation, excavation problems. Selection of foundation type. Design of footings, rafts, pile foundations, bulkhead walls. Prereq: soil mechanics; or permission. 3 cr.

766. GEOLOGICAL ENGINEERING
The influence of geology in the design of foundations, underground excavations, tunnels, dams, and highways. Includes engineering properties of rocks, rock mechanics, and tunneling. Prereq: soil mechanics; principles of geology; or permission. 3 cr.
768. SEEPA GE ANALYSIS AND EARTH DAM DESIGN
Groundwater flow, Darcy's law, flow nets, analytical techniques, Dupuit's theory, confined flow, flow through earth and rock structures, seepage toward wells, and earth dam design. Prereq: fluid mechanics and soil mechanics. 3 cr.

774. REINFORCED CONCRETE DESIGN I
Introduction to the design of reinforced concrete structural members by stress and strength theories and deflection performance. Includes beams, columns and foundations, and construction details of reinforcing. Prereq: structural analysis. 4 cr.

782. TIMBER DESIGN
Properties and characteristics of structural woods, mechanics of wood, connection methods, design of timber members, and connections in beams, columns, and trusses, and glued laminates of wood. Prereq: structural design concepts; permission. 3 cr.

784. STRUCTURAL ANALYSIS BY MATRIX AND NUMERICAL METHODS
Unifying concept of basic structural analysis theories; matrix and numerical methods of analysis, and their application by linear graph concepts using computers. Prereq: indeterminate structures. 3 cr.

785. INTRODUCTION TO STRUCTURAL VIBRATIONS
Dynamic analysis of single- and multi-degree-of-freedom systems. Simple beam and frame structures, Earthquake analysis and design. Co-or prereq: indeterminate structures. 3 cr.

786. FINITE ELEMENT APPLICATIONS FOR SOLID MECHANICS
Introductory course in the use of finite element methods for solution of various solid mechanics problems. Topics include basic matrix theory, direct stiffness method of structural analysis, development of finite element theory and modeling engineering problems with finite element modules. Prereq: intro to computer programming, indeterminate structures, or permission. 3 cr.

791. PRESTRESSED CONCRETE
Design of prestressed and post-tensioned concrete sections in flexure and shear. Prestressing systems and ultimate strength methods will be introduced. Prereq: CIV 793 or permission. 3 cr.

793. STRUCTURAL DESIGN IN STEEL
The design of members and connections: tension and compression members, beams, plate girders; riveted, bolted, and welded joints. Introduction to plastic design of beams and frames. Prereq: structural analysis or permission. 4 cr.

794. REINFORCED CONCRETE DESIGN II
Design of reinforced concrete structural members by strength. Design theory including beams, beam-columns, biaxial columns, and slabs for strength and deformations. Prereq: CIV E 774. 3 cr.

795, 796. INDEPENDENT STUDY
A limited number of qualified graduate students will be permitted to pursue independent studies under faculty guidance.

800. CIVIL ENGINEERING SEMINAR
Topics of interest to graduate students and staff; reports of research ideas, progress, and results; lectures by outside speakers. Continuing course: instructor may assign "IA" grade at the end of one semester. 1 cr.

822. HIGHWAY AND AIRPORT ENGINEERING
Design of flexible and rigid pavements and bases for highways, airports, and city streets; pavement selection, construction methods, materials, specifications, and engineering cost estimates. Prereq: CE E 721. 2-4 cr.

830. ENGINEERING RISK ASSESSMENT
Develops models of engineering problems containing uncertainty, analyzes the effects on system performance, and develops bases for design under conditions of uncertainty. Topics include extreme value models, Monte Carlo simulation, reliability-based design, and risk-benefit analysis. Prereq: probability and statistics for applications or equivalent. 3 cr.

840. HYDROLOGIC MONITORING
Laboratory exercises in the techniques of surface and subsurface hydrologic monitoring. A lecture precedes all labs. Field labs occur in field situations. Measurements include discharge, velocity, and sampling of surface and groundwater followed by interpretation of results. Methodology includes: stream gaging, weirs, dye dilution, miniature piezometers, seepage meters, borehole dilution, sediment bed and suspended load sampling, vadose zone sampling, and well monitoring. Prereq: permission. 2 cr.

842. RIVER MECHANICS
Geomorphic principles, erosion and sediment transport problems, sediment transport mechanics in pipes and open channels, sediment measurement techniques, sediment sources and yields, continental methods, effects of structures on riverine systems, design of hydraulic structures. Prereq: CE E 741 or permission. 3 cr.

843. HAZARDOUS WASTE SAMPLING AND ANALYSIS
Laboratory and field techniques for the sampling and analysis of hazardous waste. Lecture covers theory behind techniques. Prereq: environmental sampling and analysis. Lab. 4 cr.

845. ADVANCED GROUND WATER TOPICS
Review of Darcy's Law for confined and unconfined aquifers, linearization techniques, drawdown computations under varying boundary conditions, discrete kernel approach, drainage theory, recharge theory, two-phase flow, succession of steady states modeling. Finite difference and finite element techniques, contaminant transport mechanics, design of contaminant plume control systems, design of monitoring well fields, and borehole geophysics. Prereq: groundwater hydrology. 3 cr.

849. CHEMISTRY OF NATURAL WATERS
Application of chemical principles to limnology, chemical oceanography, and environmental geochemistry. Standard equilibrium treatment and kinetic constraints and the importance of interfaces: microbial activity and fluid mechanics in the cycling of chemical elements. Prereq: CE E 749 or equivalent. 4 cr.
855. ADVANCED WASTEWATER MICROBIOLOGY
In-depth study in both lecture and laboratory of the flora and fauna of wastewater treatment systems as compared to those found in natural waters. Ecological aspects of suspended and fixed film secondary and tertiary wastewater treatment and biological sludge treatment processes will be examined. Prereq: Ci E 756 or permission. Lab. 4 cr.

856. INDUSTRIAL WASTEWATER TREATMENT
Detailed consideration of the origin, characteristics, and treatment of industrial wastewater; the theory and application of unit operations unique to the treatment and disposal of industrial wastes. Prereq: water and wastewater engineering. 4 cr.

857. ADVANCED PHYSICOCHEMICAL METHODS FOR WATER AND WASTEWATER TREATMENT
The theory, application, and evaluation of physicochemical methods in the treatment of water and wastewater. The unit processes of coagulation, flocculation, sedimentation, filtration, and disinfection will be analyzed at a fundamental level stressing recent advances in environmental kinetics and surface chemistry. Current literature will be critically discussed. Prereq: Ci E 746; 749. 4 cr.

858. ADVANCED WASTEWATER SYSTEMS DESIGN
A formal design to solve a practical problem in wastewater treatment; field data will be gathered, a laboratory-scale unit run, and a design submitted based upon the experimental findings. Prereq: Ci E 746; Ci E 856. Lab. 4 cr.

864. THEORETICAL SOIL MECHANICS
Constitutive laws for soils. Introduction to critical state soil mechanics. Stress analysis in soil mechanics: finite element methods. Prereq: Ci E 763; 786; /or permission. 3 cr.

865. SOIL STABILIZATION AND SITE IMPROVEMENT
Techniques for improving support characteristics of soils for civil engineering structures. Compaction, admixtures, precompression, landfills. Prereq: Ci E 763; Ci E 765; /or permission. 3 cr.

866. SOIL TESTING FOR ENGINEERING PURPOSES
Modern techniques for measuring mechanical properties of soil in the laboratory and in the field. Shear strength, consolidation, liquefaction, and dynamic soil properties testing in the laboratory. Geophysical exploration, penetration testing, and in situ stress measurement. Prereq: Ci E 763 or equivalent. 2–4 cr.

867. SOIL DYNAMICS
Vibrations of elementary systems, wave propagation, elastic waves in layered systems, behavior of dynamically loaded soils, vibrations of foundations, isolation of footings, field measurements and instrumentation, design procedures for dynamically loaded foundations. Prereq: Ci E 763; Ci E 763; /or permission. 3 cr.

868. OFFSHORE GEOTECHNICAL PROBLEMS
Techniques for sampling and testing of marine soils; design of offshore foundations. Stability problems under wave and earthquake loading. Prereq: Ci E 763; Ci E 765; /or permission. 3 cr.

881. ADVANCED STRUCTURAL ANALYSIS I
Advanced structural theory and analysis with computer applications, including multistory structures, beam columns, frames with variable moment of inertia, continuous trusses and bents, arches and curved frames. 4 cr.

882. ADVANCED STRUCTURAL ANALYSIS II
Methods of calculating stresses and deformations in plates and shells used in engineering structures. Bending of circular and rectangular plates. Membrane and flexural analysis of shells of revolution with application in the design of domes, pressure vessel tanks, and shell roofs. 4 cr.

883. STRUCTURAL STABILITY
Study of the elastic and inelastic buckling behavior of structures. Topics include: stability of columns, mathematical treatment of buckling problems and buckling criteria, lateral stability of beams, buckling of trusses and framed structures, and stability of rings and curved beams. 4 cr.

884. DYNAMICS OF STRUCTURES
Analysis of structures subjected to dynamic loadings. Free and forced vibrations with one- and multi-degrees of freedom. Vibrations of curved beams, multistory frames, and plate structures. Prereq: Ci E 785 or permission. 4 cr.

885. APPLICATION OF SYSTEM THEORY TO STRUCTURAL ANALYSIS
Comprehensive development of the stiffness matrix of structures. Intuitive concepts of topology and linear graphs and their application to structural frameworks. Analysis of structures using linear graphs. 4 cr.

890. TOPICS IN STRUCTURES
Studies of topics of special interest and need of the student in structural design, analysis, and optimization. 2–4 cr.

895, 896. CIVIL ENGINEERING PROBLEMS
The study and investigation of problems selected to meet the needs of the students. 2–4 cr.

899. MASTER'S THESIS
6–9 cr.

999. DOCTORAL RESEARCH

Communication Disorders (Comm)

Chairperson: F. Harry Tokay

ASSOCIATE PROFESSORS: Frederick C. Lewis; F. Harry Tokay

ASSISTANT PROFESSORS: Mary A. Records Blount; Stephen N. Calculator

ADJUNCT ASSOCIATE PROFESSOR: Frederick P. Murray

Program Objectives: Students are prepared to function independently as clinicians within the field of communication disorders and to meet the academic and practicum requirements for the Certificate of
Clinical Competence of the American Speech, Language, and Hearing Association in the area of speech pathology.

Admission Procedures: Before considering a graduate application, the Communication Disorders Program must have received: application, transcripts of previous academic work, three letters of recommendation, and the Graduate Record Examination general test or Miller Analogy scores.

Required Courses: The following courses are required of all students: 706, Stuttering; 801, Articulation Disorders; 803, Organic Pathologies in Children; 804, Neuropathologies of Speech and Language; 806, Voice Disorders; 812, Diagnosis and Remediation of Language Disorders; Educ 881, Methods and Techniques of Educational Research.

Electives: The following courses may be taken to supplement required courses to satisfy a minimum of 34 credit hours and to accomplish academic requirements for certification by the American Speech, Language, and Hearing Association: 701, American Sign Language II; 702, American Sign Language III; 704, Basic Audiology; 705, Introduction to Auditory Preception and Aural Rehabilitation; 777, Speech and Hearing Science; 780, Diagnosis of Speech and Language Disorders; 810, Clinical Practicum; 816, Advanced Clinical Audiology; 820, Graduate Seminar; 895, Special Topics in Communication Disorders; 899, Thesis. Students who have not completed 777, Speech and Hearing Science and 780, Diagnosis of Speech and Language Disorders or their equivalent prior to enrolling in the master's program must complete these courses as part of their program requirements.

Clinical Practicum: Up to six credits may be completed in practicum registration. The specific number of credits needed by a student will depend on undergraduate program and experience. Students are scheduled for three hours per week of direct client contact for each credit of practicum registration and will be helped to gain the practicum requirements for certification by the American Speech, Language, and Hearing Association.

Written Examination: All students must pass a written comprehensive examination designed to assess their mastery of the professional concepts of communication disorders in the areas of normative processes, pathologies, and remediation.

Thesis Option: Students may elect the option of writing a thesis. Such students must satisfactorily complete the course in Research Methodology and must present a proposal for acceptance. Upon completion of the research project, students must defend their theses in an oral examination and must gain approval of their theses committees. Six credits will be awarded for satisfactory completion of a thesis.

702. AMERICAN SIGN LANGUAGE III
Emphasis on the advanced linguistic principles of American Sign Language, including idioms, slang, and their place in the communication patterns of the deaf. Improvement of speed and accuracy in receptive and expressive skills for communicating with the deaf. Educational and vocational problems associated with deafness. Prereq: Comm 701; permission. 2 cr.

704. BASIC AUDIOLOGY
Normal hearing process and pathologies of the auditory system. Hearing screening, pure-tone testing, and speech audiometry. Prereq: anatomy and physiology of speech and hearing mechanisms or permission. 4 cr.

705. INTRODUCTION TO AUDITORY PERCEPTION AND AURAL REHABILITATION
Research, testing, and clinical procedures of auditory perception, applied to the communicatively impaired. Prereq: Comm 704; permission. 4 cr.

706. STUTTERING
Theoretical and therapeutic considerations of the stuttering syndrome; emphasis upon clinical management. Prereq: speech pathology II or permission. 4 cr.

777. SPEECH AND HEARING SCIENCE
The physical, acoustical, and perceptual correlates of normal speech production and audition. Will include theoretical models along with the generation, transmission, detection, and analysis of speech signals. 3 cr.

780. DIAGNOSIS OF SPEECH AND LANGUAGE DISORDERS
Principles and practice for diagnosis of speech and language disorders; examination procedures and measurement techniques. Prereq: speech pathology II. 4 cr.

801. ARTICULATION DISORDERS
Phonological theories as they relate to analysis and remediation of articulation disorders. 3 cr.

803. ORGANIC PATHOLOGIES IN CHILDREN
Speech/language disorders associated with neuromotor and oro-facial pathologies in children; etiologies; methods of evaluation and treatment. 3 cr.

804. NEUROPATHOLOGIES OF SPEECH AND LANGUAGE
Principles concerning etiologies, instruments for evaluation, classification, and methods of clinical management including the team approach to rehabilitation of speech and language neuropathologies. 3 cr.

806. VOICE DISORDERS
Types, causes, and characteristics of functional and organic voice disorders. Specific evaluation of deviant vocal characteristics; treatment techniques for children and adults. 3 cr.

810. CLINICAL PRACTICUM
Practicum provides graduate student opportunity to apply advanced theoretical knowledge in clinical setting with speech, language, and hearing-impaired individuals. Diagnostic and therapy experience is supervised. Prereq: permission. (May be repeated up to 6 credits.) 1–6 cr.

Communication Disorders
812. DIAGNOSIS AND REMEDIATION OF LANGUAGE DISORDERS
Current diagnostic procedures and remediation techniques to evaluate and treat language disorders. 3 cr.

814. PEDIATRIC AUDIOLOGY
Auditory disorders in children, comprehensive diagnostic evaluations, current state of the art in hearing aids and amplification for children, and theoretical and clinical habilitation/rehabilitation of hearing-impaired children. 3 cr.

816. ADVANCED CLINICAL AUDIOLOGY
Advanced clinical testing for identification of organic and nonorganic hearing disorders; instrumentation and calibration procedures; ISO and ANSI standards. 3 cr.

820. GRADUATE SEMINAR
Current topics, recent investigations, and library research. (May be repeated up to 9 credits barring duplication of subject matter.) 3 cr.

895. SPECIAL TOPICS IN COMMUNICATION DISORDERS
Advanced study in specific areas; will involve an independent project. Prereq: permission. (May be repeated.) 1-3 cr.

899. MASTER’S THESIS
Prereq: permission. 6 cr.

Computer Science (C S)
Chairperson: R. Daniel Bergeron
PROFESSOR: Shan S. Kuo
ASSOCIATE PROFESSORS: R. Daniel Bergeron; Eugene C. Freuder; Robert D. Russell; James L. Weiner
ASSISTANT PROFESSORS: Helen M. Gigley; Michael J. Quinn
ADJUNCT ASSISTANT PROFESSOR: Sylvia Weber Russell
GRADUATE PROGRAM COORDINATOR: R. Daniel Bergeron

Master of Science
Admission Requirements: High-level language programming, assembler language programming, data structures, operating system fundamentals, and programming language concepts. Further experience in computer science, mathematics, and/or electrical engineering will also be expected. All applicants must submit general test scores from the Graduate Record Examination. The subject test in computer science is recommended.

Degree Requirements: The student may choose to follow a depth-oriented program with a thesis or a breadth-oriented program without a thesis. Both options require the completion of C S 801-802 and C S 800 (a one-credit graduate seminar). The thesis option requires six additional courses numbered 700 or above (three must be above 802), plus six credits of thesis work. The nonthesis option requires eight additional courses numbered 700 or above (four must be above 802), plus comprehensive examinations covering the two broad areas: systems and theory.

A maximum of three courses numbered 700 to 799 may be applied to the master of science degree in computer science.

710. ADVANCED SYSTEMS PROGRAMMING
Topics in systems programming, including organization and implementation of assemblers, linkage editors, job schedulers, command language decoders. File systems, protection, security, performance evaluation, and measurement. Prereq: operating system fundamentals and assembler-language programming. 4 cr.

712. COMPILER DESIGN
Formal languages and formal techniques for syntax analysis and parsing; organization of the compiler and its data structures; problems presented by error recovery and code generation. Classical top-down and bottom-up techniques currently in widespread use, general discussion of LL(k) and LR(k) parsers; automatic methods of compiler generation and compiler compilers. Students required to define a simple, nontrivial programming language and to design and implement its compiler. Prereq: prog lang concepts and features. 4 cr.

713. COMPUTER GRAPHICS
Input-output and representation of pictures from hardware and software points of view; interactive techniques and their applications; development of an interactive graphics system. Prereq: data structures and processes; operating system fundamentals; /or permission. 4 cr.

714. INTRODUCTION TO PROGRAMMING SEMANTICS
Informal, nonmathematical introduction to descriptive techniques of denotational semantics. Provides framework needed to describe formally programming languages such as PASCAL. No previous knowledge of the theory of computation or of any particular programming language is assumed. Prereq: prog lang concepts and features or permission. 4 cr.

715. INTRODUCTION TO ARTIFICIAL INTELLIGENCE
Machine intelligence, representation and control issues, search methods, problem solving, learning computer vision, natural language understanding, knowledge engineering, game playing. Heuristic programming and the LISP language. Prereq: prog lang concepts and features. 4 cr.

716. DATA BASE TECHNIQUES
Data base analysis and design. Hierarchic, network, and relational models. Data normalization, data manipulation tools, data description languages, query functions and facilities, design and translation strategies, file and index organizations, data integrity and reliability, data security techniques, distributed database systems, actual usage of selected DBMS on computers. Prereq: data structures and processes. 4 cr.

753. NUMERICAL METHODS AND COMPUTERS I
Use of scientific subroutine and plotter routine packages, floating point arithmetic, polynomial and cubic spline interpolation, implementation problems for linear and nonlinear equations, random numbers and Monte Carlo method, Romberg’s method, optimization techniques. Selected algorithms will be programmed for computer solution. Prereq: calculus II; intro programming and FORTRAN. (Also offered as Math 753.) 4 cr.
754. NUMERICAL METHODS AND COMPUTERS II
Mathematical software. Computer solutions of differential equations, eigenvalues and eigenvectors. Prereq: diff equations with linear alg; intro programming and FORTRAN. (Also offered as Math 754.) 4 cr.

758. ANALYSIS OF ALGORITHMS
Introduction to use of basic mathematics in design and analysis of computer algorithms. Topics include O-notation, divide and conquer, the greedy method, dynamic programming, and NP-completeness. Prereq: mathematical proof; data structures and processes. 4 cr.

762. INTRODUCTION TO NATURAL LANGUAGE PROCESSING
Introduction to the problem of natural language processing as viewed within the disciplines of artificial intelligence, linguistics, psycholinguistics, psychology, and neuroscience. Topics covered include: comprehension, production, and acquisition of language; neurological aspects of language performance. Prereq: C S 715 or permission. 4 cr.

790. TOPICS IN COMPUTER SCIENCE
Offered on an irregular basis with varying content. 4 cr.

The following are the basic courses for the master of science degree in computer science.

800. GRADUATE SEMINAR
Regularly scheduled seminars presented by outside speakers, UNH faculty, and graduate students. Topics include reports of research ideas, progress, and results. 1 cr. Cr/F.

801. FUNDAMENTALS OF COMPUTER SCIENCE PRACTICE
Fundamental elements of computer science practice, including elements of data structures, algorithms, verification, formal languages, programming languages, automata theory, and some finite mathematics. Emphasis on the interaction between theory and practice. Required of all entering graduate students; coreq: C S 802. 3 cr.

802. FUNDAMENTALS OF COMPUTER SCIENCE THEORY
Fundamental elements of computer science theory, including elements of data structures, algorithms, verification, formal languages, programming languages, automata theory, and some finite mathematics. Required of all entering graduate students; coreq: C S 801. 3 cr.

842. PARALLEL COMPUTERS AND COMPUTATIONS

851. DATA BASE SYSTEMS
Access control techniques; access strategies; data base software; data base related languages; data transformation techniques; recovery and restart; restructuring; concurrent access methods; very large data bases; performance and evaluation; protection and security. Prereq: C S 710 or permission. 3 cr.

852. SOFTWARE ENGINEERING
Design approaches, implementation methodologies, and management techniques required to develop large, reliable software systems including applications-oriented systems. Team programming projects. Prereq: C S 710 or permission. 3 cr.

853. ARTIFICIAL INTELLIGENCE
Current approaches to machine intelligence and the simulation of human cognitive processes, including an introduction to recursive functions and programming with the LISP language. Heuristic programming, programs for game playing and natural language understanding, elementary theory of computability. Individual computer project required. Prereq: programming experience. (Also offered as E E 853.) 3 cr.

854. AUTOMATA THEORY
Formal language and theoretical "machines" or automata. Formal grammars; context-dependent, context-free, and regular languages; finite state machines and regular expression recognizers; infinite state machines; Turing machines; unsolvable problems and the halting problem; linear-bounded and push-down automata; cellular and reproducing automata. Prereq: programming experience. (Also offered as E E 854.) 3 cr.

855. OPERATING SYSTEMS TECHNIQUES
Theoretical aspects of operating systems. Scheduling and resource allocation; deadlock; paging and segmentation; thrashing; synchronization; interprocess communication; cooperating sequential processes; protection and security; in-depth study of a complex system such as MULTICS. Prereq: C S 710 or equivalent. 3 cr.

856. COMPUTER NETWORKS
Distributed computer systems; techniques for connecting and controlling them. Tightly coupled systems and loosely coupled systems. Design, capabilities, and problems associated with different types of connections. Organizational possibilities for networks. Queuing theory applied to computer networks. Modeling and performance evaluation in distributed systems. Case studies of existing networks such as ARPANET. Prereq: E E 712 or equivalent; C S 710. 3 cr.

857. COMPUTATIONAL LINGUISTICS
Computational approach to the study of language. Problems in understanding and producing natural (or natural-like) language by computer and humans. Theories of parsing, meaning, knowledge representation, and communication, along with their mechanical embodiments will be studied and compared. Prereq: permission. 3 cr.

The following special topics courses are offered on an irregular basis with varying content. Students may repeat these courses with the instructor's permission.

881. ADVANCED TOPICS IN DATABASE SYSTEMS
3 cr.

883. ADVANCED TOPICS IN ARTIFICIAL INTELLIGENCE
3 cr.

884. ADVANCED TOPICS IN COMPUTER SCIENCE THEORY
3 cr.
Advanced Topics in Operating Systems
3 cr.

Advanced Topics in Computational Linguistics
3 cr.

Advanced Topics in Computer Graphics
3 cr.

Advanced Topics in Computer Science
3 cr.

Reading Course
1–6 cr.

Master's Thesis
6 cr.

Earth Sciences (ESci)

Chairperson: Herbert Tischler

Professor: Franz E. Anderson; Francis S. Birch; Wallace A. Bothner; S. Lawrence Dingman; Henri E. Gaudette; Francis R. Hall; Paul A. Mayewski; Cecil J. Schnee; Herbert Tischler

Associate Professor: Wendell S. Brown; Jo Laird; Theodore C. Loder III; William Berry Lyons

Assistant Professor: David A. Gust

Adjunct Professor: Robert J. Davis; Lincoln R. Page

Research Associate Professor: James D. Irish

Research Assistant Professor: Mark E. Hines

Graduate Program Coordinator: Francis S. Birch

The Department of Earth Sciences offers graduate work leading to the doctor of philosophy and master of science degrees in earth sciences, with options in either geology, oceanography, and a master of science degree in hydrology.

Admission Requirements

1) Students are expected to have completed at least one year of college chemistry, physics, and calculus;
2) Students with an undergraduate equivalent to a major in geology, chemistry, physics, mathematics, engineering, or the biological sciences will be considered;
3) All applicants must submit scores from the general test of the Graduate Record Examination. Students lacking some background in a particular area may be admitted provided they are prepared to complete courses, without graduate credit, in which they may be deficient.

The program (geology, hydrology, or oceanography) a student wishes to follow will determine the level of necessary preparation. For instance, a student with an undergraduate major in physics who wishes to change direction to marine geology would have a number of deficiencies in geology to complete besides completing the core curriculum in oceanography. However, if that student wishes to pursue a program stressing physical oceanography, fewer deficiencies would probably have to be completed. The preparation of each student will be determined prior to the beginning of the first semester in residence in order to plan the course of study.

General Degree Requirements

Students in both the M.S. and Ph.D. programs are required to complete the core curriculum for their respective area.

The core curriculum for both programs in oceanography normally includes: ESci 732, Geologic Mapping and Interpretation, 4 cr.; ESci 734, Applied Geophysics, 4 cr.; ESci 741, Geochemistry, 4 cr.; ESci 897, 898, Seminar in Earth Sciences, 1 cr. each semester of the first year.

Additional courses are to be selected from 700- or 800-level courses in the department and/or from courses numbered 600 or above in disciplines outside of the department (chemistry, engineering, physics, mathematics, etc.).

Hydrology: This program is intended for students with an interest in hydrogeology, water quality, quantitative hydrology, and water resources management.

The core curriculum for the major in hydrology usually includes: ESci 705, Principles of Hydrology, 4 cr.; ESci 710, Groundwater Hydrology, 4 cr.; ESci 732, Geologic Mapping and Interpretation, 4 cr.; ESci 897, 898, Seminar in Earth Sciences, 1 cr. each semester of the first year.

Additional courses are to be selected from 700- and 800-level courses in the department and/or from courses numbered 600 and above in disciplines outside of the department (chemistry, engineering, physics, mathematics, forest resources, etc.).

Oceanography: This option is designed for students who wish to specialize in chemical, geological, or physical oceanography. Although the broad scope of oceanography will be presented, the emphasis in the program will be placed on estuarine, coastal, and continental shelf processes and environments.

The core curriculum for the major in oceanography normally includes: ESci 752, Chemical Oceanography, 3 or 4 cr.; ESci 758, Introduction to Physical Oceanography, 3 or 4 cr.; ESci 759, Geological Oceanography, 4 cr.; ESci 897, 898, Seminar in Earth Sciences, 1 cr. taken each semester of the first year.

Additional courses are to be selected from 700- or 800-level courses in the department and/or from courses numbered 600 or above in disciplines outside of the department (chemistry, engineering, physics, mathematics, etc.).
Specific Requirements for the Master of Science

In addition to any deficiencies, students must satisfactorily complete a minimum of 30 credits, which may include the 14 credits accumulated in the core curriculum. Eight credits (not including 899) must be taken at the 800 level. Students must complete a master's thesis and give an oral presentation of the results. All students are required to participate in the instructional activities of the department.

Specific Requirements for the Doctor of Philosophy

1) reading knowledge of an appropriate foreign language; 2) passing a qualifying examination, generally after two years of study; 3) teaching experience, including basic equations, properties of water, movement of water in natural environments, formation of precipitation, relations between precipitation and streamflow, snow-melt, evapotranspiration, interception, infiltration, relations between groundwater and streamflow, and hydrologic systems of water quality. Problems of measurement and aspects of statistical treatment of hydrologic data. Transportation fee. Prereq: one year each of calculus and physics. Lab and field exercises. 4 cr.

705. PRINCIPLES OF HYDROLOGY
Physical principles important in the hydrologic cycle, alluvial channel form, computation of flow profiles, weirs, hydraulic jumps, complete equations for streamflow routing. Principles of porous-media flows; Darcy's law; soil physics; complete equations for ground-water and soil-water flow. Prereq: one year each of calculus and physics. Lab and field exercises. 4 cr.

710. GROUNDWATER HYDROLOGY
Principles for fluid flow in porous media with emphasis on occurrence, location, and development of groundwater, but with consideration of groundwater as a transporting medium. Major topics include well hydraulics, regional groundwater flow, exploration techniques, and chemical quality. Laboratory exercises involve use of fluid, electrical, and digital computer models to illustrate key concepts. Prereq: ES 705 or permission. Lab. 4 cr.

725. IGNEOUS AND METAMORPHIC PETROLOGY
The origin, formation, and geologic history of igneous and metamorphic rocks as determined from field and laboratory studies of occurrences, mineral assemblages, rock composition, and texture. Interpretation of rock and mineral compositional diagrams; application of experimental investigations. Prereq: mineralogy and petrography. Field trips. Lab. 4 cr.

732. GEOLOGIC MAPPING AND INTERPRETATION
Standard methods of geologic field mapping; interpretation of geologic maps and aerial photographs of selected areas. Course includes several one-day and long-weekend field mapping excursions to selected areas in northeastern United States. Lab fee includes transportation and housing in the field. Prereq: structural geology or permission. Lab. 4 cr.

734. APPLIED GEOPHYSICS
Gravity, magnetic, seismic, electrical, and thermal methods of investigating subsurface geology. Fieldwork and use of computers in data analysis. Prereq: one year of calculus; intro geol; one year of college physics; /or permission. Lab. 4 cr.

741. GECHEMISTRY
Thermodynamics applied to geologic processes; geochemical differentiation of the earth; the principles and processes that control the distribution and migration of elements in geological environments; stable and radiogenic isotopes in geologic processes. 4 cr.

752. CHEMICAL OCEANOGRAPHY
Water structure, chemical composition and equilibrium models; gas exchange; biological effects on chemistry; trace metals and analytical methods. Laboratory includes short cruise abroad RV Jere A. Chase. Prereq: permission. Lab (optional). 3 or 4 cr.

754. MODERN SEDIMENTS
Modern sediments from a process-oriented viewpoint. Emphasis on shallow-water modern marine sediments, including shelf, beach, and estuarine deposits. Animal/sediment interactions will be considered. The laboratory investigates applied techniques in modern sediment analysis. Prereq: intro to geology or oceanography or permission. 4 cr.

758. INTRODUCTION TO PHYSICAL OCEANOGRAPHY
Ocean basins; physical properties of seawater; atmosphere-ocean interaction; general ocean circulation; waves and tides; continental shelf and near-shore processes; instrumentation and methods used in ocean research. Simplified physical and mathematical models demonstrate the important concepts. Prereq: one year of calculus and college physics; intro oceanog; /or permission. Variable credit: 3 cr. without lab; 4 cr. with optional lab and field project.

759. GEOLOGICAL OCEANOGRAPHY
Major geological features and processes of the ocean floor; geological and geophysical methods; plate tectonics. Prereq: permission. 4 cr.

762. GLACIAL GEOLOGY
The glacial environment: glacier dynamics and glacial erosion and deposition. Review of world glacial stratigraphy in light of causes of glaciation and climatic change. Field trips. Prereq: intro geol; geomorphology; /or permission. Lab. 4 cr.

763. GLACIER RESEARCH
Glaciers as proxy indicators of climatic change with specific emphasis on the interpretation of physical and chemical time series collected from glaciers. Field and laboratory work will be used as a tool in
the course. Prereq: geomorphology; glacial geology; one year of college calculus; one semester each of college physics and chemistry; /or permission. 4 cr.

771. MINERAL DEPOSITS
Introduction to the processes of formation, geological characteristics, and environments of deposition of metallic mineral deposits, and a brief survey of the unique nature and importance of the mineral industries. Prereq: structural geology, petrography. 4 cr.

795. TOPICS IN EARTH SCIENCES
A) Tectonics; B) Geochemistry; C) Geomorphology, Advanced; D) Geophysics; E) Glacial Geology, Advanced; F) Groundwater Geology; G) Historical Geology, Advanced; H) Hydrology; I) Micropaleontology; J) Water Resource Management; K) Mineralogy, Advanced; L) Optical Crystallography; M) Ore Deposits; N) Paleontology, Advanced; O) Petrology, Advanced; P) Regional Geology; Q) Sedimentation; R) Stratigraphy; S) Structural Geology, Advanced; T) Marine Geology; U) Physical Oceanography; V) History of Geology; W) Earth Science Teaching Methods; X) Senior Synthesis; Y) Chemical Oceanography; Z) Glaciology, Advanced; AA) Thermodynamics in Geology. Special problems by means of conferences, assigned readings, and field or laboratory work, fitted to individual needs from one of the areas listed above. 1–4 cr.

803. ADVANCED HYDROLOGY
Application of quantitative methods to selected hydrologic problems. Critical examination of deterministic and stochastic models, with emphasis on conceptualizing the hydrologic problem, developing appropriate models, obtaining solutions, and evaluating models and solutions in terms of basic assumptions, data requirements, and verification of results. Prereq: ESci 705; computer methods; basic statistics. 3 cr.

804. WATER QUALITY CONCEPTS AND MODELING
Principles of chemical transport in fresh water and experience in modeling selected systems. Combination of literature review and application of existing models. Topics include the movement of: phosphorus in lakes, oxygen and dyes in streams, and selected substances in ground water. Term project to be selected and implemented by each student. Prereq: physical chemistry; geochemistry, or soil chemistry or equivalent; computer methods; hydrology or limnology; /or permission. 3 cr.

808. WATER RESOURCE MANAGEMENT
Hydrologic and statistical aspects of water resource management; nature of water resource problems and application of models in their solution; geographical aspects of water-resource problems in the U.S.; economic, social, institutional, and environmental aspects of water resource problems. Prereq: ESci 705; basic statistics; /or permission. 4 cr.

820. ADVANCED IGNEOUS PETROLOGY
Extensive readings and discussions of original sources and recent literature with reference to classical petrologic provinces. Application of thermodynamics and phase-rule chemistry to igneous petrogenesis. Prereq: permission. 3 cr. (Not offered every year.)

821. ADVANCED METAMORPHIC PETROLOGY
Extensive readings and discussions of original sources and recent literature dealing with the facies concept, equilibrium reactions, reaction kinetics, and other chemical aspects of metamorphic petrogenesis. Prereq: permission. 3 cr. (Not offered every year.)

834. ADVANCED APPLIED GEOPHYSICS
Exploration methods including gravity, magnetics, heat flow and seismics at an advanced level. Modern methods of interpretation as well as basic physics and geological applications. Prereq: ESci 734; elementary computer programming; differential equations recommended. 3 cr. (Not offered every year.)

841. ANALYTICAL GEOCHEMISTRY
Introduction to the theory, instrumentation, and applications of analytical methods in geochemistry. Prereq: permission. 3 cr. (Not offered every year.)

842. SEDIMENTARY GEOCHEMISTRY
Chemistry of recent and ancient estuarine, marine, and lacustrine sediments, emphasizing both kinetic and thermodynamic principles in the understanding of biogeochemical processes, authigenic mineral formation, and pore water chemistry in these environments. 3 cr. (Offered alternate years.)

843. THERMODYNAMICS IN GEOLOGY
An application of classical thermodynamics to geologic systems, emphasizing the relationships of heat, work, energy, entropy, and free energy. Prereq: one year of calculus, chemistry, and physics; adequate background in geology. 3 cr. (Offered alternate years.)

845. ISOTOPE GEOLOGY
Discussion of element abundance and isotope formation; radioactive decay as applied to geologic systems, detailed investigation of K-Ar, Rb-Sr, U-Pb and Sm-Nd systems, and geologic-oceanographic applications of stable isotopes. Laboratory involves mass spectrometric and chemical techniques of isotopic analysis. Course includes the completion of a laboratory project. 4 cr.

852. ADVANCED CHEMICAL OCEANOGRAPHY
Readings on physical, chemical, and biological processes that affect the distribution of chemical components in estuaries and the open ocean. Laboratory includes projects investigating selected processes. Prereq: ESci 752; /or permission. 3 or 4 cr.

856. ESTUARINE SEDIMENTATION
Sedimentary processes occurring in an estuarine environment; emphasis on fine-grained sediment transport, erosion, and deposition; factors affecting particulate matter transport and animal/sediment relations. Laboratory includes team field projects directed by graduate students. Prereq: ESci 754 or permission. Lab. 4 cr.

858. DYNAMICAL OCEANOGRAPHY
The hydrodynamics of such ocean phenomena as waves, tides, and ocean turbulence; wind-driven circulation on the continental shelf and deep ocean will be treated in detail. Prereq. ESci 758; M E 707; /or permission. 4 cr. (Not offered every year.)
859. DATA ANALYSIS METHODS IN OCEAN AND EARTH SCIENCES
Method of analysis of oceanographic, geophysical, geological, and environmental data. An introductory tutorial on important mathematical concepts precedes the development of the bases for a number of data analysis techniques; digital filtering, regression analysis, cross-spectral analysis, objective analysis, and elementary inverse theory, etc. Students use these techniques on real data. Prereq: differential equations or equivalent. 3 cr.

862. GLACIOLOGY
Physical principles controlling glacier activity and the implications of glacier activity in the context of current scientific problems. Prereq: geomorphology, glacial geology, one year of college calculus, one semester each of college physics and chemistry/or permission. Lab and/or field project optional. 3—4 cr. (Offered alternate years.)

895. TOPICS IN EARTH SCIENCES
Advanced work on an individual or group basis under members of the graduate staff. Sections of this course are the same as those listed under ESc 795. Prereq: permission of department chairperson and staff concerned. 1—4 cr. (May be taken more than once.)

897, 898. SEMINAR IN EARTH SCIENCES
A review and discussion of recent literature in the earth sciences. Required of graduate students in earth sciences. 1—3 cr.

899. MASTER’S THESIS
6 cr.

999. DOCTORAL RESEARCH

Economics (Econ)

Program Director: Richard L. Mills

PROFESSORS: Robert F. Barlow; Manley R. Irwin; Robert C. Puth; Kenneth J. Rothwell; Dwayne E. Wrightsman
ASSOCIATE PROFESSORS: Richard W. England; Marc W. Herold; Richard W. Hurst; Richard L. Mills; Marilyn B. Power; Evangelos O. Simos; Allen R. Thompson
ASSISTANT PROFESSORS: Adrienne M. McElwain; James R. Wible

The economics faculty of the Whittemore School of Business and Economics, together with the resource economics faculty, offers a program leading to the degree of doctor of philosophy. In addition, the economics faculty offers a plan of study culminating in the degree of master of arts.

Admission to both programs is open to students whose undergraduate work shows evidence of superior ability and motivation and who manifest promise of serious scholarship. Normally, the appropriate undergraduate preparation will include exposure to economic reasoning and methodology, including mathematics and statistics. Those who warrant special consideration, even though their backgrounds are deficient, should be aware that remedial work may be required.

Admission requirements in addition to those established by the Graduate School include the Graduate Record Examinations (general and subject test in economics).

Doctor of Philosophy

Ph.D. candidacy requires written evidence of proficiency in economic theory, the history of economic thought and methodology, and quantitative methods, as well as successful completion of two advanced courses and two research workshops (4 credits each) and demonstrated knowledge of one foreign language. At present, workshops exist in finance, political economy, labor economics, econometrics, international development, resource economics, and macroeconomics.

Information about fields available for the dissertation, as well as other details of the doctoral program, may be obtained from the program director.

Master of Arts

The candidate for a master’s degree may take a general course of study or the thesis option. The general requirements of the Graduate School and the following major requirements must be met:
1) 32 semester hours of graduate study, which may include 8 hours of thesis work;
2) Minimum of 24 semester hours in courses numbered 700 and above and at least 12 hours in courses numbered 800 and above apart from Econ 899, Master’s Thesis;
3) Maximum of 8 semester hours in approved courses numbered 600 (4 credit maximum) and above taken in related disciplines;
4) Written evidence of proficiency in economic theory;
5) Successful completion of an 800-level course in areas of history of economic thought and quantitative economics.

711. ECONOMIC FLUCTUATIONS

Recurrent movements of prosperity and depression; emphasis on causes and public-policy implications. Prereq: intermediate macro or permission. 4 cr.

715. MARXIAN ECONOMIC ANALYSIS

Marx’s analysis of capitalism within the classical and radical tradition; methodology; organization of capital; labor theory of value; accumulation of capital; growth and distribution; economic crises. Critical evaluation of Marx’s analysis. Prereq: intermediate micro and intermediate macro; or permission. 4 cr.

720. U.S. ECONOMIC HISTORY

From colonial times to the present. Applied economic theory; economic models and interpretation of data. Influence of technology, industrialization, foreign trade, monetary factors, and government; noneconomic factors. Prereq: intermediate micro and macro; or permission. 4 cr.

727. ADVANCED ECONOMETRICS

Relatively advanced econometric techniques such as simultaneous equation models, distributed lag models, nonlinear estimation, and limited dependent variables. Prereq: introduction to quantitative economics or Econ 826 or permission. 4 cr.

735. ECONOMICS OF FINANCIAL MARKETS

Economic analysis of financial market systems. Topics include financial market functions, theories of saving and investment, financial intermediation, flow-of-funds analysis, loanable funds theory, interest rate forecasting, portfolio theory, capital asset pricing models, structure of interest rates (in-
768. SEMINAR IN ECONOMIC DEVELOPMENT
An advanced reading seminar. Topics include: Methodologies underlying economic development theory; industrialization and post-import substitution, state capitalist development, stabilization policies, appropriate technologies, the capital goods sector, agricultural modernization schemes, and attempts at transition to socialism. Prereq: permission. 4 cr.

769. CASE STUDIES IN ECONOMIC DEVELOPMENT
A) Southeast Asia; B) Cost-Benefit and Project Analysis; C) Africa; D) Latin America; E) Middle East. Problems and policies in selected countries; evaluations of national plans, programs, and projects; comparative analysis. Prereq: prin of econ or permission. 4 cr.

798. ECONOMIC PROBLEMS
Special topics; may be repeated. Prereq: permission of adviser and instructor. 2 or 4 cr.

825. MATHEMATICAL ECONOMICS
Principal mathematical techniques and their application in economics. Topics covered: matrix algebra, derivatives, unconstrained and constrained optimization, linear and nonlinear programming, game theory, elements of integral calculus. 4 cr.

826. EMPIRICAL ECONOMIC METHODS
Application of statistical and econometric methods to problems in economics. Topics: ordinary least squares, hypothesis testing, problems involved in regression analysis, extensions of the general linear model. Prereq: undergraduate statistics course. 4 cr.

857-858. HISTORY OF ECONOMIC THOUGHT
Development of economic thought, with emphasis on different methodological approaches and the development of theories of value and income distribution. Focus on major economic thinkers of the 18th through 20th centuries, including Smith, Ricardo, Marx, neo-classical economists, Keynes, Dobb, and Sraffa. 4 cr.

873. MACROECONOMIC THEORY
Advanced analysis of such aggregates as national income, total output, employment, and the general price level. Examination of the major aggregate models. 4 cr.

874. ECONOMIC DYNAMICS
Dynamic analysis of macro- and microeconomic models. Dynamic stability, disequilibrium dynamics, growth theory, and stochastic processes. Prereq: Econ 825, 873, and 877; or equivalent. 4 cr.

877. MICROECONOMIC THEORY
Topics in microeconomics with emphasis on recent developments in such areas as general equilibrium analysis, welfare economics, demand and production theory, and capital theory. 4 cr.

878. ECONOMICS OF CENTRALIZED AND MIXED SYSTEMS
Origins of planning; planning agriculture and industry; growth models; input-output and material balances; optimal planning; value and prices in socialist economies; economic reforms and mixed...
systems; theories about nature of socialist societies. Mechanisms of centralized planning in their socio-
historical context. Prereq: Econ 873; Econ 877; /or permission. 4 cr.

895. INDEPENDENT STUDY
1–6 cr.

896. RESEARCH WORKSHOP
A) Finance; B) Political Economy; C) Labor Economics; D) Econometrics; E) Resource Economics; F) International Development; G) Macroeconomics. 2 cr. Cr/F.

899. MASTER'S THESIS
8 cr.

999. DOCTORAL RESEARCH

Education (Educ)

Chairperson: Roland B. Kimball

PROFESSORS: Michael D. Andrew; Angelo V. Boy; Donald H. Graves; Richard H. Hersh; Roland B. Kimball; Carleton P. Mengel.

ASSOCIATE PROFESSORS: Richard F. Antonak; Charles H. Ashley; John J. Carney; John G. Chalas; Ellen P. Corcoran; Ann L. Diller; David D. Draves; Edward J. Durnall; Susan D. Franzosa; Jane A. Hansen; David J. Hebert; Bruce L. Mallory; Sharon N. Oja; M. Daniel Smith; Deborah E. Stone; Dwight Webb; Mary Bowes Winslow.

ASSISTANT PROFESSORS: Janet Elizabeth Butcher; Grant L. Gioffi; Richard L. Schwab.

ADJUNCT PROFESSOR: Donald D. Durrell.

ADJUNCT ASSOCIATE PROFESSOR: Richard H. Goodman.

GRADUATE PROGRAM COORDINATOR: David D. Draves.

The Department of Education offers a variety of programs leading to the master's degree, the doctor of philosophy degree, and the certification of advanced graduate study.

Admission Requirements

The Department of Education welcomes applications from individuals qualified to undertake graduate study.

In addition to the materials required by the Graduate School, each application must include: (1) transcript for all undergraduate and graduate study; (2) at least three letters of recommendation from persons who can provide first-hand assessment of the candidate's performance in college-level courses, interpersonal strengths and weaknesses, and, when applicable, experience in positions related to the degree program to which application is made; (3) recent Graduate Record Examination general test scores; and (4) a thoughtful, well-written statement of purpose for undertaking graduate study.

Applicants for the doctoral program must also submit a writing sample. Applicants to the doctoral program will normally have completed a master's degree in education, English, or psychology and will have had full-time teaching experience in some setting. Individuals of exceptional promise who do not meet the degree and experience criteria may be considered for admission in the doctoral program.

Consultation with a program faculty member is recommended. In all cases, the applicant's relevant experience, references, and professional goals will be considered in the admission process.

Applications to all education department programs are acted on three times per year following Graduate School application deadlines with the following exceptions: applications for full-time study in the counseling M.Ed. and M.A. programs as well as the Ph.D. program in reading/writing instruction are acted on only in April; applications for part-time study in counseling are acted on only in December and April.

Master's Degree Programs

Graduate programs leading to the master's degree are offered in: counseling, developmental disabilities, early childhood education, educational administration and supervision, elementary education, reading, and secondary education.

Most programs are available to part-time admitted graduate students. Since not all courses are offered each semester, students should consult the current Time and Room Schedule for course offerings.

Counseling

Program Information: Angelo Boy, David Hebert, Dwight Webb, J. Elizabeth Butcher.

The counseling program offers students a choice of either the master of arts degree or the master of education degree. Enrollment in the M.A. program is very limited because of the thesis requirement. The M.A. degree requires completion of seven core courses (28 credits), elective courses (8 credits), and the completion of a research thesis (6 credits), for a total of 42 credits. These 42 credits should be viewed as a minimum number because in many cases it is determined that the student needs additional coursework in statistics and research methodology in order to complete the thesis requirement. The master of education degree requires completion of the seven core courses (28 credits), elective courses (8 credits), and successful completion of a written comprehensive essay examination.

These programs prepare professional counselors to function in a variety of institutions, organizations, and agencies dedicated to the educational, vocational, social, and psychological development of the person, within the context of school and university settings, human service programs, human development centers, and rehabilitation agencies. Graduates of the program are engaged in providing preventive and restorative services to persons who possess normal and developmental concerns. Graduates are typically involved in the team delivery of services and work in collaboration with other human services professionals.

Core Requirements (28 credits): Educ 820, Counseling Theory and Practice; 821, Psychology of Career and Personal Development; 822, Assessment in Counseling; 823, Group Counseling; 824, Psychological Adaptation; 825 and 826, Counseling Internship.

Electives (8 credits): In consultation with the advisor, electives may be selected from graduate-level courses that are related to the behavioral sciences and offered by a department or school in the University.

Economics, Education
Concluding Experience: A candidate for the M.A. must complete a research thesis. A candidate for the M.Ed. must complete a written comprehensive essay examination.

Developmental Disabilities

Program Information: Richard F. Antonak, Bruce L. Mallory, M. Daniel Smith (Education); Ann D. Ury, (Occupational Therapy); F. Harry Tokay, (Communication Disorders).

This program prepares graduates to assume responsibility in the service delivery system for developmentally disabled citizens (i.e., people with mental retardation, cerebral palsy, convulsive disorders, autism, multiple handicaps), including: 1) directing the interaction of various therapies and disciplines providing service to the developmentally disabled; 2) coordinating, supervising, and administering human service programs for developmentally disabled persons; 3) planning and evaluating human service programs; and 4) maintaining and improving such programs through public relations, community awareness, and grant procurement activities.

Candidates are expected to have prior experience in one of several related professions (such as nursing, medicine, occupational therapy, communications disorders, psychology, physical therapy, social work, education) and/or a strong theoretical background in these disciplines. At present, this program is available only to part-time admitted graduate students.


Electives (8 credits, minimum): elective courses may be selected, in consultation with the adviser, from the offerings of graduate departments of the University to meet individual needs and professional objectives. A maximum of eight elective credits may be earned by completing a master's research thesis (Educ 899).

Concluding Experience: Each degree candidate must pass a written comprehensive examination.

Early Childhood

Program Information: Bruce L. Mallory, Deborah Stone.

The early childhood program primarily serves experienced child workers who wish to improve their professional competence and broaden their career options. The program prepares participants as early childhood resource specialists, competent to assume roles as master teacher, program supervisor, curriculum consultant, staff development director, parent-home educator, family agency coordinator, or community college instructor. The program emphasizes field-based experience coordinated with extensive coursework in related academic disciplines. Students enroll on either a part-time or full-time basis. During the academic year, students are responsible for staffing early learning centers in local school districts, private nursery and kindergarten programs, day care centers, development centers, and special services facilities. Candidates in coursework and seminars concurrent with an internship experience through study on campus two afternoons and evenings per week. They also provide workshops for staff and parent groups and carry out independent studies in areas of special interest and significance.

Core Curriculum (26 credits): Educ 841, Child Development for the Early Childhood Professional; 843, Environment for Early Childhood; 800-801 (minimum of 2 credits), Internship and Seminar in Teaching; 846, Assessment in Early Childhood; 848, Contemporary Influences in Early Childhood; two of the following courses: Educ 733, Introduction to the Teaching of Writing; Educ 734, Children's Literature; Educ 741, Exploring Mathematics with Young Children; Educ 742, The Young Gifted Child; Educ 760, Young Children with Special Needs; Educ 806, Approaches to Language Arts Instruction; Educ 807, Foundations of Reading Instruction; Educ 847, Diagnosis and Educational Planning for Young Special Needs Children.

Electives (8 credits): Other graduate-level courses within or outside of the Department of Education are acceptable depending upon the student's background, individual goals, and adviser's approval.

Special Needs Option: Students who wish to specialize in the education and development of handicapped or exceptional children between birth and eight years may apply to the Special Needs Option. Students choosing this option will concentrate on the assessment of children with developmental disabilities or delays, the design of appropriate environments and individual programs, working with parents, and understanding the administrative and legal issues relating to young handicapped children.

Core Curriculum (34 credits): Education 841, 843, 846, 848, 800-801 (6 credits); and Education 760, Introduction to Young Children with Handicaps; 847, Diagnosis and Educational Planning for Young Handicapped Children; 849, Supporting Parents of Young Handicapped Children.

Electives (8 credits): Other graduate-level courses within the Early Childhood, Developmental Disabilities, and other Department of Education programs, as well as graduate-level courses from outside the department, are acceptable with permission of the student's adviser.

Concluding Experience: A degree candidate must successfully complete one of the following: comprehensive examination or research thesis.

Educational Administration and Supervision

Program Information: Charles Ashley, Roland Kimball, Mary Winslow.

The program is designed for the experienced teacher to become qualified in the broad area of supervision and administration, grades K-12. Emphasis is on the elementary and secondary school principalship and general instructional supervision.
Core Requirements (28 credits): Educ 872, Educational Program Evaluation; 865, Educational Supervision; 853, Seminar in Curriculum Study; 861, Public Seminar At Administration; 863, Seminar in Educational Administration; 867, Legal Aspects of School Administration; and 869, Practicum in Educational Administration.

Electives (8 credits) are individually planned, with major portion selected from the following: Educ 797, Seminar in Contemporary Educational Problems; 864, Personnel and Communication in Educational Organizations; 868, Collective Bargaining in Public Education; 886, Philosophy of Education; 895, Independent Study in Education; Admin 713, Interpersonal Skills for Managers; Admin 714, Managing Organizational Conflict; Soc 735, Complex Organizations.

Concluding Experience: 1) Comprehensive oral examination based on the theses statements prepared by the candidate or 2) major research study related to school administration, curricula, or educational supervision.

Elementary and Secondary Education

Program Information: Teacher Education Committee: Michael Andrew, chairperson; Ellen Corcoran; John Chalatas; Richard Schwab.

The elementary and secondary education programs are designed for people who have been granted teaching certificates and who intend to become or to continue to be classroom teachers.

Core Curriculum (12 credits): Selections may be made from: Educ 785, Tests and Measurements; 853, Seminar in Curriculum Study; 883, Advanced Psychology of Human Learning; 884, Advanced Human Development; 886, Philosophy of Education; and Soc 838, Sociology of Education: Social Organization of Schools and Community.

Electives (18 credits): In consultation with and with the approval of the student's adviser, electives may be taken in specialized areas from within the Department of Education, in the student's major field, or in some combination of the two. A student using the research thesis option of the concluding experience will normally use elective credits for Educ 881, Methods and Techniques of Educational Research and Educ 899, Master's Thesis.

Concluding Experience: A degree candidate must successfully complete one of the following: theses plus oral examination, or research thesis.

Reading

Program Information: John Carney, Jane Hansen, Grant Goff.

The reading program provides professional training as a teacher of reading, clinician, and consultant for individuals seeking certification as reading specialists. The program is designed to meet standards recommended by the International Reading Association for the professional training of reading personnel and certification requirements of the state of New Hampshire for reading specialists. The program train students in the areas of elementary and secondary reading foundations, clinical competencies, consultant and supervisory skills, and research capabilities.

Core Curriculum (28 credits): Educ 807, Foundations of Reading Instruction; 808-809, Clinical Diagnosis and Remediation of Reading Difficulties and Disabilities; 810, Comprehensive Reading Methods in the Secondary School; 813, Field Prac-ticum; 814, Seminar in Reading. Choose one of the following: 734, Children's Literature; 776, Reading for Children with Special Needs; 806, Approaches to Language Arts Instruction; 815, Reading and the Adult Learner.

Electives (8 credits): The remainder of courses are selected in consultation with the adviser. They may be from the offerings of the Department of Education or reflect an interdisciplinary approach with other graduate departments at the University. A student using the research thesis option as a concluding experience will use the 8 credits for Educ 899, Master's Thesis.

Concluding Experience: A degree candidate will successfully complete one of the following: written examination or research thesis.

Degree Programs for Preservation Teachers: Master of Arts in Teaching and Master of Education

Program Information: Michael Andrew or Ellen Corcoran.

The Department of Education offers two graduate programs for prospective elementary and secondary teachers, leading to either the master of arts in teaching (M.A.T.) degree or the master of education (M.Ed.) degree. Both programs require a minimum of 30 credits and are designed for two types of students: 1) those in the Five Year, Undergraduate-Graduate Program who entered the teacher preparation program as undergraduates at UNH and have thus satisfied some of the requirements for teacher certification prior to graduate study; 2) those who have completed an undergraduate program, either at UNH or elsewhere, with little or no coursework in education. Specialization may be selected for teaching at the primary, middle, and or high school levels. Students entering these master's degree programs normally have completed a bachelor's degree program with a major outside the field of education.

All professional education requirements for certification must be met either prior to or as a part of the master's degree programs for preservice teachers. These professional requirements include: Educ 500, Exploring Teaching; 700, Educational Structure and Change; 701, Human Learning and Development: Educational Psychology; 703, Alternative Teaching Models; 705, Alternative Perspectives on the Nature of Education; and 800-801, Internship and Seminar in Teaching. Before being certified, secondary teacher candidates must demonstrate academic preparation for teaching reading in the content area. All students in the teacher education program are required to prepare for working with exception children. Course guidelines for these requirements are available through the Department of Education. Additional requirements for all prospective elementary teacher candidates include: 706, Introduction to Reading Instruction in the Elementary School, and two math courses appropriate to preparation for teaching in elementary school.
All candidates who do not participate in the Live, Learn, and Teach program must complete, or have completed prior to admission, either: 1) Educ 500, Exploring Teaching, or 2) a one-semester teacher aide experience, or its equivalent, with a supportive recommendation from school staff.

The Live, Learn, and Teach program is a 10-credit, seven-week experiential summer program which may be an integral part of the master's degree program, particularly for those students who have done no previous coursework in education. The summer program consists of Educ 831 or 833 (4 cr.), 703 (4 cr.), and 700 (2 cr.). The program also satisfies the requirement for Educ 500.

Master of Arts in Teaching (Elementary and Secondary)
The M.A.T. program is most appropriate for students who wish to do a portion of their degree coursework outside of the Department of Education, in their major teaching field or associated fields.

Professional Education Requirements (12-40 credits): Either as part of the degree program or prior to admission, these required certification courses or their equivalents must be successfully completed: Educ 500, 700, 701, 703, 705, 800, 801. (In addition, for elementary teacher certification: Educ 706 and two appropriate math courses.)

Courses Related to the Teaching Field (12 credits): These courses are to be selected in consultation with one's adviser, from departments other than the Department of Education. (For those seeking elementary teacher certification, a required mathematics course may be included.)

Electives (0-6 credits): These courses, selected in consultation with one's adviser, may be from those offered by the Department of Education or other departments.

Concluding Experience: A degree candidate must successfully complete one of the following: project, theses plus oral examination, or research thesis.

Doctor of Philosophy

Reading and Writing Instruction

Program Information: John Carney, Grant Gioffi, Donald Graves, Jane Hansen.

The Department of Education offers the Ph.D. in reading and writing instruction. The primary focus of the program is the relationship between the processes of reading and writing with particular consideration of the underlying factors of language and cognition. There is a specific research emphasis on the interaction of reading and writing in instructional environments. The program prepares individuals to conduct research and teach at the college/university level or to provide leadership in literacy in public or private educational settings.

Students in the program will demonstrate competence in: 1) reading theory and practice; 2) writing theory and instruction; 3) the study of language and cognition; 4) methods of research. Because of the interdisciplinary nature of the program, students will take courses from the departments of education, English, and psychology. A central component of the program is a year-long seminar in reading and writing instruction. Students will be advanced to candidacy upon passing a qualifying examination after completing two-thirds of their program of study. Full-time students typically will complete two years of course work and a third year of doctoral research.

Certificate of Advanced Graduate Study

A Certificate of Advanced Graduate Study (C.A.G.S.) is available in two programs: Counseling, and Educational Administration and Supervision.
Counseling

Program Information: Angelo Boy, David Hebert, Dwight Webb, J. Elizabeth Butcher.

This program is designed for those who possess a master's degree in counseling or an equivalent master's degree and want to pursue further study toward the Certificate of Advanced Graduate Study. The candidate for this certificate must successfully complete 32 graduate credits beyond the master's degree.

Required Education Courses (20 credits): Edu 827, Administration of Counseling Services; 828, Advanced Counseling Theory and Practice; 829, Advanced Counseling Internship; 830, Research in Counseling; and 884, Advanced Human Development.

Electives (12 credits): In consultation with one's adviser, electives may be selected from graduate-level courses offered by the departments of education, business administration, economics, English, history, mathematics, political science, psychology, and sociology.

Concluding Experience: A degree candidate must successfully complete one of the following: written examination or written set of professional theses followed by an oral examination.

Educational Administration and Supervision

Program Information: Charles Ashley, Roland Kimball, Mary Winslow.

This program is designed for those who possess a master's degree in school administration or graduate study supplemented by work experience that is equivalent to that outlined in the University of New Hampshire M.Ed. program in Educational Administration and Supervision and who wish advanced preparation for careers as school superintendents, assistant superintendents, business managers, state department of education personnel, vocational education coordinators, curriculum coordinators, or educational personnel in private organizations.

The program requires 40 credits. Courses are required in five areas of competency: institutional analysis, organizational behavior, policy analysis, managerial leadership, and instructional leadership (16–20 credits). Candidates must complete a significant field project and field internship in an appropriate administrative setting (12 credits). Elective courses compose the balance of the program (8–12 credits).

Concluding Experience: A candidate must complete a significant field project and field internship in an appropriate administrative setting.

700. EDUCATIONAL STRUCTURE AND CHANGE

A) Educational Structure and Change; B) Education in America: Backgrounds, Structure, and Function; C) Governance of American Schools; D) School and Cultural Change; E) Teacher and Cultural Change; F) Social Perspectives of Conflict in the Schools; G) Nature and Processes of Change in Education; H) What Is an Elementary School?; I) Schooling for the Early Adolescent; J) Children with Special Needs: History and Models; K) Curriculum Structure and Change; L) Stress in Educational Organizations. Organization, structure, and function of American schools; historical, political, and social perspectives and processes of change in education. Two- and 4-credit courses offered each semester (listed in department; refer to Time and Room Schedule). Minimum of 4 credits required for teacher certification. Prereq. for teacher certification students: Exploring Teaching and permission, which is accomplished by signing the appropriate course roster in the Teacher Education Office. Prereq. for students not seeking teacher certification: permission, as described above. 2 or 4 cr.

701. HUMAN DEVELOPMENT AND LEARNING: EDUCATIONAL PSYCHOLOGY

A) Human Development and Learning: Educational Psychology; B) Human Development: Educational Psychology; C) Human Learning: Educational Psychology; D) Developmental Bases of Learning and Emotional Problems; E) Learning Theory, Modification of Behavior, and Classroom Management; F) Cognitive and Moral Development; G) Evaluating Classroom Learning; H) Delinquent, Psychopathological Education; I) Sex Role, Learning, and School Achievement; J) The Development of Thinking. Child development through adolescence, learning theory, cognitive psychology, research in teaching and teacher effectiveness, and evaluation, all applied to problems of classroom and individual teaching and therapy. Full 4-credit course and 2-credit course course offering each semester (listed in department; refer to Time and Room Schedule). Minicourses emphasize either development (first half of semester) or learning (second half). Candidates for teacher certification are required to have at least 2 credits of development and 2 credits of learning, or the full 4-credit course (701A). Prereq. for teacher certification students: Exploring Teaching and permission, which is accomplished by signing the appropriate course roster in the Teacher Education Office. Prereq. for students not seeking teacher certification: permission, as described above. 2 or 4 cr.

703. ALTERNATIVE TEACHING MODELS

A) Alternative Teaching Models; B) Curriculum Planning for Teachers; C) Alternative Strategies for Maintaining Classroom Control; D) Nature and Goals of Social Studies: K-12; E) Social Studies Instructional Materials: K-12; F) Teaching Elementary and Middle School Science; G) Language Arts for Elementary Teachers; H) Experiential Curriculum: I) Children with Special Needs: Teaching Strategies; L) LOGO and Learning. Basic teaching models, techniques of implementation, and relationships to curricula. Two- and 4-credit courses offered each semester (listed in department; refer to Time and Room Schedule). Minimum of 4 credits required for teacher certification. For secondary teacher candidates, the appropriate methods course, taught in the department of the major, usually satisfies this requirement. Edu 703B is required for candidates for elementary teacher certification who do not complete 703C, D, F, or G. Prereq. for teacher certification students: Exploring Teaching and permission, which is accomplished by signing the appropriate course roster in the Teacher Education Office. Prereq. for students not seeking teacher certification: permission, as described above. 2 or 4 cr.
705. ALTERNATIVE PERSPECTIVES ON THE NATURE OF EDUCATION
A) Contemporary Perspectives; B) Controversial Issues in Education; C) Ethical Issues in Education; D) Concepts of Teaching: Differing Views; E) Curriculum Theory and Development; F) Readings on Educational Perspectives; G) Philosophy of Education; I) Education as a Form of Social Control; K) Schooling and the Rights of Children; L) Education, Inequality, and the Meritocracy; M) Readings in Philosophies of Outdoor Education; N) Alternative Perspectives on the Nature of Education; O) Classrooms: The Social Context; P) Teaching: The Social Context; Q) School and Society. Students formulate, develop, and evaluate their own educational principles, standards, and priorities. Alternative philosophies of education are explored, and students are asked to analyze and synthesize alternative educational issues. Two- and 4-credit courses offered each semester (listed in department; refer to Time and Room Schedule). Minimum of 4 cr. required for teacher certification. Prereq. for teacher certification: Exploring Teaching and permission, which is accomplished by signing the appropriate contract roster in the Teacher Education Office. Prereq. for students not seeking teacher certification: permission, as described above. 2 or 4 cr.

706. INTRODUCTION TO READING INSTRUCTION IN THE ELEMENTARY SCHOOLS
Recent research process; current procedures and materials; diagnostic techniques; practicum experience. Course satisfies reading requirement for prospective elementary teachers in the five-year teacher education program and may be included in the 12 required graduate credits in education at the graduate level. Course may also be taken for undergraduate credit before entrance into fifth year; in this case, the course satisfies reading requirement but is not applicable toward the 12 required graduate credits. Prereq: exploring teaching. 4 cr.

707. TEACHING READING THROUGH THE CONTENT AREAS
Approaches and methods of teaching reading through content materials; course work includes practical applications through development of instructional strategies and materials. 2 cr. (May be used to satisfy 2 cr of Educ 700.)

720. INTRODUCTION TO COMPUTER APPLICATIONS FOR EDUCATORS
Major issues related to class computation: computer applications: historical development; computer functioning; methods of introduction, problem solving, educational software development and evaluation; conducting technological needs assessments in schools; psychological and sociological affect of the computer on children and learning. Classroom applications of programming languages BASIC and LOGO and authoring language PILOT. Design and implementation of computer-assisted educational exercises. Hands-on sessions. 4 cr.

733. INTRODUCTION TO THE TEACHING OF WRITING
Development of writers, child to adult; ways to respond to writing, and the organization of the classroom for the teaching of writing. Persons taking the course will need to have access to students to carry out course requirements. Prereq: permission. 4 cr.

734. CHILDREN'S LITERATURE
Interpretive and critical study of literature for children in the elementary, middle, and junior high schools. Methods of using literature with children. 4 cr.

741. EXPLORING MATHEMATICS WITH YOUNG CHILDREN
Laboratory course for those who teach young children mathematics and who are interested in children's discovery, learning, and creative thinking; offers chance to experience exploratory activities with concrete materials, as well as mathematical investigations, on an adult level, that develop the ability to provide children a mathematically rich environment, to ask problem-posing questions, and to establish a rationale for doing so. 4 cr.

742. THE YOUNG GIFTED CHILD
Identification and teaching of young gifted children (preschool through primary). Considers historical perspectives, issues, exemplary models of gifted education, multiple teaching strategies, and relevant materials. Of interest to pre-service and in-service teachers, parents, and advocates for the gifted. 4 cr.

750. INTRODUCTION TO EXCEPTIONALITY
Survey of the social, psychological, and physical characteristics of exceptional individuals including intellectual (gifted, retarded, learning disabled); sensory (visual, auditory); motor (orthopedic); health; and communication exceptionalities. Implications for educational and human service delivery. 4 cr.

751. EDUCATING EXCEPTIONAL LEARNERS
Issues in special education (labeling, mainstreaming, efficacy); techniques of special teaching (referral; assessment, observation, task analysis, profiling, selecting materials, intervention); and issues in special teaching (behavior modification, ability training). Primary application to mild and moderate exceptionalities. Co- or prereq: Educ 750 or permission. 4 cr.

752. DIAGNOSIS AND REMEDIATION OF LEARNING DISABILITIES
Terminology, etiology, common characteristics, and symptoms; theory and practice in gross-motor, visual, and auditory remediation; testing procedures used in diagnosis and remediation programs. 4 cr.

753. TEACHING CHILDREN WITH BEHAVIOR DISORDERS
Nature and scope of emotional disturbances and social maladjustments in children, including causes, characteristics, treatment implications, and educational problems. 4 cr.

755-756. DIAGNOSTIC-PRESCRIPTIVE TEACHING OF EXCEPTIONAL LEARNERS
A two-semester course to develop teacher competence to analyze learners and learning environments, specify learner characteristics, and determine, describe, implement, and evaluate educational interventions. Applications in the areas of language, mathematics, reading, science, social studies, perceptual-motor, behavioral, adaptive, and social skills. Focus on mildly and moderately handicapped children in regular class and resource room. Prereq: Educ 750; 751 or 700J, 703I; or permission. 4 cr.
758. PROGRAM DEVELOPMENT AND ADMINISTRATION IN DEVELOPMENTAL DISABILITIES
Analysis and application of techniques for program development and administration, including grantsmanship, program planning, staff supervision, program evaluation, fiscal management, and statutory issues. Focus on programs for disabled infants and adults. Prereq: permission. 4 cr.

760. INTRODUCTION TO YOUNG CHILDREN WITH SPECIAL NEEDS
The needs of children (birth to eight years) with handicaps or who are at risk for handicaps. Strengths and special needs of handicapped children; causes, identification, and treatment; current legislation; parent and family concerns; program models. 4 cr.

763. INTRODUCTION TO EDUCATIONAL MEDIA
Educational media in the learning process; curricular integration of materials and equipment in the school library media center; design and implementation of learning systems that provide a framework for the development of individual skills. 4 cr.

764. TELEVISION AND THE YOUNG CHILD
The emergence of television as a cultural force and its effect upon the development of the young child—physically, socially, emotionally, and intellectually. Working with parents, teachers, and children to help them become better television consumers and planning alternatives for utilizing the technology of television more positively. Knowledge of some of the many research studies conducted and in process expected. 4 cr.

775. DIAGNOSTIC TEACHING OF READING
Classroom implementation of diagnosis and remediation of reading disabilities; for teachers, counselors, administrators, and other school personnel. 4 cr.

776. READING FOR CHILDREN WITH SPECIAL NEEDS
Techniques and procedures for teaching reading to children with special learning needs: the mentally retarded; learning disabled; gifted; culturally diverse. Emphasis will be placed on the implications of providing reading instruction in the least restrictive alternative. 4 cr.

785. EDUCATIONAL TESTS AND MEASUREMENTS
Theory and practice of educational evaluation; uses of test results in classroom teaching and student counseling; introductory statistical techniques. 4 cr.

797. SEMINAR IN CONTEMPORARY EDUCATIONAL PROBLEMS
Issues and problems of special contemporary significance, usually on a subject of recent special study by faculty member(s). Prereq: permission. May be repeated for different topics. 1–4 cr.

800, 801. INTERNSHIP AND SEMINAR IN TEACHING
A two-semester, full-time, supervised internship consisting of less-than-full teaching responsibility in selected educational settings and programs. Weekly seminars and occasional workshops held concurrently with internship. Admission by application. 2–6 cr.

806. APPROACHES TO LANGUAGE ART INSTRUCTION
Teaching practices in speaking, listening, writing, and reading. Language development and application to school curriculum. 4 cr.

807. FOUNDATIONS OF READING INSTRUCTION
Survey of reading process, theoretical models, and basic approaches to the teaching of reading. Emphasis on current methods, materials, and programs. 4 cr.

808-809. CLINICAL DIAGNOSIS AND REMEDIATION OF READING DIFFICULTIES AND DISABILITIES
Examination of theories and procedures for the diagnosis and remediation of moderate to severe disabilities in reading through case studies, discussions, demonstrations, and practice. Clinical experience each semester. Prereq: Educ 807; 810; for permission. 4 cr.

810. COMPREHENSIVE READING METHODS IN THE SECONDARY SCHOOL
The nature of the reading process, diagnostic and developmental methods and materials, study skills, and reading in the content areas at the secondary level. Designed for secondary school teachers who wish to foster continuous development of students' reading and study skills. 4 cr.

813. FIELD PRACTICUM
Field-based experience focusing on roles of the reading specialist in the school setting. Prereq: permission. 4 cr.

814. SEMINAR IN READING
Investigation of current research findings in reading and the related language arts. Seminars will focus on significant research projects, program designs, and analysis of the field of reading research and ramifications for the reading specialist. Prereq: permission. 4 cr.

815. READING AND THE ADULT LEARNER
Current practices in teaching adults to read; the reading process and adult cognitive development; development of literacy in a technological society. A major portion of the course work will involve a case study in which students will examine an extant program or develop a new course of study that addresses a particular need in adult reading education. Prereq: permission. 4 cr.

818-819. SEMINAR ON RESEARCH IN READING/Writing INSTRUCTION
(1) examines the relationship between reading and writing; (2) studies procedures for research in reading and writing; (3) provides students with an opportunity to conduct research projects; (4) encourages interdisciplinary exchanges between both faculty and students. The seminar is offered every other year and is a requirement for the Ph.D. students in Reading and Writing. Prereq: permission. 4 cr.
820. COUNSELING THEORY AND PRACTICE
Basic approaches to counseling are examined—their theoretical foundations, process components, goals, and outcomes. 4 cr.

821. PSYCHOLOGY OF CAREER AND PERSONAL DEVELOPMENT
Career and personal development and how each influences the other; literature and research examined to clarify application to individual and group career-counseling and to career education. 4 cr.

822. ASSESSMENT IN COUNSELING
Evaluative instruments and methods that have particular use in counseling. Systematic procedures for measuring samples of an individual's behavior and statistical concepts that underlie psychological testing. Assessment is viewed from the perspective of its use in the counseling process as well as its use in accountability. 4 cr.

823. GROUP COUNSELING
Theoretical and applied dimensions of the group counseling process. Class may include laboratory experience to examine one's interactive behavior as a group member and leader. Prereq: Educ 820; permission. 4 cr.

824. PSYCHOLOGICAL STRESS AND ADAPTATION
Problems in stress that are significant for human adaptation. Behavior patterns that pose the most common problems encountered by contemporary counselors are reviewed, with emphasis upon the concepts and processes of adaptation. 4 cr.

825. COUNSELING INTERNSHIP I
Introductory supervised field experience focusing on the integration of counseling theory and practice, including laboratory microcounseling and seminars in contemporary professional issues. Interns select an approved field placement reflecting their professional interests. Prereq: permission. 4 cr.

826. COUNSELING INTERNSHIP II
Supervised counseling at approved field site. Opportunities also provided for involvement in consultative, evaluative, and other organizational procedures. Focus is on critiques of audio/video samplings of intern's counseling. Prereq: permission. 4 cr.

827. ADMINISTRATION OF COUNSELING SERVICES
Organizational patterns and administrative procedures that influence the effectiveness of counseling services. Emphasis upon staff development, accountability, professional issues, and productive supervisory behaviors. Prereq: permission. 4 cr.

828. ADVANCED COUNSELING THEORY AND PRACTICE
Detailed analysis of the counseling relationship: its characteristics, processes, and outcomes. Prereq: permission. 4 cr.

829. ADVANCED COUNSELING INTERNSHIP
Supervised application of advanced counseling theory and practice in counseling relationships. Samplings of the advanced counseling practices of students will be analyzed and evaluated. Open only to C.A.G.S. candidates in UNH graduate program in counseling. Prereq: Educ 828; permission. 4 cr.

830. RESEARCH IN COUNSELING
Research design and methodology in counseling. Students develop research projects that demonstrate knowledge of research procedures in evaluating the processes and outcomes of counseling. Prereq: permission. 4 cr.

831. SEMINAR AND PRACTICUM IN ELEMENTARY SCHOOL TEACHING
Supervised Practicum: Exploratory summer practicum in a local summer elementary school to examine teaching as a career and to prepare for the internship in the fall. Students: 1) a prepracticum workshop focusing on interpersonal skill development; 2) a prepracticum curriculum and instructional laboratory; 3) a six-week practicum in which candidates, with the help of the staff, serve as the teaching staff in a local summer school; 4) seminars in curriculum and instruction. Opportunities for teaching high school students are available for candidates who wish to determine better what level of teaching they prefer. Prereq: admission to the M.A.T. program or M.Ed. program for preservice teachers. 4 cr. (Summer Session only.)

835. SEMINAR AND PRACTICUM IN SECONDARY SCHOOL TEACHING
Supervised Practicum: An exploratory summer practicum in a local summer high school to examine teaching as a career and to prepare for the internship in the fall. Summer includes: 1) a prepracticum workshop focusing on interpersonal skill development; 2) a prepracticum curriculum and instructional laboratory; 3) a six-week practicum in which candidates, with the help of the staff, serve as the teaching staff in a local summer school; 4) seminars in curriculum and instruction. Opportunities for teaching on elementary level are available for candidates who wish to determine better what level of teaching they prefer. Prereq: admission to the M.A.T. or M.Ed. programs for preservice teachers. 4 cr. (Summer Session only.)

841. CHILD DEVELOPMENT FOR THE EARLY CHILDHOOD PROFESSIONAL
To understand child growth; components of the course involve students in extended contacts with significant adults related to children in an early learning environment. Includes informal visits to family centers, home visits, interviews with parents and other relatives, and observations of children in the family setting. Extensive readings, discussions, case study models, film viewings, and continued in-depth child study. Prereq: previous experience with young children. 4 cr.

843. ENVIRONMENT FOR EARLY CHILDHOOD
Examination of various environments with attention to use of time, space, and materials. Study of multiple professional roles needed in providing appropriate learning center adjustments to maximize individual child development. 4 cr.

845. PROGRAMMING FOR SEVERELY/MULTIPLY HANDICAPPED YOUNG CHILDREN
Information and suggestions for working with the severely and/or multiply handicapped child, ages birth to eight. Emphasis will be on individualized
program planning, particularly developmental and multidisciplinary approaches. Prereq: permission. 4 cr.

846. ASSESSMENT IN EARLY CHILDHOOD
Study, administer, and design a range of assessment materials. Develop strategies for selection and utilization of clusters of assessment materials. Collect and organize relevant data. Prereq: Educ 841 or equivalent; Educ 843. 4 cr.

847. DIAGNOSIS AND EDUCATIONAL PLANNING FOR YOUNG SPECIAL NEEDS CHILDREN
Focus on information and practical experiences relating to assessment and remediation of developmental handicaps in children from birth to eight years old. Formal and informal criterion-referenced assessment, individualized education plans, multidisciplinary approaches, parental roles, report writing. Prereq: Educ 760, 841, or equivalent. 4 cr.

848. CONTEMPORARY INFLUENCES UPON EARLY CHILDHOOD EDUCATION
Examination of historical and contemporary philosophies of early childhood development and learning. Analysis of model programs for young children. Investigation of specific current topics such as child abuse, family changes, out-of-home child care, etc. Review of the impact of economic and social changes on families caring for young children. 4 cr.

849. SUPPORTING PARENTS OF YOUNG SPECIAL NEEDS CHILDREN
Social, economic, and psychological consequences of raising a child with a handicapping condition. Issues will include diagnosis and prognosis for the child, parent-child attachment, and interactions with other care givers. Counseling and support techniques. 4 cr.

851. LAWS AND REGULATIONS AFFECTING THE EDUCATION OF HANDICAPPED CHILDREN
Analysis of current federal and state policies affecting handicapped children. Focus will be on Public Law 94-142. The role of policy making and constitutional and ethical issues will be discussed. 4 cr.

853. SEMINAR IN CURRICULUM STUDY
Analysis of recent trends in public school curriculum; structures, philosophy, development, change, and evaluation. Primarily for experienced teachers and administrators. Prereq: teaching experience. 4 cr.

854. SURVEY OF DEVELOPMENTAL DISABILITIES
Mental retardation, cerebral palsy, epilepsy, autism, and related handicapping conditions; causal factors, physical and psychological characteristics, educational and therapeutic implications. Observations of programs and services for the developmentally disabled are required. 4 cr.

855. SERVICE DELIVERY SYSTEMS IN DEVELOPMENTAL DISABILITIES
Service delivery system models in developmental disabilities; pre- and postnatal, preschool, elementary, secondary, postschool, institutional, and adult occupational. Examination of plans for the provision of services and facilities for the developmentally disabled; administrative, social, legal, and educational implications. 4 cr.

856-857. FIELD PRACTICUM AND SEMINAR IN DEVELOPMENTAL DISABILITIES
One semester of supervised experiences in a diversity of agencies and facilities serving the developmentally disabled; a one-semester experience in a setting approximating the student's career choice; biweekly seminars on topics related to the delivery of service to the developmentally disabled. Prereq: permission. 8 cr.

858. ANALYSIS OF TEACHING
Comparative analysis of current techniques and instrumentation for studying the process of teaching in the classroom. Consideration of substantive and procedural issues involved in planning for teaching. Prereq: teaching experience. 4 cr.

861. PUBLIC SCHOOL ADMINISTRATION
Introductory course; major issues in policy making, school management, personnel, public relations, finance, and research in school administration. Prereq: teaching experience. 4 cr.

862. EDUCATIONAL FINANCE AND BUSINESS MANAGEMENT
Principles of financing education, budgetary procedures, accounting, auditing, school indebtedness, financial reporting, and business management. Handling practical school finance problems will be part of the project work. Prereq: Educ 861. 4 cr.

863. SEMINAR IN EDUCATIONAL ADMINISTRATION
Cases and concepts in decision-making, motivation, job satisfaction, value clarification, delegation of responsibilities, and definition of duties. Planning, power, ethical considerations, minorities, and rural and urban problems. Prereq: Educ 861 or permission. 4 cr.

864. PERSONNEL AND COMMUNICATION IN EDUCATIONAL ORGANIZATIONS
Problems of personnel and communications processes. Implications of group problem-solving processes. Interpersonal relations and group dynamics among students, faculty, staff, administration, and the community. Application of theories. 4 cr.

865. EDUCATIONAL SUPERVISION
Theoretical foundations and practical applications of supervisory and instructional practices and procedures; consideration of instruments and techniques. Each student will conduct a field supervision project. Prereq: teaching experience or permission. 4 cr.

866. PRACTICUM IN SUPERVISION AND CURRICULUM
Supervision of teaching and curriculum development projects in the schools. Opportunity to apply skills in supervising and curriculum development techniques. Prereq: Educ 853; Educ 865; permission. 4 cr.

867. LEGAL ASPECTS OF SCHOOL ADMINISTRATION
Relationship of law to public education. Emphasis on federal constitution, New Hampshire statutes, and case law related to public interests served by
elementary and secondary education. Special topics: church-state relationship, due process, desegregation, supervision of school districts, school boards, teacher employment, negotiations, student rights, tort liability, school finance. Prereq: Educ 861; Educ 863. 4 cr.

868. COLLECTIVE BARGAINING IN PUBLIC EDUCATION
An examination of collective bargaining as practiced by school boards, administrators, and teacher organizations. Consideration will be given to collective bargaining statutes, case law, employee relations boards, unit determinations, exclusive representation, union security provisions, scope of bargaining, good faith, grievance procedures, bargaining strategies, strikes, public interest, mediation, fact finding, arbitration, and the administration of the negotiated contract. Prereq: Educ 863. 4 cr.

869. PRACTICUM IN EDUCATIONAL ADMINISTRATION
Supervised practical experience in planning and implementing student-initiated field projects. Prereq: All core requirements. 4 cr.

870. THE CHANGE PROCESS IN EDUCATION
Role of change agent and the change process in education as related to school personnel, structural characteristics of the school culture; change theory and systems analysis techniques. Students will be required to apply some of the theories in an institutional setting. 4 cr.

871. SCHOOL FACILITIES MANAGEMENT
Techniques and procedures involved in the long-range planning of school facilities. For example: school population projections; characteristics of the educational program; space requirements; evaluation of existing facilities, future use of existing buildings, analysis of financial resources available, identification of reasonable alternatives, and an examination of the probable consequences of such alternatives, including educational effectiveness and tax impact. Prereq: Educ 863 or permission. 4 cr.

872. EDUCATIONAL PROGRAM EVALUATION
Selected models for educational program evaluation; rationale underlying these models examined and compared; practical applications developed. Each student will plan a complete evaluation design for an appropriate educational program. Prereq: Educ 853; Educ 861; or permission. 4 cr.

873. ANALYSIS OF EDUCATION POLICY
Policy systems and disciplinary perspectives shaping the development and enactment of educational policy at the federal, state, and local levels. Prereq: Educ 870 or permission; 869. 4 cr.

874, 875. ADMINISTRATIVE INTERNSHIP AND FIELD PROJECT
Field-based internship. Administrative experiences in one or several educational and community agencies. Participation in administrative and supervisory work of the agencies. Each intern completes a major field project requiring analysis and action appropriate for resolution of a significant administrative problem at the intern site. Supervised by University faculty. Prereq: permission of graduate adviser. A grade of credit (CR) will be given upon successful completion of the internship and field project. 6 cr.

880. RESEARCH IN THE TEACHING OF WRITING
Review of the last 30 years of research in writing, focusing on trends in design, research procedures, the contributions of linguistics, cognitive and developmental psychology, with a view to the conduct of research by participants. Prereq: permission. 4 cr.

881. METHODS AND TECHNIQUES OF EDUCATIONAL RESEARCH
Conceptual aspects and practical realities of the research process applied to problems in education and human service disciplines. Develops skills necessary to use as well as conduct research. 4 cr.

883. ADVANCED PSYCHOLOGY OF HUMAN LEARNING
Review and integration of learning theory, teacher effectiveness, motivation theory, and development through adolescence; application of these to teaching generally and to the areas of specialization of the participants. Prereq: Educ 701 or equivalent. 4 cr.

884. ADVANCED HUMAN DEVELOPMENT
Selected principles and skills humankind must consider in the attempt to maximize individual, social, and educational potential; emphasis on personal implementation. Prereq: Educ 701, intro to psych, or equivalents. 4 cr.

886. PHILOSOPHY OF EDUCATION
Seminar in comparative analysis of contemporary educational objectives and practices and the philosophical foundations upon which they are based. Application of theoretical criteria for assessing educational philosophies and for developing one's own position. 4 cr.

890. DEVELOPMENTAL PERSPECTIVES ON ADULTHOOD
Research and theory about critical life issues; developmental tasks of the life cycle; periods of transition; stages of intellectual, moral, and personality development of the adult; and the design of significant learning experiences for adults within a variety of educational settings and institutions. 4 cr.

895. INDEPENDENT STUDY IN EDUCATION
Opportunity for intensive investigation of a special problem or issue in the field of education. Prereq: permission. 1–4 cr. May be repeated to a maximum of 8 cr.

899. THESIS
Prereq: permission of the department. 6–10 cr.

999. DOCTORAL RESEARCH

Electrical and Computer Engineering (E E)

Chairperson: John L. Pokoski

PROFESSORS: Fletcher A. Blanchard, Jr.; Ronald R. Clark; Albert D. Frost; Joseph B. Murdoch; John L. Pokoski; Kondagunta Sivaprasad
ASSOCIATE PROFESSORS: Allen D. Drake; Glen C. Gerhard; Filson H. Glanz; L. Gordon Kraft; John R. LaCourse; Donald W. Melvin; Walter T. Miller III; Paul J. Nahin
ASSISTANT PROFESSORS: Kent A. Chamberlin; Richard A. Messner; Andrzej Ruinski; Donald S. Szarkowicz
GRADUATE PROGRAM COORDINATOR: Paul J. Nahin

A student admitted to graduate study in electrical engineering should have completed a baccalaureate degree in electrical engineering or have comparable training, which included courses in mathematics and physical science, network theory, digital systems, fields and waves, electronics, solid state circuits, semiconductor device theory, with appropriate laboratory experiences. In addition to taking advanced coursework, master's students must demonstrate their ability to do independent work and report their results. This can be done in either of two ways: 1) a minimum of 24 credits of coursework plus 6 credits of thesis (E E 899) or 2) a minimum of 27 credits of coursework plus a three-credit, one-semester project (E E 895). With the consent of the graduate committee, a student who has demonstrated the ability to do independent work through sufficient industrial experience may substitute an approved course for E E 895.

Those who intend to undertake graduate work in electrical engineering must consult with the departmental graduate adviser in order to plan the program of study. No specific course requirements are mandated; each candidate will meet with the departmental graduate committee to set up a program of study. Normally, a minimum of 12 credits of 800-level courses is required, not including thesis or project.

The electrical and computer engineering department considers the development of professional communication skills, through a teaching assignment, a basic component of a graduate education. Every master's candidate is required to participate in seminar or course lectures as needed to satisfy the teaching requirement. Since many graduate courses are given by demand, actual course offerings vary from semester to semester.

Areas of Specialization
The faculty of the electrical and computer engineering department has research interests in the following areas. Students in the M.S. electrical engineering or the engineering Ph.D. program may select courses and research topics in these areas.

Biomedical Engineering: Topics of study in these areas include biomedical instrumentation, computer applications to medical problems, patient safety, applications of signal processing and instrumentation techniques to medical areas, and noninvasive instrumentation for the diagnosis of atherosclerosis. Additional details are available upon request.

Communications Systems and Information Theory: Areas of interest and activity include electromagnetic and acoustic wave technologies, and the identification of signals in the presence of noise through the use of coding, correlation, or optimal filtering. Related facilities for experiments extending from VLF to microwave frequencies are available in a rooftop communications system for space, terrestrial, and ocean applications.

Computer Engineering and Digital Systems: Theoretical aspects of switching theory; systems that recognize patterns, learn, and exhibit intelligence; application of switching logic, design and interfacing of minicomputer peripherals; application of minicomputers to process control and bioelectronics. The Digital Systems Laboratory includes four minicomputers with magnetic tape units, teletype terminals, high speed paper tape units, AD and DA converters, graphics output, and interconnect capability with a TR-48 analog computer.

Control and Systems Engineering: Digital, hybrid, and analog computer control of industrial processes and systems. Discontinuous and fluidic control theory for industrial, marine, and oceanographic applications. Linear and stochastic analysis, synthesis techniques in the frequency domain, optimal control, and systems optimization.

Fiber Optics: Optical fibers and their electromagnetic characteristics. Fiber optic communication systems. Use of optical fibers in instrumentation. Biomedical applications of optical fibers.

Geophysical Sensing and Propagation: Ground-based electromagnetic techniques for probing of upper atmosphere and the ionosphere; electromagnetic pulse techniques for probing of ice, snow, and other material media. Wave propagation studies in weakly turbulent media such as the sea, the atmosphere, and plasmas. Acoustic probing of bottom and subbottom sediment in water.

Illumination Engineering: Design techniques for evaluating contrast rendition factor and equivalent sphere illumination; inverse-square-law approximations for nonpoint light sources; design of daylighting systems; hand calculator programs for interior and exterior lighting design; lighting energy budgets.

Ocean Engineering and Instrumentation: Instrument systems (digital and analog) for measuring and recording physical, chemical, and biological parameters primarily associated with ocean behavior: temperature, pressure, and salinity measurements at midocean depths; wave height and direction determination; buoy performance as affected by waves and currents; remote sensing of the ocean surface; and underwater acoustics.

Permission of instructor is required for enrollment in all electrical and computer engineering courses taken for graduate credit. Seven-hundred-level courses are offered subject to adequate student demand.

704. ELECTROMAGNETIC FIELDS AND WAVES II
Loop antennas; aperture and cylindrical antennas; self and mutual impedance; receiving antennas and antenna arrays; bounded plane waves; rectangular and cylindrical waveguides; waveguide discontinuities and impedance matching; solid state microwave sources. Prereq: electromag fields and waves 1. 4 cr.

705. SEMICONDUCTOR DEVICES
Physical theory of semiconductors: models of solids, electronic properties, energy bands, and transport processes. PN junction theory; bipolar and field effect transistors; charge-transfer, optoelectronic, and integrated devices; and device fabrica-
tion technology. Prereq: gen. physics; adv. electronics, electromag fields and waves; or equivalent. 4 cr.

711. DIGITAL SYSTEMS
Advanced switching theory techniques; digital design tools; design of microprocessor-based systems; general design procedures, including top-down design techniques, documentation, noise reduction, etc. Prereq: logical design of digital computers; permission. Lab. 4 cr.

712. MICROCOMPUTER SYSTEM DESIGN
Further development and application of concepts introduced in E E 711. Each student will design, build, test, and evaluate a microprocessor-based system using state-of-the-art microcomputer development tools. Classroom emphasis will be on creative design techniques, troubleshooting strategies, and circuit analysis. Students will make oral presentations and write formal engineering reports. Prereq: E E 711; permission. Lab. 4 cr.

714. MINICOMPUTER APPLICATIONS ENGINEERING
Organization and operation of minicomputer-based systems. Interfacing of special purpose peripherals, digital filters, system simulation, program and data organization, priority interrupt processing of tasks, real-time monitor systems. Applications to communication, automated measurement, and process-control systems. Prereq: elements of digital systems or intro to digital systems; programming experience; permission. Lab. 4 cr.

727. POWER SYSTEMS
Modeling and planning of electric power transmission systems. Prereq: electromech devices; electrical networks; permission. 4 cr.

741. NONLINEAR SYSTEMS MODELING
Modeling of hydraulic, pneumatic, and electromechanical systems. Solution methods including linearization and computer simulation of nonlinear equations. Methods of generalizing the nonlinear models for design purposes are developed. (Also offered as M E 741.) 4 cr.

745. FUNDAMENTALS OF ACOUSTICS
Acoustic wave equation for air; laws of reflection, refraction, and absorption; characteristics and measurement of acoustical sources; human perception of sound, loudness, intensity; microphones; acoustical materials; problems in environmental sound; ultrasonics; architectural acoustics. Prereq: general physics II; differential equations; permission. Lab. 4 cr.

757. FUNDAMENTALS OF COMMUNICATION SYSTEMS
Discussions of deterministic signals, Fourier spectra, random signals and noise, baseband communication, analog and digital modulation schemes, and system signal to noise ratio. Prereq: probability and discreet systems; permission. Lab. 4 cr.

758. COMMUNICATION SYSTEMS
Design of high-frequency communication systems. RF amplification, modulators for AM and FM systems, receiving techniques, antennas, free-space propagation, propagation characteristics of the ionosphere. Prereq: electromagnetic fields and waves I; E E 757 or equivalent. Lab. 4 cr.

760. INTRODUCTION TO FIBER OPTICS
Basic physical and geometric optics; solution to Maxwell's equations for slab waveguides and cylindrical waveguides, of both step index and graded index profiles; modes of propagation and cutoff; polarization effects; group and phase velocity; ray analysis; losses; fabrication; sources; detectors; couplers; splicing; cabling; applications; system design. Prereq: electromagnetic fields and waves I; permission. Lab. 4 cr.

762. ILLUMINATION
Radiation; color and spectra; physics of light production; sources of ultraviolet, visible, and infrared energy; lamp circuitry; control of light; lighting design, applications of light in business, industry, school, home, and outdoors. Lab. 4 cr.

775. APPLICATIONS OF INTEGRATED CIRCUITS
Design and construction of linear and nonlinear electronic circuits using existing integrated circuits. Limitations and use of operational amplifiers. Laboratory course in practical applications of nondigital integrated circuit devices. Prereq: advanced electronics. Lab. 4 cr.

781. PHYSICAL INSTRUMENTATION
Analysis and design of instrumentation systems. Sensors, circuits, and devices for measurement and control. Elements of probability and statistics as applied to instrument design and data analysis. Transmission, display, storage, and processing of information. The design, implementation, testing, and evaluation of an instrument system is an integral part of the course. Prereq: permission. (Also offered as O E 781.) 4 cr.

782. CONTROL SYSTEMS
Fundamental principles involved in the design and analysis of feedback control systems. Topics include stability criterion, time-domain analysis, frequency-domain analysis, and introduction to nonlinear systems. Prereq: permission. Lab. (Also offered as M E 782.) 4 cr.

783. BIOMEDICAL ENGINEERING
Engineering applied to cardiovascular, renal, gastrointestinal, sensory, reproductive, and other organ systems. Design and utilization of diagnostic, monitoring, and prosthetic techniques and devices. Lab. 4 cr.

784. BIOMEDICAL INSTRUMENTATION
Principles of physiological and biological instrumentation design including transducers, signal conditioning, recording equipment, and patient safety. Laboratory includes the design and use of instrumentation for monitoring of electrocardiogram, electromyogram, electroencephalogram, pulse, and temperature. Current research topics, such as bio-telemetry, ultrasonic diagnosis, and computer applications. Lab. 4 cr.

785. UNDERWATER ACOUSTICS
Vibrations, propagation, reflection, scattering, reverberation, attenuation, sonar equations, ray and mode theory, radiation of sound, transducers, and small- and large-signal considerations. (Also offered as O E 785.) 4 cr.

786. INTRODUCTION TO RADIO ASTRONOMY
Electromagnetic radiation, propagation. Positional astronomy and the radio sky, discrete radio
833-834. PRACTICUM IN CLINICAL ENGINEERING
Seminars in medical equipment management; evaluation, testing, and standards; working experience in laboratory and in community hospitals in conjunction with the Clinical Engineering Center. Prereq: permission of instructor and director of CEC. A year-long continuous course; 3 credits each semester. "IA" grade (continuous course) will be given at the end of the first semester. 3 cr.

836. BIOMEDICAL ENGINEERING II
Applications of engineering in such areas as surgery, critical-care units, neurophysiology, biotelemetry, modeling, and interaction of waves with biological tissues. Prereq: E E 783 or equivalent. 3 cr.

839. STATISTICAL THEORY OF COMMUNICATIONS
An introduction to probability theory and random waveforms leading to a discussion of optimum receiver principles. Topics include random variables, random processes, correlation, power spectral density, sampling theory, and optimum decision rules. 3 cr.

840. INFORMATION THEORY
A continuation of E E 839. Introduction of information-theory concepts. Topics include: message sources, entropy, channel capacity, fundamentals of encoding, Shannon’s theorems. Prereq: E E 839. 3 cr.

841. DIGITAL SIGNAL PROCESSING
Theory and practice of digital signal processing: elements of nonrecursive and recursive digital filters, random number generators and simulation of time series, the fast Fourier transform, spectral estimation, envelopes and phases, modeling of time series. Samples of data from various physical experiments will be analyzed as student projects. Some exposure to programming is desirable. 3 cr.

842. DISCONTINUOUS CONTROL
Analysis and synthesis of feedback control systems operating on quantized information; compensation and performance improvement methods that use the quantized nature of the information are also developed. Design methods for pulse-width modulation, optimum quantizers, and limit cycle behavior of quantized systems are developed. (Also offered as M E 842.) 4 cr.

844. NONLINEAR CONTROL SYSTEMS
Analysis and design of nonlinear control systems from the classical and modern viewpoints are discussed. Liapunov’s stability theory; phase space methods; linearization techniques; simulation; frequency response methods; generalized describing functions; transient analysis utilizing functional analysis; and decoupling of multivariable systems. Prereq: E E or M E 851. (Also offered as M E 844.) 4 cr.

851. ADVANCED CONTROL SYSTEMS I
State-space representation of multivariable systems; analysis using state transition matrix. Controllability and observability; pole placement using state and output feedback; Liuenberger observers. Introduction to computers and controlled systems (sampling, discrete state representation, hybrid systems), nonlinear analysis (Liapunov, Popov, describing function). Prereq: E E or M E 782. (Also offered as M E 851.) 3 cr.
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852. ADVANCED CONTROL SYSTEMS II
Special topics in control theory: continuous and discrete systems; optimal control systems, including calculus of variations, maximum principle, dynamic programming, Weiner and Kalman filtering techniques, stochastic systems, adaptive control systems. Prereq: E E or M E 851. (Also offered as M E 852.) 3 cr.

853. ARTIFICIAL INTELLIGENCE
Current approaches to machine intelligence and the simulation of human cognitive processes, including an introduction to recursive functions and programming with the LISP language. Heuristic programming, programs for game playing and natural language understanding, elementary theory of computability. Individual computer project required. Prereq: programming experience. (Also offered as C S 853.) 3 cr.

854. AUTOMATA THEORY
Formal languages and theoretical "machines" or automata. Formal grammars; context-dependent, context-free, and regular languages; finite state machines and regular expression recognizers; infinite state machines; Turing machines; unsolvable problems and the halting problem; linear-bound and push-down automata; cellular and reproducing automata. Prereq: programming experience. (Also offered as C S 854.) 3 cr.

855. ESTIMATION AND FILTERING
Stochastic systems course with application to control and communications. Topics include random variables, noise in linear systems, Bayesian and minimum variance estimation theory, optimal state estimators, Weiner and Kalman filters, combined estimation and control, prediction, parameter identification, and nonlinear filtering. Prereq: M E or E E 851; Math 735 or equivalent. (Also offered as M E 855.) 3 cr.

860. COMPUTER ARCHITECTURE
Advanced topics in computer organization. Parallel and pipeline processing; associative and stack computers; microprogramming; virtual memory; current topics. Prereq: logical design of digital computers. 3 cr.

865. INTRODUCTION TO PATTERN RECOGNITION
Machine classification of data, feature space, clustering, linear separability, fictitious play algorithm, Braverman's hyperplane training and learning algorithm, learning and game playing computer programs that recognize patterns. Prereq: knowledge of computer terminal operation; BASIC language; probability and statistics or equivalents. 3 cr.

895. MASTER'S PROJECT
Independent theoretical and/or experimental work under guidance of a faculty adviser. A written report is required, as is an oral examination on the work and related subjects. 3 cr.

898. INDEPENDENT STUDY
Independent theoretical and/or experimental investigation of an electrical engineering problem under the guidance of a faculty member. 1-3 cr.

899. MASTER'S THESIS
6 cr.

999. DOCTORAL RESEARCH

Engineering Ph.D. Program (Engr)

Coordinator Donald W. Melvin

The College of Engineering and Physical Sciences offers a program of study leading to the degree of doctor of philosophy in engineering. The program has five areas of specialization: chemical engineering, civil engineering, electrical engineering, mechanical engineering, and systems design. The systems design area is an interdepartmental program that addresses contemporary engineering and scientific problems that can be solved only through the cooperation of a variety of disciplines. Problems addressed in the other four areas of specialization follow the four classical departmental boundaries.

Areas of Specialization

Chemical Engineering: Stephen S. T. Fan, area co-ordinator

This area deals with the design and analysis of processes regarding the transfer and transformation of material and energy. It includes fields such as fluid mechanics, heat transfer, mass transfer, reaction kinetics, polymer processing, biochemical engineering, process dynamics, pollution control, and energy. Current research activities include solar energy, new energy sources, pollution control, combustion, particle formation, polymer kinetics, coal liquefaction, coal gasification, irradiation, radiative heat transfer, biomedical engineering, and energy conservation.

Civil Engineering: Pedro A. De Alba, area coordinator

This area involves both analytical and experimental topics, including solid mechanics, structural mechanics, classical and continuum mechanics, soil mechanics, systems analysis, environmental engineering, and materials science. Current research activities include water and wastewater treatment, treatment of hazardous wastes, groundwater containment transport, evaluation of hazards to small community water supplies, fabric identification in sands by acoustic methods, studies of in-situ stresses and consolidation characteristics using a self-boring pressure meter, influence of aggregate gradation on controlling the water-cement ratio of Portland cement, of concrete while maintaining workability, and of internally sealed concrete, coupled, twisting-bending vibrations of continuous curved beams, effects of rotary inertia and shear on multispans curved frames, computer-aided structural planning and design of buildings, computer-graphics applications in structural engineering, and design investigations for the reconstruction of small/low-head hydropower facilities.

Electrical Engineering: Paul J. Nahin, area coordinator

This area involves any topic, whether analytic or experimental, which is normally a branch of studies in the Department of Electrical and Computer Engineering. Current research areas include: acoustics, biomedical systems and instrumentation, computer and digital systems, distributed computers, fault-tolerant computing, VLSI, digital and optical signal
processing, EM-wave propagation, control systems, geophysical sensing, lighting design, fiber optics, signal propagation, robotics, machine vision and image processing, and systems modeling.

The development of professional communication skills, through a teaching assignment, is considered a basic component of a graduate education. Every degree candidate is eligible for admission to the program, required to participate in seminar and/or course presentations, as determined by the department, to satisfy this teaching requirement.

**Mechanical Engineering:** John A. Wilson, area coordinator.

Programs of study are offered from the viewpoint of the engineering sciences and of engineering design with concentration in the areas of theoretical and applied mechanics and the thermal sciences. These programs include those aspects of engineering, physics, and applied mathematics that are relevant to a fundamental understanding in each area of the theoretical foundations and their consequent applications.

Current research topics include mechanical properties of materials such as viscoelasticity, plasticity, creep, and fatigue; classical and continuum mechanics applied to wood fibers; elastic-wave propagation; structural dynamics including nonlinear dynamics of ocean structures, vehicles, and electromechanical systems; fluid and thermal sciences applied to solar and other alternative energy processes; control-signal propagation in long fluid lines; laminar/turbulent instabilities; and ocean engineering topics such as ocean sediment acoustics, and estuary hydrodynamics and pollution.

**Systems Design:** Charles K. Taft, area coordinator.

Students entering this area of the Engineering Ph.D. Program can elect either one of two professional directions. The first develops professionals with the technical expertise of a Ph.D. and with the ability to work with and direct groups of people working on large-scale technical projects. The second direction develops engineers with capabilities in the theory and analysis of large-scale complex systems. Concentration in an area of specific individual interest is combined with participation in a larger interdisciplinary project.

Current projects related to the area include coastal engineering, marine soil mechanics, submersibles and underwater habitats, ocean instrumentation, marine structures and buoy systems, arctic engineering, discontinuous control systems, vehicle and transportation systems, nonlinear dynamic systems modeling, fluid-power systems, stepping and brushless motor dynamics and design, electromechanical systems, nonlinear decoupling control, computer systems, vehicle dynamics, illuminating engineering systems, facility systems, social and business systems, biomedical systems and instrumentation, and environmental engineering.

**Requirements**

Qualified students with bachelor's or master's degrees in engineering, mathematics, or the physical sciences are eligible for admission to the program. To be admitted, students must present evidence that they have sufficient background in the area in which they propose to specialize.

Following entrance into the program, a guidance committee will be appointed for the student by the Dean of the Graduate School upon recommendation of the student's area coordinator. This committee assists students in outlining their program and may specify individual coursework requirements in addition to those required by the area of specialization. The committee will also conduct an annual in-depth review of each student's progress and, following substantial completion of a student's coursework, will administer the qualifying examination. This committee is also responsible for administering the language examination and/or research-tool proficiency requirements. Coursework and language requirements should normally be completed by the end of the second year of full-time graduate study, and must be completed before the student can be advanced to candidacy.

Upon the successful completion of the qualifying examination and other proficiency requirements, the student will be advanced to candidacy and, upon the recommendation of the student's area coordinator, a doctoral committee will be appointed by the Dean of the Graduate School. The doctoral committee shall conduct an annual review of the student's progress, supervise and approve the doctoral dissertation, and administer the final dissertation defense.

To obtain a Ph.D. degree in engineering, a student must meet all of the general requirements as stated under academic regulations and degree requirements of the Graduate School. Students will normally be expected to take coursework equivalent to two full-time academic years beyond the baccalaureate and complete a dissertation on original research that will require at least one additional year of full-time study. A student should consult specific course offerings and descriptions of each department and should consult the area coordinator for additional information.

**English (Eng)**

**Chairperson:** Carl Dawson

**PROFESSORS:** Thomas A. Carnicelli; Carl Dawson; Michael V. DePorte; Karl C. Diller; Robert Hapgood; Jean E. Kennard; Gary H. Lindberg; Terence P. Logan; Edmund G. Miller; Donald M. Murray; Philip L. Nicoloff; John C. Richardson; Charles D. Simic; Mark R. Smith; Thomas A. Williams, Jr.; John A. Yount

**ASSOCIATE PROFESSORS:** Janet E. Aikens; Mary Morris Clark; Lester A. Fisher; Melody Graulich; Elizabeth Hageman; Mekeel McBride; Andrew H. Merton; Thomas R. Newkirk; Hugh M. Potter III; Susan Schibanoff; Patrocinio P. Schweikart; David H. Watters

**ASSISTANT PROFESSORS:** Robert J. Connors; Jane Harrigan; Rochelle Lieber; Sarah Way Sherman; David V. Siddall

**GRADUATE PROGRAM COORDINATOR:** Michael V. DePorte

The Department of English offers three advanced degrees, master of arts, master of science for teachers, and doctor of philosophy. All applicants are required to submit Graduate Record Examination scores for the general test. Applicants for the doctor of philosophy degree program must also submit scores for the subject test of literature in English. All applicants must submit writing samples. Applicants for the Ph.D. are normally expected to have a reading knowledge of at least one foreign language. Specific requirements for each degree program can be obtained from the department.
Master of Arts Programs

Master of Arts in Literature

The master of arts may be undertaken as a terminal degree or as preparation for a doctoral program. The program encourages students to pursue their individual interests and to correct deficiencies in their undergraduate training.

An M.A. candidate must complete 32 credit hours including at least two seminar courses and four credits of English 895. Of the 32 credits, 28 credits must be at the 800 level. At least four courses must be in English or American literature (as distinct from courses in critical analysis, linguistics, writing, teaching methods, or other literature). Each M.A. candidate must pass the master's seminar in the study of literature (Engl 819) and one course in the English language or in the teaching of composition. As a general rule, all courses counting toward the M.A. degree should be taken in the English department. In special circumstances, however, a student may be allowed to apply toward the degree up to two graduate courses offered by other departments. For students planning a teaching career, the department requires at least one semester of teaching experience (subject to availability of funds).

An M.A. candidate must pass a reading examination in a foreign language. Foreign students whose native language is not English may be exempt from this requirement. Each candidate for the M.A. degree must register for four credits of Engl 895 and produce a substantial scholarly paper.

Master of Arts in Writing

The master of arts in writing is designed for students who intend to become professional writers. Eight working writers supervise the program. Students may elect to specialize in fiction, nonfiction, or poetry. Each member of the writing faculty is accomplished in at least one of these fields.

The writers at UNH emphasize conference teaching. Each student meets frequently with writers specializing in the student's area of study. In addition, each student works closely with a writer-adviser throughout the program.

Workshop courses provide forums for prompt, detailed criticism of each student's writing by instructors and fellow students. Each student takes at least two workshops in his or her specialty and may elect to take an additional workshop in another area as well. Form-and-theory courses and literature courses complete the program. The program consists of 32 credit hours, of which 28 credits must be at the 800 level.

Upon completion of the required courses, the student submits a portfolio of writing to the staff. The portfolio might consist of short stories, a novel, nonfiction articles, a nonfiction book, or a collection of poetry. The degree is awarded upon approval of the portfolio by a committee of writers. There is no foreign language requirement.

Master of Arts in English Language and Linguistics

Students who wish to specialize in any of the various areas of English language and linguistics may design an M.A. program to meet their interests. Specialties include applied linguistics and the teaching of English as a second language as well as the traditional subfields of linguistics. Psycholinguistics courses are offered through the psychology department.

To earn the M.A. degree, students must complete at least 32 credit hours, including two seminar courses, and 4 credits of Engl 895 in which they are to produce a substantial scholarly paper. At least 24 credits must be at the 800 level. Unless the student already has a strong background in linguistic theory, the program of study must include one course in phonetics and phonology (Engl 893) and one in syntax and semantics (Engl 894). Reading knowledge of one foreign language is required. The student's course of study must be approved by the program adviser.

Master of Science for Teachers

The master of science for teachers is designed for high school teachers. No foreign language is required. The student must complete 32 credit hours in English courses, numbered 700 and above. At least eight credits must be at the 800 level. The remaining credits may be taken at either the 700 or 800 level and should normally include at least one course in the teaching of writing and in the study of language. Applicants should consult the General Regulations of the Graduate School for the special admissions requirements for this program.

Doctor of Philosophy

A student admitted to the Ph.D. program must hold an M.A. degree or be in the final stage of completing requirements for the degree.

The Ph.D. program offers professional training in literature, language, and the teaching of composition. The program combines the essential guidance and discipline of coursework with the equally essential freedom of independent study and research. Accordingly, in the first year the student is encouraged to follow a program suited to individual interests and needs.

Ph.D. candidates will normally complete ten English courses beyond the M.A. degree. Four of these courses must be graduate seminars in this department. Each student's program must include 32 credits at the 800 level and must include: Introduction to the Teaching of Writing (Engl 810); a course on criticism; a half-course (2-credit) ungraded module on the teaching of literature (Engl 839); and a half-course (2-credit) ungraded module on bibliography and professional methods (Engl 800). In special circumstances, a course at the 700 level or a course from another department may be included among the ten courses with approval of the graduate committee.

In addition to meeting course requirements, each student must pass: 1) reading examinations in two foreign languages; 2) after preliminary work for the Ph.D. degree, a general examination; and 3) a later qualifying examination in three related areas to a proposed dissertation and projected teaching specialties. A student must also write a dissertation and defend it at a final oral examination.

M.A. and Ph.D. students holding assistantships teach under supervision; such teaching is considered a vital part of the student's professional training. At least a year of intern teaching or its equivalent is required of all doctoral candidates.

Graduate students should note that not all seminars are offered every year. A detailed guide to the department's programs is available from the secretary for graduate programs, Department of English.

See English department brochure for detailed descriptions of current course offerings.
600. ENGLISH AS A SECOND LANGUAGE
A course designed for foreign graduate students in their first semester at UNH to give them English language skills necessary for effective graduate work at the University. The course will include work on listening skills (understanding lectures, note-taking, etc.), reading skills, the writing of research papers, the making of oral reports, and general study skills, with work on grammar and pronunciation for those who need it. Credits may not be used to fulfill minimum degree requirements of a graduate program. 2–4 cr. Cr/F. (Course may be repeated.)

701, 702/801, 802. ADVANCED WRITING OF FICTION
Workshop discussion of advanced writing problems and readings of students' fiction. Individual conferences with instructor. Prereq: writing fiction or equivalent. Written permission of instructor required for registration. May be repeated for credit with the approval of the department chairperson. 4 cr.

703, 704/803, 804. ADVANCED NONFICTION WRITING
A workshop course for students intending to write publishable magazine articles or nonfiction books. Equal stress on research and writing techniques. Prereq: newswriting; written permission of instructor required. May be repeated for credit with the approval of the department chairperson. 4 cr.

705, 706/805, 806. ADVANCED WRITING OF POETRY
Workshop discussion of advanced writing problems and submitted poems. Individual conferences with instructor. Prereq: writing poetry or equivalent. Written permission of instructor required for registration. May be repeated for credit with the approval of the department chairperson. 4 cr.

707/807. FORM AND THEORY OF FICTION
A writer's view of the forms, techniques, and theories of fiction. The novels, short stories, and works of criticism studied will vary, depending on the instructor. 4 cr.

708/808. FORM AND THEORY OF NONFICTION
A writer's view of contemporary nonfiction, emphasizing the choices the writer faces in the process of research and writing. 4 cr. (Not offered every year.)

709/809. FORM AND THEORY OF POETRY
A writer's view of the problems, traditions, and structures of poetry. 4 cr.

710/810. TEACHING WRITING
An introduction to various methods of teaching writing. Combines a review of theories, methods, and texts with direct observation of teaching practice, 2 or 4 cr. (Degree candidates must enroll for 4 cr.)

713, 714/813, 814. LITERARY CRITICISM
Major critics from Plato to the present; the chief critical approaches to literature. 4 cr. (Not offered every year.)

715/815. APPLIED LINGUISTICS:
TEACHING ENGLISH AS A SECOND LANGUAGE
Methods of teaching and learning foreign languages; background work on theories of language acquisition; the methodology of teaching English as a second language. 4 cr.

716/816. PROBLEMS IN APPLIED LINGUISTICS
Variable topics course; problems such as language acquisition in children and adults, bilingualism, and linguistic field methods. 4 cr. (Not offered every year.)

718/818. ENGLISH LINGUISTICS AND LITERATURE
An introduction to linguistics for students of literature. Includes a survey of the grammar of English (phonology, morphology, syntax, dialect variation, historical change) with application to the analysis of the language of poetry and prose. 4 cr. (Not offered every year.)

720. NEWSPAPER INTERNSHIP
Students intending to pursue careers in journalism spend a semester working full- or part-time for a daily newspaper under close supervision of editors. Reporting is stressed, but students may do some editing as well. The number of internships is very limited. Prereq: newswriting or equivalent; and permission. 4–16 cr.

741/841. LITERATURE OF EARLY AMERICA
Prose and poetry of the periods of exploration, colonization, early nationalism, Puritanism, Enlightenment; Individual works and historical-cultural background. 4 cr. (Not offered every year.)

742/842. AMERICAN LITERATURE, 1815–1865
Fiction, nonfiction, and poetry in the period of romanticism, transcendentalism, nationalism. Individual works and cultural background. 4 cr. (Not offered every year.)

743/843. AMERICAN LITERATURE, 1865–1915
Fiction, nonfiction, and poetry in the period of realism, naturalism, industrialism, big money. Individual works and cultural background. 4 cr.

744/844. AMERICAN LITERATURE, 1915–1945
Fiction, poetry, and drama in the period of avant-garde and leftism, jazz age, and depression. Individual works and cultural background. 4 cr.

745/845. CONTEMPORARY AMERICAN LITERATURE
A gathering of forms, figures, and movements since 1945. Individual works and cultural background. 4 cr.

746/846. STUDIES IN AMERICAN DRAMA
Topics vary from year to year. Examples: 20th-century American drama; contemporary playwrights; theatricality in American life. 4 cr. (Not offered every year.)

747/847. STUDIES IN AMERICAN POETRY
Topics vary from year to year. Examples: poets of the open road; Pound and his followers; major
American poets; contemporary American poetry. 4 cr. (Not offered every year.)

748/848. STUDIES IN AMERICAN FICTION
Topics vary from year to year. Examples: the romance in America; the short story; realism and naturalism; the city novel; fiction of the thirties. 4 cr.

749/849. MAJOR AMERICAN AUTHORS
Intensive study of two or three writers. Examples: Melville and Faulkner; Fuller, Emerson, and Thoreau; James and Wharton; Dickinson and Frost. 4 cr.

750/850. SPECIAL STUDIES IN AMERICAN LITERATURE
Topics vary from year to year. Examples: the Puritan heritage; ethnic literatures in America; landscape in American literature; five American lives; pragmatism; American humor; transcendentalism; women regionalists. 4 cr.

751/851. MEDIEVAL EPIC AND ROMANCE
The two major types of medieval narrative; comparative study of works from England, France, Germany, and Iceland, including Beowulf, Song of Roland, Niebelungenlied, Gottfried's Tristan, Njal's Saga, and Malory's Morte d'Arthur. All works read in modern English translations. 4 cr. (Not offered every year.)

752/852. HISTORY OF THE ENGLISH LANGUAGE
Evolution of English from the Anglo-Saxon period to the present day. Relations between linguistic change and literary style. 4 cr. (Not offered every year.)

753/853. OLD ENGLISH
Introduction to Old English language and literature through the readings of selected poetry and prose. 4 cr.

754/854. BEOWULF
A reading of the poem and an introduction to the scholarship. Prereq: Eng 753. 4 cr.

755, 756/855, 856. CHAUCER
755/855: Troilus and Criseyde, in the context of continental literature by Boccaccio and other influences. 756/856: Chaucer—A study of The Canterbury Tales in its original language. 4 cr.

758/858. SHAKESPEARE
A few plays studied intensively. Live and filmed performances included as available. 4 cr.

759/859. MILTON
Milton and his age. Generous selection of Milton's prose and poetry, with secondary readings of his sources and the scholarship. 4 cr. (Not offered every year.)

763/863. CONTINENTAL BACKGROUNDS OF THE ENGLISH RENAISSANCE
Major philosophers, artists, and writers of the continental Renaissance (in translation): Petrarch, Pico, Vives, Valla, Castiglione, Machiavelli, Luther, Calvin, Rabelais, Montaigne, Cervantes, Erasmus, and Thomas More, as representative of the early English Renaissance. 4 cr. (Not offered every year.)

764/864. PROSE AND POETRY OF THE ELIZABETHANS
Shakespeare and his contemporaries. Major works, including Spenser's Faerie Queene, Sidney's Astrophil and Stella, Shakespeare's Sonnets, Marlowe's Dr. Faustus: their literary and intellectual backgrounds. 4 cr. (Not offered every year.)

765/865. ENGLISH LITERATURE IN THE 17TH CENTURY
Major writers of the 17th century, including Donne, Jonson, Herbert, Bacon, and Hobbes. 4 cr. (Not offered every year.)

767, 768/867, 868. LITERATURE OF THE RESTORATION AND 18TH CENTURY
Representative works; texts studied closely; the ways they reflect the central intellectual problems of their age. 767/867: Milton, Dryden, Rochester, Restoration plays, Defoe, Swift, and Pope. 768/868: Fielding, Johnson, Boswell, Voltaire, Sterne, Rousseau, Beckford, Diderot, Godwin, and Blake. 4 cr.

769, 770/869, 870. THE ENGLISH ROMANTIC PERIOD
Major literary trends and authors, 1798 to 1832. Focus on poetry but attention also to prose works and critical theories. 769/869: Wordsworth, Coleridge, Lamb, Hazlitt, DeQuincey. 770/870: Byron, Shelley, Keats. 4 cr. (Not offered every year.)

771, 772/871, 872. VICTORIAN PROSE AND POETRY
Major writers; social and cultural history. Typically included in 771/871, Carlyle, Ruskin, Newman, Tennyson, Browning, and others; in 772/872, Arnold, the pre-Raphaelites, Swinburne, Hopkins, and others. 4 cr. (Not offered every year.)

773, 774/873, 874. BRITISH LITERATURE OF THE 20TH CENTURY
Poets and novelists; the concept of modernity in literature. Offerings vary by year and by instructor, but normally include such figures as Joyce, Lawrence, Yeats, Woolf, Forster, and contemporary writers such as Burgess, Fowles, Murdoch, and Golding. 4 cr.

775/875. IRISH LITERATURE
Survey from the beginnings to the present; works in Irish (read in translation) such as The Cattle Raid of Cooley, medieval lyrics, and Mad Sweeney; and works in English from Swift to the present. Twentieth-century authors: Joyce, Yeats, Synge, O'Casey, Beckett, and Flann O'Brien. 4 cr. (Not offered every year.)

778/878. BRAIN AND LANGUAGE
An introduction to neurolinguistics, a study of how language is related to the structure of the brain. The course is open to both the students and the instructor at the beginning of the class. The primary aim of the course is to give students a practical introduction to linguistic analysis without the support of a text. Theoretical concepts will be introduced as needed. 4 cr.

779/879. LINGUISTIC FIELD METHODS
Devoted to the study, with use of an informant, of some non-Indo-European language that is unfamiliar to both the students and the instructor at the beginning of the class. The primary aim of the course is to give students a practical introduction to linguistic analysis without the support of a text. Theoretical concepts will be introduced as needed. 4 cr.
ENGLISH DRAMA TO 1640
Development of the drama through the Renaissance, emphasizing the Elizabethan and Jacobean dramatists. 4 cr.

ENGLISH DRAMA FROM 1660 TO 1780
Representative plays, both serious and comic, by such writers as Wycherley, Congreve, Etheridge, Goldsmith, Sheridan, Davenant, Dryden, Otway, Rowe, and Lillo. 4 cr.

MODERN DRAMA
Major English, American, and (translated) European plays of the modern period by such playwrights as Shaw, Ibsen, Chekhov, Strindberg, Pirandello, O’Neill, Brecht, Beckett, Williams, Miller, Pinter. Live and filmed performances studied as available. 4 cr. (Not offered every year.)

THE ENGLISH NOVEL OF THE 18TH CENTURY
The rise and development of the novel through study of selected major works by Defoe, Richardson, Fielding, Smollett, Sterne, and Austen. 4 cr.

THE ENGLISH NOVEL OF THE 19TH CENTURY
Representative novels from among Austen, Scott, Dickens, Thackeray, Emily Brontë, Charlotte Brontë, Trollope, George Eliot, Hardy, and Conrad. 4 cr.

MAJOR WOMEN WRITERS
Intensive study of one or more women writers. Selections vary from year to year. 4 cr.

SPECIAL TOPICS IN LINGUISTIC THEORY
An advanced course on a topic to be chosen by the instructor. Inquire at the English department office for a full course description each time the course is offered. Topics such as word formation, dialectology, linguistic theory and language acquisition, language and culture, cross-disciplinary studies relating to linguistics. Barring duplication of subject, may be repeated for credit. 4 cr.

ENGLISH GRAMMAR
A survey of the grammar of English (pronunciation, vocabulary, sentence structure, punctuation, dialect variation, historical change) with special attention to the distinction between descriptive and prescriptive grammar and to the problems students have with formal expository writing. 4 cr.

TEACHING SECONDARY SCHOOL ENGLISH
Methods of teaching language, composition, and literature in grades 7-12. Required of all students in the English teaching major. Open to others with permission. 4 cr.

PHONETICS AND PHONOLOGY
The sounds and sound systems of English in the context of linguistic theory: comparisons of English to other languages. Prereq: a basic linguistic course or permission. 4 cr. (Not offered every year.)

SYNTAX AND SEMANTIC THEORY
The relationship of grammar and meaning as viewed from the standpoint of modern linguistic theory. Emphasis on the syntax and semantics of English, with special attention to the construction of arguments for or against particular analyses. Prereq: a basic linguistic course or permission. 4 cr.

INDEPENDENT STUDY
To be elected only with permission of the department chairperson and of the supervising faculty member or members. Barring duplication of subject, may be repeated for credit up to a maximum of 16 credits. 1-16 cr.

SPECIAL STUDIES IN LITERATURE
A) Old English Literature; B) Medieval Literature; C) 16th Century; D) 17th Century; E) 18th Century; F) English Romantic Period; G) Victorian Period; H) 20th Century; I) Drama; J) Novel; K) Poetry; L) Nonfiction; M) American Literature; N) A Literary Problem; O) Literature of the Renaissance. The precise topics and methods of each section will vary. Barring duplication of subject, may be repeated for credit. For details, see the course descriptions available in the English department. 4 cr.

BIBLIOGRAPHY AND METHODS
Introduction to enumerative and physical bibliography and major research and reference works of the field, to prepare the student for original research in the graduate program and later. Required of all Ph.D. students. 2 cr. Cr/F.

HISTORICAL AND THEORETICAL STUDIES IN RHETORIC
The rhetorical tradition in Western culture, with a special focus on three critical periods: the classical period (Aristotle, Cicero, Quintilian), the eighteenth century (Blair and Campbell), and the modern era (Burke, Booth, Perelman, Ong, Weaver). 4 cr.

SEMINAR IN TEACHING WRITING
Review of the current professional literature on composition; research projects in areas selected in consultation with instructor. Prereq: Engl 810 or permission. 4 cr.

THE GRADUATE STUDY OF LITERATURE
Techniques, resources, and purposes of literary study: close reading; practical criticism; critical theories and their values; pertinence of intellectual and historical backgrounds. Approaches applied to a specific area of literary study, which varies from year to year. 4 cr.

COMPOSITION THEORY
Recent advances in our understanding of the composing process; the social and cultural context of literacy learning. 4 cr.

PROBLEMS IN TEACHING ENGLISH
Special topics in teaching within the discipline of English. Inquire at the department to see what topics in the teaching of literature, language, or writing may be scheduled. Open only to graduate students with a professional interest in teaching or to practicing teachers. 1-6 credits depending on the specific course.

SEMINARS
LINGUISTICS
4 cr.
821. SEMINAR—STUDIES IN OLD ENGLISH 4 cr.

824. SEMINAR—STUDIES IN MEDIEVAL LITERATURE 4 cr.

825. SEMINAR—STUDIES IN 16TH-CENTURY LITERATURE 4 cr.

826. SEMINAR—RHETORICAL AND COMPOSITION THEORY 4 cr.

827. SEMINAR—STUDIES IN SHAKESPEARE 4 cr.

828. SEMINAR—STUDIES IN MILTON 4 cr.

829. SEMINAR—STUDIES IN EARLY 17TH-CENTURY LITERATURE 4 cr.

830. SEMINAR—STUDIES IN 18TH-CENTURY LITERATURE 4 cr.

832. SEMINAR—STUDIES IN THE ROMANTIC PERIOD 4 cr.

833. SEMINAR—STUDIES IN THE VICTORIAN PERIOD 4 cr.

834. SEMINAR—STUDIES IN 20TH-CENTURY BRITISH LITERATURE 4 cr.

836. SEMINAR—LITERATURE OF EARLY AMERICA 4 cr.

837. SEMINAR—STUDIES IN 19TH-CENTURY AMERICAN LITERATURE 4 cr.

838. SEMINAR—STUDIES IN 20TH-CENTURY AMERICAN LITERATURE 4 cr.

840. SEMINAR—STUDIES IN ENGLISH DRAMA 4 cr.

895. READING AND RESEARCH 2, 4, or 8 cr. IA, Cr/F.

999. DOCTORAL RESEARCH

Entomology (Ento)

Chairperson: Paul C. Johnson

PROFESSOR: James S. Bowman
ASSOCIATE PROFESSORS: John P. Burger; G. Thomas Fisher; Paul C. Johnson; R. Marcel Reeves
ASSISTANT PROFESSOR: Donald S. Chandler
ADJUNCT ASSISTANT PROFESSOR: Siegfried E. Thewke

An applicant for admission to graduate study in entomology is expected to have at least the basic (Ento 402) course in entomology as well as adequate preparation in the allied sciences of chemistry, botany, and zoology. During the first semester of residency, degree candidates' backgrounds in entomology will be reviewed in conference with at least three faculty members. Students lacking the necessary background courses may be required to complete certain of these courses, which do not carry credit, before they are admitted to full candidacy for a degree.

The program of graduate study is designed to meet the needs of those students planning to take further work leading to a career in professional entomology. Areas of specialization include taxonomy, ecology, ethnology, biological control, pest management, chemical control, problems in medical entomology, forest entomology, and agricultural entomology. A thesis is required of all candidates for the master's degree. An oral examination on the thesis is required as well as an oral exam covering general entomological expertise. Students are given the opportunity to assist the professional staff in field research and as laboratory assistants, and they are also encouraged to attend professional meetings in their appropriate fields.

No language requirements are made for the M.S. degree. Applicants are required to submit general and subject biology scores from the Graduate Record Examination.

704. MEDICAL ENTOMOLOGY
Survey of past and present trends in arthropod-borne diseases transmitted to human populations, emphasizing dynamics of arthropod-host-pathogen/parasite relationships, natural nidality of disease, and role of arthropods and other animals as reservoirs or vectors of disease and maintenance of zoonoses. Laboratory emphasizes survey of arthropod groups important as disease vectors or in envenomizing humans. Lab. 4 cr.

705. SYSTEMATICS AND TAXONOMY OF INSECTS
The kinds and diversity of insects and their relationships, emphasizing methods of species and population analysis, concepts of classification and nomenclature, and application to identification. Prereq: intro entomology; or permission. Lab. 4 cr.

706. SOIL ARTHROPODS
Biology and systematics of terrestrial arthropods, with emphasis on the springtails, sowbugs, myriapods, mites, spiders, and other arachnids. Prereq: permission. Lab. 4 cr. (Not offered every year.)

707. IMMATURE INSECTS
Identification of immature stages of insects, especially of holometabolous orders. Aquatic forms not included. Prereq: insect morphology, intro ento, or permission. 4 cr. (Not offered every year.)

709. AQUATIC INSECTS
Biology, ecology, and taxonomy of aquatic insects, including their role in succession and food webs of aquatic ecosystems, origin and evolution of adaptations to aquatic environments and relationship between habitat type and faunal diversity. Laboratory emphasizes qualitative and semi-quantitative sampling techniques, collection and identification of principal aquatic groups. Prereq: intro ento, principles of zoology, or permission. Lab. 4 cr. (Not offered every year.)
710. INSECT MORPHOLOGY
External and internal anatomy of insects, with the integration of body structure and function. Prereq: permission. Lab. 4 cr. (Not offered every year.)

720. AGRICULTURAL ENTOMOLOGY
For advanced students interested in agribusiness. Economic effect of insect pests on forage, fruit, and vegetable crops. Life cycles; damage and current methods of control. Prereq: permission. Lab. 4 cr.

721. PRINCIPLES OF BIOLOGICAL CONTROL
Natural and applied aspects of biological control of insect and plant pests. Prereq: permission. 4 cr. (Not offered every year.)

722. CHEMICAL CONTROL OF INSECTS
For advanced students in applied entomology. Review of the chemical compounds for insect control. Modes of pesticide entry; toxicology. Basic understanding of chemistry is desired. Prereq: permission. Lab. 4 cr.

723. REGULATORY PEST CONTROL
For students preparing for careers dealing directly with or associated with the movement of agricultural commodities in internal and foreign trade. Legal documents; federal and state statutes. Prereq: basic entomology and plant pathology courses; permission. 2 or 4 cr. (Not offered every year.)

724. STRUCTURAL PEST CONTROL
For students wishing to study household and industrial entomology. Prereq: permission. Lab. 4 cr.

801. GRADUATE ENTOMOLOGY
Concentrated studies in insect biology, systematics, and biological control or chemical control of insects. Subject matter, hours, and credits to be arranged. 1–4 cr.

825. INSECT ECOLOGY
Role of insects in: coevolution of plant-herbivores and predator/parasite-prey systems, ecosystem energetics, population dynamics, niche theory, competition, coexistence, diversity, and stability. Prereq: permission. 4 cr. (Not offered every year.)

826. INTEGRATED PEST MANAGEMENT
Integration of pest management techniques involving biological, cultural, and chemical control with principles of insect ecology into management approach for insect pests. Prereq: permission. 4 cr. (Not offered every year.)

897, 898. ENTOMOLOGY SEMINAR
Selected topics and current developments. Required of all graduate entomology students. May be repeated. 1 cr.

899. MASTER'S THESIS
Hours and credits to be arranged. 6–10 cr.

Family and Consumer Studies (FCS)

Chairperson: Larry J. Hansen

ASSOCIATE PROFESSORS: Larry J. Hansen; Michael F. Kalinowski; Victor R. Messier; Elizabeth A. Snell

ASSISTANT PROFESSORS: Kristine M. Baber; Elizabeth M. Dolan

GRADUATE PROGRAM COORDINATOR: Kristine M. Baber

The Department of Family and Consumer Studies offers a program of study and research leading to the master of science degree. The goal of the program is to provide students with an understanding of theory and methods relevant to child, family, and consumer studies. Each student will develop a specialization consistent with the department's philosophy of family advocacy. A core curriculum will provide students with an understanding of the general departmental orientation and enable students to develop skills and resources to design and implement research proposals.

Program requirements for the master of science degree include: 1) full-time study for a minimum of one year or a pre-approved alternative plan of study; 2) completion of the 16-credit core curriculum that includes Theoretical Approaches to Family and Consumer Studies (FCS 893), Research Seminar (FCS 894), an approved advanced statistics course, and a minimum of 2 Practicum (FCS 707) credits per semester for at least two semesters; 3) completion of 20 additional semester hours of coursework, of which up to six hours may consist of thesis work and six of independent study; and 4) successful completion and defense of a thesis in accordance with the guidelines available in the Graduate Student Handbook.

Upon admission to the program, each student will be assigned a temporary faculty adviser who will 1) provide the student with necessary information about the expectations of the program, 2) ensure that each student fulfills the requirements regarding the core curriculum, and 3) work with the student in identifying a thesis adviser. Each student will work closely with the thesis adviser to carry out research and write the thesis. All students are expected to become involved in the teaching and research activities of the department, particularly in their areas of specialization.

Admission to the program is limited to those students who desire the M.S. degree and whose undergraduate records demonstrate good academic standing. Students with undergraduate degrees in any related field are encouraged to apply. If a student's undergraduate program did not include an introductory statistics course or the equivalent, successful completion of such a course will be required before beginning graduate work. Application for admission must be made on the appropriate forms obtained directly from the Graduate School. Students seeking admission must submit recent scores from the Graduate Record Examination general test.

707. PRACTICUM
Supervised in-depth experience in teaching, research, or advocacy in a professional setting to increase the student's understanding of children, families, or consumer issues. A) Child; B) Family; C) Consumer Studies. Prereq: FCS major; permission. 1–6 cr. Cr/F.

708. CHILD DEVELOPMENT LABORATORY INTERNSHIP
Supervised positions within the UNH Child and Family Center. A) Videotape Assistant; B) Assessment Assistant; C) Toddler Program Assistant; D) Preschool Program Assistant. Prereq: permission. 1–6 Cr. Cr/F.
733. SUPERVISING PROGRAMS FOR YOUNG CHILDREN
Philosophical bases and theoretical rationales of various programs for young children; program alternatives and resources; issues in administration including supervision, finances, and regulations. Prereq: permission. 4 cr. (Fall semester only.)

734. CURRICULUM FOR YOUNG CHILDREN
Designing and implementing developmentally appropriate activities for young children; assessing the effectiveness of activities; evaluating materials and equipment. Prereq: FCS 733; permission. 4 cr. (Spring semester only.)

735. FAMILY ECONOMICS
The effect of economic change on families and family income and resource allocation. Prereq: one course in economics or permission. 4 cr.

736. DEMONSTRATION CLASSROOMS
Seminar in contemporary issues related to economic deprivation in families. Exploration of causes and effects of poverty in American families. Prereq: permission. 4 cr. (Not offered every year.)

737. CRITICAL PROBLEMS IN FAMILY LIFE
Evaluation of the needs and resources of families with critical problems; maturational and situational sources of stress influencing the contemporary American family; students will demonstrate mastery of theoretical concepts by developing self-help strategies to be used by families experiencing stress. Prereq: permission. 4 cr.

893. THEORETICAL APPROACHES TO FAMILY AND CONSUMER STUDIES
Scientific knowledge and the scientific method, the relationship between theory and research as it applies to family and consumer studies; why and how theories change; major theories in historical context. Prereq: permission. 4 cr.

894. RESEARCH SEMINAR
Introduction to social science research methods; analysis of research reports and other professional papers in family and consumer studies; development and evaluation of research proposals. Prereq: FCS 893 and permission. 4 cr.

895. SEMINAR AND SPECIAL PROBLEMS
A) Consumer Research; B) Family Relations; C) Education; D) Family Resource Management; and E) Human Development. The student will contribute to a selective review and critical evaluation of the research and current literature and an examination of issues and trends. Independent projects may be a part of the experience. These seminars are open to graduate students with sufficient background and will not be scheduled every semester. One or more semesters, maximum of 4 credits in one area. Prereq: permission. 2–4 cr.

897. ADVANCED RESEARCH SEMINAR
Interdisciplinary approach to research in child, family, and consumer studies. Emphasis on the multidimensionality of family problems, appropriate research strategies, and critical analysis of current literature. Prereq: permission. 4 cr.

74. MASTER'S THESIS
6 cr.

Forest Resources (FoR)
Chairperson: Harold W. Hocker, Jr.

PROFESSORS: James P. Barrett; Gordon L. Byers; Nicolas Engalichev; Robert D. Harter; John L. Hill; Harold W. Hocker, Jr.; William Mautz; David P. Olson

ASSOCIATE PROFESSORS: Robert T. Eckert; Nobel K. Peterson; R. Marcel Reeves; Richard R. Weyrick

ASSISTANT PROFESSORS: William A. Befort; Theodore E. Howard; John A. Livavitis; Richard G. Parker; C. Tattersall Smith

ADJUNCT PROFESSOR: Robert S. Pierce

ADJUNCT ASSOCIATE PROFESSORS: C. Anthony Federer; James W. Hornbeck; William B. Leak; Sidney A.L. Pilgrim; Lawrence O. Safford

ADJUNCT ASSISTANT PROFESSORS: Maurice E. Demeritt, Jr.; Peter W. Garrett

GRADUATE PROGRAM COORDINATOR: David P. Olson

The Department of Forest Resources offers master of science degrees in three areas.

Forest Resources: forest resource management, forest marketing, wood industry management, forest mensuration, forest tree improvement, and wood science and technology.
Soil science: soil chemistry, soil classification and genesis, and forest soils.

Wildlife: habitat evaluation and management, wildlife nutrition and physiology, and land-use planning for wildlife.

Admission Requirements
Students admitted to these programs are expected to have completed either an undergraduate degree in the field in which they plan to specialize or show adequate preparation in the basic support courses of the field. Students with good undergraduate records who lack a background in a particular field may be admitted to a program, provided they are prepared to correct the deficiencies. All entering students must have taken at least one statistics course or do so at the graduate level. The Graduate Record Examination (general) may be required of some applicants.

Students entering the forestry program may elect to develop concentrations within forest management or forest/wood science. Students with a forest management emphasis are usually expected to have completed a bachelor's degree in forestry equivalent to that obtained at a school accredited by the Society of American Foresters. Students with a forest science or wood science interest should have an appropriate background for study in the specific interest area. Entering students in soil science are required to have adequate preparation in the physical sciences as well as biological or earth sciences.

Students interested in wildlife are expected to have adequate preparation in biological sciences, chemistry, and mathematics.

Degree Requirements
An M.S. degree is conferred upon successful completion of the following: 1) A program amounting to not less than 30 credits, including the following course requirements or equivalent: FoRs 893-894, Seminar, 2 cr.; FoRs 803, Approach to Research, 2 cr.; a quantitative methods course; 2) FoRs 898, Directed Research, 4-6 cr. or FoRs 899, Thesis, 6-10 cr.; and 3) a final oral and/or written examination.

Intercollege Cooperative Programs
The Department of Forest Resources participates in three doctoral degree programs with other departments in the University. A Ph.D. program in chemistry is available to students in soil science through the chemistry department. A Ph.D. program in genetics is available to students in forest resources through the genetics program. Through informal cooperative arrangements with the electrical and mechanical engineering departments, opportunities are available for doctoral study in wood science and technology in the College of Engineering and Physical Sciences, leading to the Ph.D. degree in engineering.

Forest Resources (FoRs)

711. STATISTICAL METHODS II
Intermediate course; basic concepts of sampling, linear models and analyses for one-way and multivariate classification, factorial arrangement of treatments, multiple regression, and covariance. Computer programs used in analyzing data. Examples from environmental sciences. Prereq: applied statistics or equivalent. 4 cr.

712. SAMPLING TECHNIQUES
Techniques of sampling finite populations in environmental sciences; choice of sampling unit and frame, estimation of sample size, confidence limits, and comparisons of sample designs. Prereq: applied statistics or equivalent. 2-4 cr. (Not offered every year.)

713. QUANTITATIVE ECOLOGY
Applied quantitative techniques: basic concepts in probability and statistics applied to ecological systems; population dynamics; spatial patterns; species abundance and diversity; classification and ordination; production; and energy and nutrient flow. Additional credit for in-depth mathematical analysis of a particular topic. Prereq: introductory courses in calculus, statistics, and ecology. 3 or 4 cr. (Not offered every year.)

720. FOREST GENETICS
Genetics of forest tree improvement; variation in natural populations, breeding methods, physiological characters, quantitative data analysis. Prereq: prin of genetics; silviculture; statistics; or permission. Transportation fee. Lab. 3 cr. (Not offered every year.)

722. ADVANCED SILVICULTURE
Intensive silviculture of forest stands. Regeneration (e.g., alternative regeneration methods and site preparation); stand management (e.g., thinning schedules and fertilization). Prereq: silviculture; permission. Transportation fee. 3 cr. (Not offered every year.)

734. FOREST PROTECTION SEMINAR
Discussion and special problems based on principles and techniques of forest protection. Prereq: permission. 3 cr. (Not offered every year.)

745. FOREST MANAGEMENT
Forest land ownership; management objectives; forest inventory regulation and economic analysis; forest administration; professional responsibilities and opportunities. Transportation fee. Lab. 4 cr.

753. QUANTITATIVE METHODS FOR FOREST RESOURCE MANAGEMENT
Quantitative tools for decision making in forest resource management activities; capital investment analysis, break-even and marginal analysis, linear and dynamic programming, simulation, decision analysis. Prereq: calculus; forest economics; statistics; mensuration. Lab. 4 cr.

754. WOOD PRODUCTS MANUFACTURE AND MARKETING
Wood products from harvesting and procurement of raw material to finished product processes; management decisions, marketing, and promotion problems. All-day field trips to manufacturing plants and, occasionally, to associated harvesting operations, weather permitting. Transportation fee. Prereq: wood sci. and tech. or permission. Lab. 4 cr.

755. REGIONAL SILVICULTURE AND FOREST MANAGEMENT
Extended field trip to another forest region. Prereq: FoRs 745; or permission. (Limited enrollment.) 2 cr. Cr/F.

757. BASICS OF REMOTE SENSING
Fundamentals for application of photographic and nonphotographic sensors to information gathering
in natural resource fields; emphasis is on the interpretation of aerial photographs. Applications to forestry, wildlife, land-use planning, earth sciences, soils, hydrology, and engineering. Lab. 2 cr.

758. TERRAIN ANALYSIS
Visual interpretation of aerial and satellite imagery for study of landform, geology, hydrology, vegetation, and cultural patterns; applications in U.S. geography. Prereq: FoRs 757 or equivalent; binocular vision an advantage. Transportation fee. Lab. 2 cr.

759. DIGITAL GEOIMAGE ANALYSIS
Use of mainframe and microcomputer-based systems in remote sensing image analysis; introduction to microcomputer-based geographic information systems. Prereq: FoRs 757 or equivalent. Lab. 2 cr.

764/864. FOREST INDUSTRY ECONOMICS
Business methods and economics in the forest industry; planning for minimum cost operations and profitable use of capital in a forest enterprise. Individual projects. Prereq: permission. 4 cr. (Not offered every year.)

798. FOREST RESOURCES MANAGEMENT SEMINAR
The integration of demands from human population changes and needs on forest productivity through planning. The recognition of environmental quality and ecological concepts as planning criteria. Class discussions and group planning are a critical component. Prereq: FoRs 745. Lab. 4 cr.

801. FOREST MANAGEMENT SEMINAR
Seminar discussions of current literature, plans, principles, and new developments in the general field of forest management. Transportation fee. Prereq: permission. 2 cr. (Not offered every year.)

803. APPROACH TO RESEARCH
The meaning of science and the application of logic in the scientific method. Principles and techniques of scientific research. Survey of experimental design procedures. Organization of investigative work problems, working plans, and scientific writing. (Also offered as REco 803.) Prereq: permission. 2 cr.

805. UTILIZATION SEMINAR
Conferences, discussions, and reports on assigned topics. Consideration of current literature and developments in the general field of wood utilization. Prereq: permission. 2 cr. (Not offered every year.)

806. FORESTRY ECONOMICS SEMINAR
Discussions and reports on current economic and policy issues affecting forest resources and their management. Prereq: permission. 1–4 cr. (Not offered every year.)

810. FOREST STAND DYNAMICS
A consideration of forest dynamics to include soil-site quality evaluation, individual tree growth, stand growth and yield, and economic decision making. Evaluation of current literature and student presentations. Prereq: permission. 2 cr. (Offered every other year.)

816. QUANTITATIVE FOREST ECOLOGY SEMINAR
Preparation, presentation, and discussion of recent topics in quantitative ecology such as remote sensing, population growth, competition between species, modeling of a population, and energy flow. Seminar is 2 credits; an additional 2 credits available for an in-depth study of a particular topic. 2–4 cr. (Not offered every year.)

818. ADVANCED FOREST BIOLOGY
Topical orientation with presentations by faculty and students. Emphasis will be placed on management impacts on biological systems. Likely topics include impacts of silvicultural practices, atmospheric pollutants, pesticides, etc. on forest tree growth and species diversity. Prereq: permission. 2 cr. (Not offered every year.)

893. NATURAL AND ENVIRONMENTAL RESOURCES SEMINAR
Presentation and discussion of recent research, literature, and policy problems in the natural and social sciences influencing resource use. (Also offered as REco 893, 894.) 1 cr. Cr/F.

895. INVESTIGATIONS IN:

898. DIRECTED RESEARCH
Hours and credits to be arranged. Prereq: permission. Not available if credit obtained for FoRs 899. A year-long course; an “IA” grade (continuous course) given at the end of the first semester. 2–6 cr. Cr/F.

899. MASTER’S THESIS
6–10 cr.

Soil Science (Soil)

702. CHEMISTRY OF SOILS
Chemical composition of soil; colloidal phenomena and the exchange and fixation of elements, cation exchange capacity and source of negative charge; inorganic reactions in soil and their effect on soil properties. Prereq: one year of college chemistry or permission. 3 cr.

704. SOIL CLASSIFICATION AND MAPPING
Soil genesis, morphology, classification, and mapping; major classification systems used in the U.S. and throughout the world as they relate to human uses of the soil. Prereq: soils and the environment; introductory geology; or permission. Transportation fee. 4 cr.

709. SOILS AND COMMUNITY PLANNING
Using a town plan and soils map, students develop reports for multiple urban and rural land-use—housing, sewage, recreation, transportation, runoff, etc. USDA soil classification system; Soil Conservation Service rating criteria; New Hampshire soils. Guest lecturers. Prereq: permission. 2 cr.

795. INDEPENDENT WORK IN SOIL SCIENCE
A) Soil-Plant Relationships; B) Physics of Soils; C) Chemistry of Soils; D) Soil Classification; E) Forest Soils. Prereq: permission. 1–4 cr.

802. SPECIAL TOPICS IN SOIL SCIENCE
Topics may include soil mineralogy, advanced soil
895. INDEPENDENT WORK IN SOIL SCIENCE
A) Soil-Plant Relationships; B) Physics of Soils; C) Chemistry of Soils; D) Soil Classification; E) Forest Soils. Elective only after consultation with the instructor in charge. 1–4 cr.

Wildlife (Wild)

737. GAME MANAGEMENT I
Biological characteristics, habitat requirements, research and management practices of upland game birds and big game animals. Several all-day field trips required (possibly on weekends) to New England wildlife areas. Transportation fee. Prereq: permission. Lab. 4 cr.

738. GAME MANAGEMENT II
Biological characteristics, habitat requirements, research and management practices of small game animals, furbearers, and predators. Several all-day field trips required (possibly on weekends) to New England wildlife areas. Transportation fee. Prereq: wildlife management major or permission. Lab. 4 cr.

809, 810. WILDLIFE MANAGEMENT SEMINAR
Discussions and assigned reports on current investigations and developments in wildlife management. Prereq: undergraduate courses in wildlife management; permission. 1–4 cr.

895. INVESTIGATIONS IN:
A) Wildlife Energetics and Physiology; B) Habitat Management; C) Population Dynamics; D) Waterfowl Management; E) Fire Ecology; F) Game Management. Prereq: permission. 1–4 cr.

Genetics Program (Gen)

Chairperson: J. Brent Loy

PROFESSORS: James P. Barrett; Thomas P. Fairchild; Donald M. Green; Harold W. Hocker, Jr.; Frank K. Hoornbeek; Yun-Tzu Kiang; J. Brent Loy; Subhash C. Minocha; Lincoln C. Peirce; Owen M. Rogers; Willard E. Urban, Jr.; Robert M. Zsigray

ASSOCIATE PROFESSORS: Robert T. Eckert
ASSISTANT PROFESSORS: Roger A. Cady; Thomas M. Davis; Clyde L. Denis; Florence E. Farber; Anita S. Klein

ADJUNCT ASSISTANT PROFESSORS: Maurice E. Demeritt; Peter W. Garrett

GRADUATE PROGRAM COORDINATOR: J. Brent Loy

The interdepartmental Genetics Program offers graduate work leading to the degrees of master of science and doctor of philosophy. Qualified students are admitted to the program with the approval of the genetics faculty and the chairperson of the department in which they have a major interest. Undergraduate preparation should include mathematics through calculus, chemistry through organic, physics, animal or plant biology courses and laboratories, and genetics with laboratory. Preparation in statistics and computer science is desirable. The general and subject (biology) tests of the Graduate Record Examination are required.

The program is conducted by faculty members from animal sciences, biochemistry, botany, forest resources, microbiology, plant science, and zoology, as well as faculty from the Agricultural Experiment Station and the U.S. Forest Service, Northeastern Forest Experiment Station.

All students are required to participate in a one-year directed teaching experience and are required to attend genetics seminars.

Master of Science

The program for the master of science degree is formulated by the student with the approval of the guidance committee. Master's students are required to take a core of at least 3 genetics courses for a minimum of 10 credits (seminars and thesis excluded). Candidates for the degree will be required to complete a thesis, pass an oral examination covering graduate courses and thesis.

Doctor of Philosophy

The chairperson of the Genetics Program, with the concurrence of the chairperson of the department of major interest, will nominate the student's guidance and doctoral committees, which will administer the qualifying and final examinations. Specific course requirements will be developed by the student and the guidance committee. Doctoral students are expected to have a broad exposure to genetics courses, exceeding that required of master's students. Students must complete a dissertation on original research in genetics.

The guidance committee for each graduate student will determine whether a foreign language will be required.

705. POPULATION GENETICS
Population growth and regulation; genetic variation; factors affecting gene frequency; ecological genetics. Prereq: prn of genetics or permission. (Also offered as PSc 705.) 4 cr. (Not offered every year.)

706. GENETICS LABORATORY
Experiments and demonstrations in animal, plant, and microbial genetics and cytogenetics, including research techniques applicable to biochemical, population, and transmission genetics. Prereq: prn of genetics or equivalent. 3 cr.

740. EVOLUTIONARY BIOLOGY
Origin of source of genetic variation, population structure, mechanisms of evolution; molecular evolution; ecological adaptation in animals, plants, and humans; community structure and evolution. Prereq: prn of genetics or permission. (Also offered as PSc 740.) 4 cr. (Not offered every year.)

771. BIOCHEMICAL GENETICS
Mechanisms of storage, replication, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Prereq: Bchm 751 or permission. (Also offered as Bchm 771.) 3 cr.

772. INTRODUCTORY LABORATORY IN MOLECULAR GENETIC TECHNIQUES
Modern biochemical gene manipulation tech-
niques, including the genetic, physical, and enzymatic characterization of gene vectors, gene cloning, construction of genetic probes, and sequencing of nucleic acids. Prereq: Bchm 751-752; either Bchm 771, Bchm 781, or Micr 804. (Also offered as Bchm 772.) 2 cr.

802. DESIGN OF EXPERIMENTS
Practical application of common experimental designs to research problems; the use of design to compensate for interfering factors, treatment, selection (particularly when several factors are suspected of having an influence on response), and computer-aided analysis of results. Prereq: statistics. (Also offered as PlSc 802.) 4 cr. (Not offered every year.)

803. GENETIC ENGINEERING IN PLANTS
Theory and techniques of genetic manipulation in plants; mechanism of gene expression; gene vectors; somatic cell genetics; protentials and limitations of the techniques. (Also offered as Bot 803C and PlSc 803C) 2 cr.

812. ADVANCED STATISTICAL METHODS
Methods and techniques for handling typical problems that arise in the analysis of data. Topics include the multiple comparison of means, analysis of unweighted means, proportional subclass numbers, weighted squares of means, orthogonal polynomials, and least squares. Prereq: FOrS 711; digital computer systems; or permission. 3 cr. (Not offered every year.)

895, 896. SPECIAL TOPICS IN GENETICS
Intended for study in specialty areas not ordinarily included in other courses. May involve formal classes, discussions, or independent investigations. Prereq: permission. 2—4 cr.

898. GENETICS SEMINAR
Presentation and discussion of selected genetic topics. 1 cr. Cr/F. (May be repeated.)

899. MASTER'S THESIS
6—10 cr.

999. DOCTORAL RESEARCH

Courses Available in Related Areas

These courses are fully described below and under the course of the appropriate department for the convenience of the student.

Animal and Nutritional Sciences

712. ANIMAL BREEDING AND IMPROVEMENT
Principles of genetic evaluation, selection, and breeding systems as they apply to the genetic improvement of farm animals. Prereq: prin of genetics or permission. Lab. 4 cr. (Not offered every year.)

812. QUANTITATIVE GENETICS AND SELECTION
Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, correlated characters. Prereq: one course each in genetics and statistics. 3 cr. (Not offered every year.)

Forest Resources

711. STATISTICAL METHODS II
Intermediate course; basic concepts of sampling, linear models and analyses for one-way and multiway classification, factorial arrangement of treatments, multiple regression, and covariance. Computer programs used in analyzing data. Examples from environmental sciences. Prereq: applied statistics or equivalent. 4 cr.

720. FOREST GENETICS
Genetics of forest tree improvement; variation in natural populations, breeding methods, physiological characters, quantitative data analysis. Prereq: prin of genetics; silviculture; or permission. Transportation fee. Lab. 3 cr. (Not offered every year.)

Microbiology

704. MICROBIAL GENETICS
Expression and transfer of genetic elements (chromosomal and nonchromosomal) in prokaryotic and eukaryotic microorganisms; consideration of factors influencing public health, industry, the environment, and society. Prereq: general microbiology; physiological chemistry and nutrition. Lab. 4 cr.

804. ADVANCED MICROBIAL GENETICS
Advanced studies in expression, regulation, recombination, and transmission of genetic information in prokaryotic microorganisms. Prereq: Micr 704; permission. Lab. 4 cr. (Not offered every year.)

Plant Science

773. BREEDING IMPROVED VARIETIES
Techniques for creating new varieties of crop and ornamental plants. Prereq: genetics. Coreq: PlSc 873. 3 cr. (Not offered every year.)

780. BIOTECHNOLOGY AND PLANT GENETICS
Plant cell culture techniques; characterization of economically important traits at the molecular level; approaches to induced mutation, in vitro selection, and introduction of foreign DNA into plants; transposable elements and transformation vectors; new ideas in plant biotechnology; social implications. Prereq: course in genetics; plant biology. Lab. 4 cr. (Not offered every year.)

851. PLANT GENETICS
Euploidy, aneuploidy, cytoplasmic inheritance, somatic cell genetics, and genetics of disease resistance. Prereq: intro genetics. 3 cr. (Not offered every year.)

853. CYTOGENETICS
Chromosome structure, function, and evolution. Eukaryotic genome organization. Theory of, and laboratory techniques in, cytogenetic analysis of plants and animals. Prereq: prin of genetics. Lab. 3 cr. (Not offered every year.)

873. TOPICS IN CROP IMPROVEMENT
Discussion and assigned readings in crop breeding. Coreq: PlSc 773. 1 cr.
Zoology

707. HUMAN GENETICS
Inheritance patterns; gene and chromosome mutation rates and effects; linkage and gene frequency.
Prereq: prin of genetics or equivalent; /or permission, 4 cr. (Not offered every year.)

History (Hist)

Chairperson: Hans Heilbroner
PROFESSORS: Charles E. Clark; Robert C. Gilmore; Hans Heilbroner; Charles A. Jellison, Jr.; William R. Jones; David E. Long; Francis D. McCann, Jr.; Robert M. Mennel; Harvard Sirkoff; John O. Voll; Douglas L. Wheeler; Donald J. Wilcox
ASSOCIATE PROFESSORS: Jeffry M. Dieffenbaur; Marion E. James; Allen B. Linden; Janet Polasky; Marc L. Schwarz
ASSISTANT PROFESSORS: J. William Harris; Laurel T. Ulrich
GRADUATE PROGRAM COORDINATOR: Charles E. Clark

Admission Requirements
The department usually requires completion on the undergraduate level of eight semester courses in history together with some preparation in other areas of the humanities and social sciences.
Applicants for admission to any graduate program in history should have a minimum of B average in history, allied humanities, and social sciences. In addition, applicants must submit general test and subject (history) test scores on the Graduate Record Examinations. The department assesses the student's entire application, including letters of recommendation, in making its decision on admission. Deficiencies in an undergraduate program may be rectified by course work as a special student, but such coursework cannot be used to satisfy requirements for an advanced degree. The department also recommends that a beginning graduate student have some training in a foreign language. Students in seminar or reading courses in other than American history are often required to have a reading knowledge of at least one foreign language appropriate to the particular course. Applicants intending the Ph.D. degree should include with their applications a personal statement indicating their reason for undertaking graduate study at the University of New Hampshire.
All graduate students are reviewed annually by the faculty of the department. A student accumulating two course failures is automatically barred from continuing in any degree program in history, but the department reserves the right to exclude others whose overall performance does not give reasonable assurance of a successful program completion. Students are allowed no more than three attempts to meet any language requirements.

Degree Programs
The department offers the master of arts and doctor of philosophy degrees. The general degree requirements are outlined below, but specific programs are tailored to the goals of the student. The graduate program coordinator of the department serves as the initial adviser to entering graduate students, the adviser-of-record to all students throughout their years of graduate study, and, with the Graduate Committee of the department, has general supervision of all student programs. By the beginning of a student's second semester in residence, the student intending a degree will ordinarily have selected a single member of the faculty as the program chairperson and, with that faculty member as principal adviser, will have worked out a specific program of studies leading toward a degree. The graduate program coordinator must approve the registration of special students and students from other departments in graduate history courses. The department welcomes the opportunity to work with students from other departments.

Master of Arts
The student intending the M.A. degree has the choice of designing a specific program to meet either of two sets of requirements; the first allows substantial training and research in a single subfield of history but within a foundation of broader coursework that also allows substantial breadth over at least two subfields. The subfields in history are as follows: the ancient world; medieval Europe; early modern Europe; modern Europe; European intellectual history; medieval England; early modern England; modern England; Iberian history; Russia; early American history; modern American history; colonial Latin America; modern Latin America; the Far East; the Near East; sub-Saharan Africa; and the history of science.
Completion of the degree under either set of requirements normally requires between three and four semesters of full-time study (three to four courses per semester). Either plan may prepare a student for entrance to the Ph.D. program. Plan B is particularly recommended for practicing teachers.

Plan A: The student shall complete successfully at least eight courses in history numbered above 700, of which a minimum of four shall be numbered between 889 and 896. In addition, the student shall prepare within the context of any single subfield a thesis meriting the unanimous approval of a thesis committee consisting of the student's program chairperson, under whose direction the thesis shall be prepared, and two other members of the graduate faculty (at least one of them in history). The preparation of the thesis is considered to be the equivalent of two additional semester courses each bearing the designation History 899 for the purpose of meeting the general regulations of the Graduate School.

Plan B: The student shall complete successfully at least ten courses in history numbered above 700 of which a minimum of four shall be numbered between 889 and 896. Following completion of coursework or during the final semester of coursework, the student shall demonstrate a broad competence in two subfields of history ordinarily in oral examination before a committee of three consisting of the student's program chairperson and two other members of the faculty in history. Students proceeding under Plan B shall have stood examination no less than three weeks prior to the Commencement at which the degree is to be granted.
Students should note that Plan A thesis readings and Plan B examinations during the summer are available only with the consent of all faculty involved.
Doctor of Philosophy

The department offers work leading toward the degree of doctor of philosophy with a concentration in either of the two subfields of American history. The degree requires more than formal coursework; it is awarded in recognition of high attainment and ability in history as shown by performance in qualifying examinations and by preparation and defense of a dissertation. Normally an entering student intending to be a candidate for the doctorate will complete an M.A. program as a prerequisite. Students with the M.A. from another institution, however, can begin the doctoral program immediately, and a student in residence can, with the consent of the department, omit the M.A. and proceed directly toward the Ph.D.

The doctoral student's primary intellectual relationship is with that member of the faculty under whom he or she will write the dissertation and who serves as the student's program chairperson. This relationship should be established early, and a broad background will be of the intended area of dissertation research worked out in consultation with the program chairperson. The program, which must be approved by the Graduate Committee of the department, shall involve each of the following:

1) Two required research seminars in American history, one in early America and one in modern America.

   The history department offers these required research seminars in the first semester of each year, alternating between the two fields. Each entering student, with or without the M.A., should take one in each of the first two years in the program. Other seminars and reading courses at the 800 level will also form part of the program drawn up in consultation with the student's program chairperson.

2) Required courses in historiography and historical methods. The history department will offer one of these courses in the second semester of each year, on an alternate-year basis. Each entering student, with or without the M.A., should take one in each of the first two years in the program.

   No student will be considered to be intending to pursue a Ph.D. program who is not in the process of satisfying these requirements. Only students who are intending to pursue the Ph.D. are considered for graduate assistantships.

3) Two languages or one language and a special research technique, whichever is deemed most relevant to the area of research.

4) The entirety of American history, with accent upon either of the subfields of early or modern America, and two subfields outside of American history.

5) A cognate field outside of history entirely or a subfield of non-Western history.

   Students' preparations for the qualifying examination will be guided by representatives of each subfield or cognate field in their programs. These representatives will make up a student's guidance and, subsequently, examining and dissertation committees. Students will normally not take the qualifying examination until they have completed sixteen semester courses or more (including work undertaken in a master's program). This requirement is three years of study beyond the bachelor's degree, the greater portion of which is ordinarily accomplished in full residence. Qualifying examinations will test a mastery of broad subfields of historical knowledge rather than of particular courses. Students are, therefore, expected to read widely and independently in order to expand their knowledge beyond formal coursework and to become acquainted with aspects of the subfields not covered in that coursework.

   Normally there will be eight steps in attaining the degree. Students are expected to be registered in the University for all regular academic semesters during their progress.

   1) Satisfaction of historiography, historical methods, and research seminars requirement.

   2) Correction of any deficiencies in the student's previous program; for example, lack of a first language.

   3) The demonstration of proficiency in a second language or a special research technique. (Departmental regulations regarding the latter are available from the director of graduate studies.)

   4) Successful performance in a two-part qualifying examination: the first part, a four-hour written examination covering breadth of knowledge in the subfield of specialization (early or modern American history); the second part, oral and covering all subfields and (if any) the cognate field specified in the program.

   5) Within the same semester as step three, admission to candidacy and the approval by the candidate's dissertation committee of the specified topic and research plan for the dissertation.

   6) Submission of an acceptable dissertation no more than three years after advancement to candidacy.

   7) Successful public defense of the dissertation before the dissertation committee.

   8) Formal submission of the dissertation to the department and Graduate School at least two weeks prior to the commencement at which the degree is to be conferred.

Apprenticeship

The department considers that graduate work in history, and particularly doctoral work, is professional training. All entering graduate students intending a Ph.D. are, consequently, required (and all others are urged) to participate on a continuing basis in History 801, Proseminar: History as a Profession. Moreover, the department recognizes the dual concerns of the historian's life—teaching and research; when feasible, therefore, all doctoral students are expected to undertake teaching in the department during a part of their residence. Participation in proseminar and in teaching constitutes an apprenticeship in conjunction with formal study.

774. HISTORIOGRAPHY

Analysis of ancient and modern historians. Required of all entering Ph.D. candidates; open to undergraduates with permission. 4 cr. (Not offered every year.)

775. HISTORICAL METHODS

Introduction to contemporary historical methods. Required of all entering Ph.D. candidates; open to undergraduates with permission. 4 cr. (Not offered every year.)

789. SEMINAR IN THE HISTORY OF SCIENCE

Selected topics conducted through special lectures, individual study, oral and written reports. Subject varies. Cannot be used for credit in history without permission of the department. Prereq: permission of adviser and instructor. 4 cr.
790. QUANTIFICATION AND COMPUTERS FOR THE HISTORIAN
The historian's use of computers and statistics; practical applications of both interactive terminal operations and batch processing. Data generation and processing, computer languages (BASIC, FORTRAN), programming and library programs, elementary statistics; students will undertake operations of their own on material supplied and will consider particular quantitative studies in history in terms of techniques used. No previous knowledge of computers or college mathematics required. Prereq: graduate student in history or permission. 4 cr.

797. COLLOQUIA IN HISTORY
Selected topics in American, European, and non-Western history. Students must select section in department office at the time of registration. Intended primarily for undergraduate history majors. 4 cr.

Graduate Seminars and Tutorials

801. PROSEMINAR: HISTORY AS A PROFESSION
Entering graduate students intending the doctorate and all advanced graduate students serving as research, program, or teaching assistants in the department meet periodically to discuss the obligations and mechanics of the historian's profession, including teaching, scholarship, university and college structures, and the role of the faculty therein. 0 cr.

803. EARLY AMERICAN HISTORY
Advanced study in early American history. The development of an Anglo-American society and culture along the eastern seaboard of North America, 1600-1750. 4 cr.

805, 806. AMERICA IN THE 18TH CENTURY AND THE REVOLUTION
Advanced study in American colonial and revolutionary history from 1740 through the adoption of the Constitution and the establishment of Washington's first administration. 4 cr.

810. AMERICAN STUDIES: NEW ENGLAND CULTURE AND CHANGING TIMES
Advanced study in New England culture. A team of three instructors from history, literature, and art investigate major contributions New England has made to American life. Focus on the Puritan era, 1620-90; the transcendental period, 1830-60; and the period of emerging industrialism in the late 19th century. 4 cr.

811, 812. 19TH-CENTURY AMERICA
Advanced study of 19th-century America. Domestic and international factors in the development of the American republic, its institutions and people, from the inception of the new nation in 1789 to the emergence of the United States as a world power in 1900. 4 cr.

815, 816. 20TH-CENTURY AMERICA
Advanced study of the U.S. after 1900; cultural, political, and social factors causing major changes in American life. Semester I: progressivism through the New Deal. Semester II: World War II to the present. 4 cr.

819, 820. THE FOREIGN RELATIONS OF THE UNITED STATES
Advanced study in the foreign relations of the U.S. Primarily the history of American diplomacy, with attention given to the nondiplomatic aspects. Semester I: American Revolution to 1890. Semester II: 1890 to date. 4 cr.

821, 822. HISTORY OF AMERICAN THOUGHT

824. AMERICAN URBAN HISTORY
Advanced study in the urbanization process from the colonial period to the present. 4 cr.

831. LATIN AMERICAN HISTORY: REGIONAL OR COUNTRY STUDIES
Advanced study of Latin America; readings and discussions of literature relative to region or country being studied. 4 cr.

832. LATIN AMERICAN HISTORY: TOPICAL STUDIES
Advanced study of Latin America; readings and discussion of literature relative to selected topics. 4 cr.

839, 840. THREE MEDIEVAL CIVILIZATIONS
Advanced study in medieval civilizations. Denise of classical antiquity in the lands bordering the Mediterranean, and the genesis and fruition of three new cultural traditions: Latin Christian, Islamic, and Byzantine. Religious, literary, and scholarly survivals and innovations from 400 A.D. to 1400 A.D. 4 cr.

841. AGE OF THE RENAISSANCE
Advanced study in the Renaissance. Its birth, economic, social, and political roots, and the flowering of Renaissance culture. Covers period from 1300-1600, with stress on Italy. 4 cr.

842. AGE OF REFORMATION
Advanced study in the reformation of church, society, and human values that shook Europe in the 16th century, and its roots in the 14th and 15th centuries. 4 cr.

847. FRANCE FROM LOUIS XIV THROUGH THE FRENCH REVOLUTION
Advanced study of France from Louis XIV through the French Revolution. Pressures and influences that led to the French Revolution. 4 cr.

848. MODERN FRANCE
Advanced study of French society from Napoleon to Mitterand, including the Revolution of 1848 and the Paris Commune; world wars and the Vichy regime; existentialism, DeGaulle, and the Revolt of May-June 1968. 4 cr.

851, 852. EUROPEAN INTELLECTUAL HISTORY
Advanced study in the European intellectual tradition from the Greek philosophers to the end of World War II. How basic ideas have developed out of previous modes of thought in response to new challenges. 4 cr.
856. 20TH-CENTURY EUROPE
Advanced study of 20th-century Europe. World War I, European totalitarianism, World War II, the loss of European primacy, and the search for a new Europe. 4 cr.

859. HISTORY OF SPAIN AND PORTUGAL
Advanced study of Iberian states and their peoples from the coming of liberalism to the present. Failure of Iberian and liberal government. Political and social change, imperial and intellectual movements, influence of Western European thought and activity. 4 cr.

861, 862. ENGLAND IN THE TUDOR AND STUART PERIODS
Advanced study of England during the Tudor and Stuart periods. Political, religious, socio-economic, and intellectual forces for change at work in England from the accession of Henry VII to the revolution of 1688-89. 4 cr.

863. RUSSIA: ORIGINS TO MODERNIZATION
Advanced study of Russia from its foundation to emancipation and reform. Political developments, foreign relations, intellectual and ideological currents. 4 cr.

864. RUSSIA: FROM TSARIST TO SOVIET EMPIRE
Advanced study of modern Russia. The cost of modernization; Leninist and Stalinist revolutions; Soviet consolidation. 4 cr.

867. EARLY MODERN GERMANY:
REFORMATION TO THE REVOLUTION OF 1848
Advanced study of early modern Germany. Conflict between Holy Roman Empire and petty states; rise of Prussia; religious conflict and Enlightenment. 4 cr.

868. MODERN GERMANY SINCE 1848
Advanced study of early modern Germany. Bismarck and Imperial Germany; Weimar and the rise of Hitler; post–World War II divided Germany. 4 cr.

877. THE HELLENISTIC-ROMAN WORLD
Advanced study of the Mediterranean and Near East from the time of Alexander to the reign of Constantine: the main political and social developments; artistic, scientific, philosophical, and religious trends, with particular emphasis on the rise of Christianity, Zoroastrianism, and the general religious climate that prepared the way for Islam. 4 cr.

881. TOPICS IN THE HISTORY OF MODERN CHINA
Advanced study of issues in modern Chinese history, 1800 to present. 4 cr.

883. RELIGION IN WORLD HISTORY
Advanced study in the religious experience of man from the perspective of world history. The major modes of religion; development of the major religious traditions and institutions. 4 cr.

884. HISTORY OF SOUTHERN AFRICA SINCE 1820
Advanced study of southern Africa. Struggle for political and economic control in the only region of Africa where European groups remain in power. Effect of European imperialism, European settler nationalism, racial conflict, economic competition and industrialization, apartheid, and assimilation with special attention to development of European hegemony. Official American policy. 4 cr.

885. THE MODERN MIDDLE EAST
Advanced study of the Middle East from 18th century to the present. Problems created by modernization and reform of the traditional society; conservative reaction to reform, impact of nationalism, and appearance of new ideologies. 4 cr.

889, 890. SEMINAR IN AMERICAN HISTORY
1) Early American Society; 2) Early American Culture; 3) Revolutionary Period; 4) 19th Century; 5) 20th Century. 3 cr.

891, 892. SEMINAR IN EUROPEAN HISTORY
1) Medieval; 2) Early Modern; 3) Modern. 3 cr.

893, 894. SEMINAR IN AFRICAN, ASIAN, LATIN AMERICAN HISTORY
1) African; 2) Asian; 3) Latin American; 4) Middle East. 3 cr.

895, 896. TUTORIAL READING AND RESEARCH IN HISTORY
A) Early American History; B) American National History; C) Canada; D) Latin America; E) Medieval History; F) Early Modern Europe; G) Modern European History; H) Ancient History; I) Far East and India; J) Near East and Africa; K) European Historiography; L) American Historiography; M) Russia; N) World History; O) English History; P) New Hampshire History; Q) Historical Methodology; R) Irish History. Prereq: permission. 1–6 cr.

899. MASTER'S THESIS
6 cr.

999. DOCTORAL RESEARCH

Intercollege Course (Inco)

890. COLLEGE TEACHING
Acquisition of theoretical and practical knowledge of the basics of college teaching, the role of the college teacher in facilitating learning. Course participants will work to improve three aspects of their work: teaching methods with large and small groups, planning teaching sessions, and assessment of student learning. Participants will be encouraged to develop a teaching style that is effective and compatible with their philosophy, attitudes, and aptitudes. 2 cr. (Not offered every year.)

Master's Continuing Enrollment (MCE)

890. MASTER'S CONTINUING ENROLLMENT
Master's students who have completed all course requirements and have previously registered for the maximum number of thesis or project credits and are on campus completing their master's program must register for Master's Continuing Enrollment. MCE 890 is an enrollment designation that appears on the academic record. Students registered for MCE 890 are considered full-time; no credit hours are accumulated nor a grade given.
Mathematics (Math)

Chairperson: Richard H. Balomenos

PROFESSORS: Richard H. Balomenos; Homer F. Bechtell, Jr.; David M. Burton; Arthur H. Copeland, Jr.; Donald W. Hadwin; A. Robb Jacoby; Loren D. Meeker; Eric A. Nordgren; James Radlow; Shepley L. Ross; Albert O. Shar; Robert J. Silverman; Donovan H. Van Osdol

ASSOCIATE PROFESSORS: Albert B. Bennett, Jr.; William E. Bonnice; Marie A. Gaudard; William E. Geeslin; Samuel D. Shore

ASSISTANT PROFESSORS: Kenneth B. Constantine; Joan Ferrini-Mundy; Edward K. Hinson; Sie-Keung Tse; Lee L. Zia

GRADUATE PROGRAM COORDINATOR: Richard H. Balomenos

The Department of Mathematics offers programs leading to an M.S.T. degree in mathematics, an M.S. degree in mathematics, a Ph.D. degree in mathematics, and a Ph.D. degree in mathematics education.

In general, the master's degree programs offer the student a high level of professional training for employment as well as appropriate preparation for entering programs leading to the Ph.D. degree. The Ph.D. programs are designed primarily to lead to a career in post-secondary-school teaching and research.

Our graduate programs are intended to have limited enrollments so that a student has the opportunity of working closely with the faculty in their areas of expertise.

Master of Science for Teachers

Admission requirements: Completion of all requirements for secondary school teacher certification in mathematics.

Degree requirements: 1) Ten semester courses approved by the department. These will normally be taken from the courses numbered 801–829 and will usually include the six courses numbered 803–808. A comprehensive examination based primarily on material in courses 803–808. It is not possible to study full time during the academic year toward the master of science for teachers degree. The courses in this program are offered during summer sessions.

Master of Science

Admission requirements: Undergraduate courses in mathematics, preferably in analysis, algebra, or topology.

Degree requirements: Ten semester courses approved by the department and chosen from courses numbered 701–799 or 830–849; at least six of the ten courses must be from the 830–849 group. An oral comprehensive examination is required.

Doctor of Philosophy

The department offers programs leading to a Ph.D. in mathematics or mathematics education. A detailed description of the Ph.D. program is available from the department.

Admission requirements: same as for the master of science in mathematics.

Basic degree requirements: 1) all of the courses numbered 833–839; 2) experience in teaching equivalent to at least half time for one year; and 3) written comprehensive examination in algebra, analysis, and topology.

Additional degree requirements for the Ph.D. in mathematics: 4) proficiency in reading mathematical literature in two of three languages: French, German, and Russian; 5) advanced work in a major (the field of the thesis) and a minor (usually another field of mathematics), with an oral examination in these two fields; and 6) a thesis that includes original results in mathematics. Thesis work is available in algebra, applied mathematics, statistics, analysis, and topology.

Additional degree requirements for the Ph.D. in mathematics education: 4) language requirement as in Ph.D. in mathematics except that mastery of an approved research tool must be substituted for one language; 5) advanced work in a major (mathematics-education) and a minor (usually education) with an oral examination in these two fields; and 6) a thesis that includes original results in mathematics education. A maximum of four of the following courses may be applied to the degree of master of science in mathematics.

730. ADVANCED APPLICATIONS OF PROBABILITY AND STATISTICS

Probability concepts, random variables, parameter estimation, hypothesis testing. Additional topics chosen from analysis of variance, regression, chi-squared methodology, nonparametric statistics, or (approved) student project. Prereq: permission. 4 cr. (Not for credit if credit received for Math 735 or 736.)

735. PROBABILITY

Sample spaces (discrete and continuous); random variables; conditional probability; moments; binomial, Poisson, and normal distributions; limit theorems for sums of random variables. Prereq: multidim calculus. 4 cr.

736. STATISTICS

Sampling theory, parameter estimation, hypothesis testing, regression, analysis of variance, nonparametric methods. Prereq: Math 735. 4 cr.

737. DECISION THEORY AND BAYESIAN METHODS

Utility, decision problems, prior and posterior distributions, sufficiency, estimation and hypothesis testing, linear models, and sequential sampling. Emphasis on applications to business and economics. Prereq: Math 735. 4 cr. (Not offered every year.)

738. MULTIVARIATE STATISTICAL ANALYSIS

Multivariate distributions, estimation and hypothesis testing, principal components, canonical correlations, factor analysis, discriminant analysis. Prereq: Math 736 and 762. 4 cr. (Not offered every year.)

739. LINEAR STATISTICAL MODELS

Estimation, testing, and diagnostic methods for linear regression, analysis of variance, and analysis of
covariance. Some experience in the use of packaged statistical computer programs. Prereq: Math 736 and 762. 4 cr. (Not offered every year).

740. NONPARAMETRIC STATISTICAL METHODS Methods of nonparametric statistical inference for one-sample and two-sample problems, one-way and two-way layouts, correlation, and regression. Prereq: Math 736. 4 cr. (Not offered every year).

742. STATISTICS INTERNSHIP Analysis of real data in a consultant setting; statistical methodology necessary for the project; use of the computer. 2–6 credits/semester; course can be repeated for a maximum of 8 credits.

745-746. FOUNDATIONS OF APPLIED MATHEMATICS Basic concepts and techniques of applied mathematics intended for graduate students of mathematics, engineering, and the sciences. Fourier series and transforms, Laplace transforms, optimization, linear spaces, eigenvalues, Sturm-Liouville systems, numerical methods, conformal mapping, residue theory. 4 cr.

753. NUMERICAL METHODS AND COMPUTERS I Use of scientific subroutine and plotter-routine packages, floating point arithmetic, polynomial and cubic spline interpolation, implementation problems for linear and nonlinear equations, random numbers and Monte Carlo method, Romberg's method, optimization techniques. Selected algorithms will be programmed for computer solution. Prereq: calculus II; intro programming and FORTRAN. (Also offered as C S 753.) 4 cr.

754. NUMERICAL METHODS AND COMPUTERS II Mathematical software. Computer solutions of differential equations, eigenvalues, and eigenvectors. Prereq: diff equations with linear alg.; intro programming and FORTRAN. (Also offered as C S 754.) 4 cr.

761. ABSTRACT ALGEBRA Basic properties of groups, rings, fields, and their homomorphisms. 4 cr.


764. ADVANCED ALGEBRA Topics to be selected from among rings, modules, algebraic fields, and group theory. Prereq: Math 761. 4 cr. (Not offered every year.)

767. ONE-DIMENSIONAL REAL ANALYSIS Theory of limits, continuity, differentiability, integrability. 4 cr.

768. ADVANCED ANALYSIS Metric spaces; sequences and series of real functions; uniform convergence; Fourier series; differentiability of mappings from n-space to m-space. Prereq: Math 767. 4 cr. (Not offered every year.)

776. LOGIC Induction and recursion; sentential logic; first-order logic; completeness, consistency, and decidability; recursive function. 4 cr. (Not offered every year.)

783. SET THEORY Axiomatic set theory, including its history, Zermelo-Fraenkel axioms, ordinal and cardinal numbers, consistency, independence, and undecidability. 4 cr. (Not offered every year.)

784. TOPOLOGY Open sets, closure, base, and continuous functions. Connectedness, compactness, separation axioms, and metrizability. 4 cr.

788. COMPLEX ANALYSIS Complex functions, sequences, limits, differentiability and Cauchy-Riemann equations, elementary functions, Cauchy's theorem and formula, Taylor's and Laurent's series, residues, conformal mapping. Prereq: Math 767. 4 cr.

791. MATHEMATICS EDUCATION Methods of teaching secondary school mathematics with particular attention to curricula and instructional materials, teaching reading in mathematics, problem solving, theories of learning mathematics, computers and calculators, and professional organizations and publications. Prereq: exploring teaching and permission. 4 cr.

The following courses may be applied to the degree of master of science for teachers in mathematics and to no other degree in mathematics.

801-802. MATHEMATICS AND COMPUTING FOR TEACHERS An introductory course designed to familiarize the students with the capabilities of a computer and to enable them to use it confidently. Applications to algebra, analysis, logic, and game theory are examined; includes introduction to microcomputers. 3 cr.

803-804. HIGHER ALGEBRA FOR TEACHERS The integers, integral domains, and topics from number theory; equivalence relations and congruences; real numbers, complex numbers, fields, and polynomials; group theory; matrix theory; vectors and vector spaces; rings; Boolean algebra. 3 cr.

805-806. HIGHER GEOMETRY FOR TEACHERS Systems of postulates of various geometries; geometric invariants; synthetic and analytic projective geometry; an introduction to non-Euclidean geometry and topology. 3 cr.

807-808. HIGHER ANALYSIS FOR TEACHERS The real number system; functions and limits; elements of set theory; numerical sequences and series; continuity; the derivative and the Riemann integral; maxima and minima. 3 cr.

809. PROBABILITY AND STATISTICS FOR TEACHERS Permutations and combinations; finite sample spaces; random variables; binomial distributions; statistical applications. 3 cr.
810. MATHEMATICS EDUCATION
Current developments and issues in mathematics education; content, curricula, methods, and psychol- ogy of teaching mathematics. 1-4 cr.

811. COMPUTERS AND THEIR USES
Consideration of the role of microcomputers in schools; preparation of classroom materials for TRS80, Apple II, and Rainbow; exchange of ideas and software. 3 cr.

814. TOPOLOGY FOR TEACHERS
Fundamental concepts of elementary topology; network and map problems; sets, spaces, and transformations. 3 cr.

816. THEORY OF NUMBERS FOR TEACHERS
Divisibility and primes; congruences; quadratic reciprocity; number theoretic functions; Diophantine equations; perfect and amicable numbers. 3 cr.

817. THEORY OF SETS AND ELEMENTARY LOGIC
An introduction. 3 cr.

819. THE REAL NUMBER SYSTEM
A poststructural approach to fundamentals of algebraic structure; sequences, limits, and continuity. 3 cr.

820. HISTORY OF MATHEMATICS
A problem-study approach to mathematical problems from the period of Greek mathematics until the modern era. 3 cr.

821. A MODERN APPROACH TO GEOMETRY
The foundations and development of Euclidean geometry, with emphasis on the recent recommendations in the field of high school geometry. 3 cr.

826. SELECTED TOPICS IN ALGEBRA
Topics selected to supplement the teacher’s previous training in algebra, chosen from among the following: linear algebra, vector spaces, groups, rings and ideals, and fields. 3 cr.

827. SELECTED TOPICS IN GEOMETRY
Topics selected to supplement the teacher’s previous training in geometry, chosen from among the following: analytic projective geometry, non-Euclidean geometry, transformation theory, elementary metric differential geometry, topology. 3 cr.

828. SELECTED TOPICS IN ANALYSIS
Topics selected to supplement the teacher’s previous training in analysis, chosen from among the following: sequences and series of real functions, Riemann integration, partial differentiation, complex functions, differential equations. 3 cr.

829. DIRECTED READING
A directed reading project on a selected topic in mathematics, planned in collaboration with a faculty member. 3 cr.

The following are the basic courses for both the master of science and doctor of philosophy degrees in mathematics.

833. ALGEBRA I
Fundamental results in group and ring theory. Prereq: algebra. 3 cr.

834. ALGEBRA II
Fundamental results in module and field theory. Prereq: Math 833. 3 cr.

835. MEASURE AND INTEGRATION
Measurable spaces and functions, measures, Lebesgue integrals, convergence theorems. Prereq: real analysis. 3 cr.

836. FUNCTIONAL ANALYSIS
Banach and Hilbert spaces, Hahn-Banach theorem, open mapping and closed graph theorems, dual spaces, topological vector spaces. Prereq: Math 835. 3 cr.

837. COMPLEX ANALYSIS
Cauchy theory and local properties of analytic functions, Riemann mapping theorem, representation theorems, harmonic functions. Prereq: real and complex analysis. 3 cr.

838. ALGEBRAIC TOPOLOGY
Chain complexes; homology of simplicial complexes, singular homology and cohomology; axiomatic homology; cup and cap products. Prereq: Math 761 and 784. 3 cr.

839. GENERAL TOPOLOGY
Subspace, product, and quotient topologies; embedding; separation and countability axioms; connectedness; compactness and compactifications; paracompactness, metrization, and metric completion. Prereq: Math 784. 3 cr.

The following more specialized courses are offered on an irregular schedule whenever mutual faculty and student interest justifies it. Content will vary from year to year and will normally be chosen from among the topics listed. With the permission of the instructor, each of these courses may be taken more than once for credit.

841. TOPICS IN LOGIC AND FOUNDATIONS
Recursive functions; independence proofs; models; forcing techniques. 3 cr.

842. TOPICS IN ALGEBRA
Homological algebra; algebraic number theory; local algebra; category theory; group theory; ring theory; field theory. 3 cr.

843. TOPICS IN TOPOLOGY
Topological groups; algebraic topology; general topology. 3 cr.

844. TOPICS IN ANALYSIS
Calculus of variations; harmonic analysis; integral equations; operator theory; linear topological spaces; partially ordered spaces; topological algebras; complex variables. 3 cr.

845. TOPICS IN DIFFERENTIAL EQUATIONS
Linear systems; general autonomous systems; two-dimensional systems; boundary value problems; qualitative theory; stability theory; partial differential equations; functional analytic methods. 3 cr.

846. TOPICS IN APPLIED MATHEMATICS
Distribution theory; potential theory; mechanics; control theory; mathematical biology; model theory; operations research. 3 cr.
847. TOPICS IN MATHEMATICS EDUCATION

The psychology of teaching and learning mathematics; supervision in mathematics teaching; curriculum theory; new curriculum projects; curriculum evaluation; introduction to research in mathematics education. 3 cr.

848. TOPICS IN GEOMETRY

Analysis on manifolds; differential geometry; Riemannian geometry; algebraic geometry; convexity. 3 cr.

849. TOPICS IN PROBABILITY AND STATISTICS

Time series analysis; analysis of variance; stochastic processes; probability; design of experiment; hypothesis testing; estimation theory; nonparametric statistics. 3 cr.

898. READING COURSES

A) Algebra; B) Analysis; C) Topology; D) Geometry; E) Functional Analysis; F) Differential Equations; G) Applied Mathematics; H) Probability and Statistics; I) Mathematics Education. 1–6 cr.

999. DOCTORAL RESEARCH

Mechanical Engineering

(M E)

Chairperson: Charles K. Taft

PROFESSORS: Robert W. Corelli; David E. Limbert; Godfrey H. Savage; Charles K. Taft; Russell L. Valentine

ASSOCIATE PROFESSORS: Sedat Biringen; Barbaros Celikkol; Frederick G. Hochgraf; William Mosberg; M. Robinson Swift; John A. Wilson

ASSISTANT PROFESSORS: Kenneth C. Baldwin; Alan D. Freed; James E. Krzanowski

RESEARCH ASSISTANT PROFESSOR: Raymond G. Gauthier

GRADUATE PROGRAM COORDINATOR: John A. Wilson

The mechanical engineering department offers programs of study from the viewpoint both of the engineering sciences and of engineering design, in the areas of mechanics, materials science, automatic control, and the thermal sciences, leading to the degree of master of science in mechanical engineering. The programs provide the background required for careers in research, engineering design, teaching, or for further graduate study.

Students admitted to graduate study in mechanical engineering should have completed work equivalent to that required by the University of New Hampshire for a bachelor of science degree in the field.

A candidate for the degree of master of science shall satisfy the requirements of either a thesis plan or a project plan. The thesis plan requires 24 semester hours of coursework in addition to 8 semester hours of M E 899, Master's Thesis; the project plan requires 28 semester hours of coursework in addition to 4 semester hours of M E 892, Master's Project. Individuals who can demonstrate accomplishments from professional engineering experience comparable to that expected from a master's project may petition the department to substitute an additional 800-level course for the project requirement.

At least eight credits must be earned in 800-level courses other than M E 899, Master's Thesis, M E 892, Master's Project, or the 800-level course substituted for the master's project course. No more than two graduate courses taken prior to admission to the Graduate School may be applied to the master's degree. An oral examination covering the candidate's graduate work will be given for both the thesis and project plans.

Students interested in graduate study beyond the master's degree should refer to the section entitled Engineering Ph.D. Program.

Permission of the instructor and consent of the adviser are required for enrollment in all mechanical engineering graduate courses. Some courses listed may not be offered every year.

701. MACROSCOPIC THERMODYNAMICS

Thermodynamic principles using an analytic, postulational approach and Legendre transformations to obtain thermodynamic potentials. 4 cr.

702. STATISTICAL THERMODYNAMICS

Macroscopic thermodynamic principles developed by means of microscopic analysis. Prereq: thermodynamics. 4 cr.

707. ANALYTICAL FLUID DYNAMICS

Development of the Navier-Stokes equations; vorticity theorems; turbulence and boundary-layer theory. Prereq: fluid dynamics. 4 cr.

708. GAS DYNAMICS

Basic equations of motion of one-dimensional, subsonic and supersonic flows of compressible, ideal fluids. Wave phenomena. Rankine-Hugoniot relations. Linear approach to two-dimensional flow problems. Prereq: fluid dynamics. 4 cr.

709. COMPUTATIONAL FLUID DYNAMICS

Solution of basic finite-difference methods for incompressible and compressible flows with practical examples. Treatment of boundary-initial conditions; analysis of stability and convergence of the numerical schemes. Prereq: fluid dynamics; heat transfer or permission. 4 cr.

710. SOLAR HEATING SYSTEMS

Analysis and computer modeling of solar radiation as an energy source for heating. Phenomena, availability, collection, performance, and economy of solar energy for heating systems. Prereq: heat transfer. 3 cr.

717. CRYOGENICS

Phenomena and processes at very low temperatures. Basic engineering sciences applied to problems of low temperature measurement, liquefaction, refrigeration, separation, and storage; transport of cryogenic fluids; measurement systems; vacuum technology. Prereq: thermodynamics. 4 cr.

723. ADVANCED DYNAMICS

Classical dynamics oriented to contemporary engineering applications. Prereq: Review of particle dynamics, Hamilton's principle and the Lagrange equations. Kinematics and dynamics of rigid bodies, gyroscopic effects in machinery and space structures. 4 cr.

86
VIBRATION THEORY AND APPLICATIONS
Discrete vibrating systems. Linear system concepts; single-degree-of-freedom systems with general excitation. Matrix theory and eigenvalue problems. Many degrees of freedom, normal mode theory for free and forced vibration. Numerical methods; introduction to continuous systems; applications to structural and mechanical systems. Prereq: intro vibrations. 4 cr.

EXPERIMENTAL MECHANICS
Experimental methods and theoretical bases applied to measurement of stress, strain, and motion. Transmitted and scattered-light photoelasticity; strain gage applications; brittle coating and grid techniques; dynamic measurements, and associated instrumentation. 4 cr.

ADVANCED MECHANICS OF SOLIDS
Beams on elastic foundation, curved bars, inelastic behavior, instability, introduction to thin plates and shells, introduction to elasticity, energy methods, and numerical methods. 4 cr.

MECHANICAL BEHAVIOR OF MATERIALS
Elastic and inelastic behavior of materials in terms of micro- and macromechanics. Stress, strain, and constitutive relations related to recent developments in dislocation theory and other phenomena on the atomic scale and to the continuum mechanics on the macroscopic scale. Elasticity, plasticity, viscoelasticity, creep, fracture, and damping. Anisotropic and heterogeneous materials. 4 cr.

NONLINEAR SYSTEMS MODELING
Modeling of hydraulic, pneumatic, and electromechanical systems. Solution methods including linearization and computer simulation of nonlinear equations. Methods of generalizing the nonlinear models for design purposes are developed. (Also offered as E E 741.) 4 cr.

SYSTEMS MODELING & EXPERIMENTATION II

NAVAL ARCHITECTURE IN OCEAN ENGINEERING
Selected topics in the fundamentals of naval architecture pertinent to ocean engineering, including hydrostatic characteristics, basics of resistance and propulsion, and rules and regulations for surface, semisubmersible, and submersible marine vehicles. Computer applications. Prereq: fluid dynamics; mechanics; 1 or permission. (Also offered as O E 751.) 4 cr.

SUBMERSIBLE VEHICLE SYSTEMS DESIGN
Conceptual and preliminary design of submersible vehicle systems; submersibles, environmental factors, hydromechanic and structural principles, materials, intra/extravehicle systems, operating considerations, predesign and design procedures. Design projects selected and completed by student teams. Prereq: permission. (Also offered as O E 752.) 4 cr.

COASTAL ENGINEERING AND PROCESSES
Introduction to small amplitude and finite amplitude wave theories. Wave forecasting by significant wave method and wave spectrum method. Coastal processes and shoreline protection. Wave forces and wave structure interaction. Introduction to mathematical and physical modeling. Prereq: fluid dynamics or permission. (Also offered as Ci E 757; O E 757.) 3 cr.

PHYSICAL METALLURGY I
Introduction to the electron theory of metals, intermetallic compounds, ferromagnetism, displacements, and slip phenomena. 4 cr.

PHYSICAL CERAMICS
Characteristics of crystalline and noncrystalline ceramic solids; defect structures; diffusion in ceramic materials; nucleation and crystal growth, spinodal decomposition, and solid-state reactions; kinetics of grain growth; sintering, and vitrification. Prereq: permission. 4 cr.

COMPUTER-AIDED ENGINEERING
Data acquisition and experiment control, multivariable data curve fitting, computer simulation of lumped systems based on analytical and data-based models, graphical display of data and simulation results. Interactive graphics and 3-D line drawing of objects for finite element analysis. Introduction to finite element analysis and survey of other software available. Prereq: M E 749 or permission. 3 cr.

MATHEMATICAL METHODS IN ENGINEERING SCIENCE I
Solution of discrete and continuous systems. Review of calculus, linear algebra, complex numbers, Fourier series, differential and partial differential equations with examples from acoustics, vibration theory, hydrodynamics, elasticity, solid mechanics, transport theory, and particle mechanics. 4 cr.

CONTROL SYSTEMS
Fundamental principles involved in the design and analysis of feedback control systems. Topics include stability criterion, time-domain analysis, frequency-domain analysis, and introduction to nonlinear systems. Lab. Prereq: permission. (Also offered as E E 782.) 4 cr.

SPECIAL TOPICS IN MECHANICAL ENGINEERING
New or specialized courses and/or independent study. May be repeated for credit. 2-4 cr.

IRREVERSIBLE THERMODYNAMICS
Nonequilibrium thermodynamics from the viewpoint of fluctuation theory. The Onsager reciprocal relations. Prereq: M E 701. 4 cr.

CONDUCTION HEAT TRANSFER
Heat conduction equation temperature fields and heat flux vector; analytical solution of the conduction equation in several variables; initial and boundary value problems; numerical methods of solution. 4 cr.

RADIATION HEAT TRANSFER
The fundamentals of radiant heat transfer. Development and solution of the wave equation for electromagnetic radiation. Analysis of Planck's law of radiation and earlier theories. Methods of solution
of radiant interchange in real systems with and without absorbing media. 4 cr.

806. CONVECTION HEAT TRANSFER
An analytical study of heat transfer to laminar and turbulent boundary layers of compressible and incompressible fluids. Basic differential equations governing the heat transfer are derived and analytical solutions are obtained where possible and checked with experimental results. 4 cr.

807. COMPRESSIBLE FLUID FLOW
General equations of motion for real and ideal compressible fluid flow including normal and oblique shocks, Prandtl Meyer flow, and methods of solutions. Applications to jet propulsion and turbo machinery. Prereq: M E 707 or 708. 4 cr.

808. THEORETICAL AERO/HYDRO-MECHANICS
The mathematical development of the equations of frictionless fluid flow, using both tensor notation and various coordinate systems. Conformal mapping; Blasius theorem; Joukowski hypothesis; flow around airfoils. Schwarz Christoffel theorem and vortex motion. 4 cr.

822. CONTINUUM MECHANICS
Conservation laws for gases, liquids, and solids in a continuum are developed starting from Liouville and Boltzmann equations. Passage from a discrete system to a continuum is discussed. Constitutive equations for viscoelastic and thermoelastic fields; and nonlinear gas, liquid, and elastic fields. General discussion of rheological behavior. Causality conditions for continuum fields. Examples for solids, liquids, and gases, and biomechanics. Introduction to phenomenological Lagrangian theories. 4 cr.

824. VIBRATIONS OF CONTINUOUS MEDIA
Classical and numerical methods are employed to study the vibration of continuous elements and structures. Topics considered are axial and torsional vibration of rods, transverse vibration of beams and thin plates, wave propagation, and vibration of simple structures. 4 cr.

826. THEORY OF ELASTICITY
The analysis of stress and deformation in elastic solids; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions; elastodynamic fields; inhomogeneous, anisotropic, wave equations; wave propagation and stress concentration problems; generalizations to thermoelasticity and viscoelastic fields. Complex variable techniques will be used. 4 cr.

827. THEORY OF PLASTICITY
Analysis of stress and deformation in inelastic solids; general development of stress invariants, variational principles, constitutive relations, and yield and loading functions. Special emphasis on ideal plasticity, strain-hardening, creep, limit analysis, and limit design. 4 cr.

829. THEORY OF PLATES AND SHELLS
Theory of elasticity developed for plates and shells; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions; stress and strain relations in curvilinear coordinates; thin and thick plate and shell theories; vibration of spherical, cylindrical, and conical shells and plates. 4 cr.

838. THEORETICAL ACOUSTICS
Fundamentals are presented with emphasis on theory and applications in underwater acoustics and in the acoustic determination of dynamic material properties. Topics include: a review of vibration theory; derivation of nonlinear acoustic field equations; linearization; Green's function techniques and solution of boundary value problems; scattering, reflection theories of boundary roughness; development of ray theory (geometric optics) from field equations; and Eikonal approximations. 4 cr.

842. DISCONTINUOUS CONTROL
Analysis and synthesis of feedback control systems operating on quantized information; compensation and performance improvement methods that use the quantized nature of the information are also developed. Design methods for pulse-width modulation, optimum quantizers and limit cycle behavior of quantized systems are developed. (Also offered as E E 842.) 4 cr.

844. NONLINEAR CONTROL SYSTEMS
Analysis and design of nonlinear control systems from the classical and modern viewpoints are discussed. Liapunov's stability theory; phase space methods; linearization techniques; simulation; frequency response methods; generalized describing functions; transient analysis utilizing functional analysis; and decoupling of multivariable systems. Prereq: E E or M E 851. (Also offered as E E 844.) 4 cr.

851. ADVANCED CONTROL SYSTEMS I
State-space representation of multivariable systems; analysis using state transition matrix. Controllability and observability; pole placement using state and output feedback; Luenberger observers. Introduction to computer-controlled systems (sampling, discrete state representation, hybrid systems); nonlinear analysis (Liapunov, Popov, describing function). Prereq: E E or M E 782. (Also offered as E E 851.) 3 cr.

852. ADVANCED CONTROL SYSTEMS II
Special topics in control theory: continuous and discrete systems; optimal control systems, including calculus of variations, maximum principle, dynamic programming, Weiner and Kalman filtering techniques, stochastic systems, adaptive control systems. Prereq: E E or M E 851. (Also offered as E E 852.) 3 cr.

855. ESTIMATION AND FILTERING
Stochastic systems course with application to control and communications. Topics include random variables, noise in linear systems, Bayesian and minimum variance estimation theory, optimal state estimators, Weiner and Kalman filters, combined estimation and control, prediction, parameter identification, and nonlinear filtering. Prereq: M E or E E 851; Math 735 or equivalent. (Also offered as E E 855.) 3 cr.

861. PHYSICAL METALLURGY II
Thermodynamics of solid solutions and mixtures, kinetics of selected solid state reactions including precipitation and recrystallization, martensitic transformations. 4 cr.

882. MATHEMATICAL METHODS IN ENGINEERING SCIENCE II
Continuation of M E 781. Complex variable techniques, integral transform techniques for the solu-

892. MECHANICAL ENGINEERING
MASTER'S PROJECT
The student works with a faculty member during one or two semesters on a well-defined research and/or original design problem. A written report and seminar are presented. 4 cr.

895. GRADUATE SPECIAL TOPICS
Investigation of graduate-level problems or topics in mechanical engineering. 2-4 cr.

899. MASTER'S THESIS
8 cr.

999. DOCTORAL RESEARCH

Microbiology (MICR)

Chairperson: Thomas G. Pistole

PROFESSORS: William R. Chesbro; Galen E. Jones; Thomas G. Pistole; Robert M. Zsigray
ASSOCIATE PROFESSOR: Richard P. Blakemore
ASSISTANT PROFESSORS: Florence E. Farber; Frank G. Rodgers
GRADUATE PROGRAM COORDINATOR: Frank G. Rodgers

Students admitted to graduate study in microbiology are expected to have had adequate preparation in the biological and physical sciences. This typically includes general and organic chemistry, physics, one semester of calculus, a year of general biology, a semester or more of biochemistry, and general microbiology. Formal courses in quantitative analysis and statistics are recommended. Students with deficiencies in these background courses who are admitted to the program may be required to complete appropriate coursework without graduate credit. Submission of Graduate Record Examination scores on the general test is recommended. Each applicant to the graduate program must be sponsored by a faculty member in the department. The sponsor's decision is usually based on the "Statement of Interest" section of the Application to Graduate School form. Persons planning to apply to the program should contact the graduate program coordinator in microbiology to obtain information on the department and the specific research interests of its faculty.

Doctor of Philosophy

Students with appropriate academic training at the baccalaureate or master's level may be considered for admission to the doctoral program. Persons enrolled in the doctoral program are required to develop and execute an independent research project in conjunction with a faculty adviser, to complete and defend successfully a dissertation based on this research, to pass a written qualifying examination administered by the student's guidance committee, and to complete one semester of teaching.

During the student's first two semesters, a guidance committee is appointed to determine specific coursework requirements. This committee also administers the qualifying examination. The student's faculty adviser chairs this committee. Upon successful completion of the qualifying examination, the student is advanced to candidacy. A doctoral committee, established according to guidelines published by the Graduate School, is appointed to supervise preparation of the dissertation and its final public defense.

The department's acceptance of the thesis is contingent on (1) its approval by the doctoral committee and (2) evidence that at least one manuscript based on the research has been submitted to a refereed scientific journal appropriate to the topic.

All graduate students are expected to enroll in MICR 897, Microbiology Seminar, each semester. In addition to thesis copies required by the Graduate School, students must submit two additional bound copies to the department.

701. TAXONOMY AND ECOLOGY
Isolation, identification, and classification of prokaryotic microorganisms by classical and newer techniques; analysis of the interplay between organisms and environment based on energy metabolism and use of this to deduce a natural classification; uses of taxonomic and ecological information. Prereq: gen micr; gen bchm. Lab. 4 cr.

704. MICROBIAL GENETICS
Expression and transfer of genetic elements (chromosomal and nonchromosomal) in prokaryotic and eukaryotic organisms; consideration of factors influencing public health, industry, the environment, and society. Prereq: general microbiology; physiological chemistry and nutrition. Lab. 4 cr.

705. IMMUNOLOGY AND SEROLOGY
Examination of the immune response in vertebrates. Characterization of the major components of the immune system; study of host-defense mechanisms and immunopathology; use of serological techniques for identification and diagnosis. Prereq: pathogenic micro; permission. Lab. 4 cr.

706. VIROLOGY

707. MARINE MICROBIOLOGY
Characterization of microorganisms in the sea including taxonomy, physiology, and ecology; sam-

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pling, enumeration, distribution; and effects of marine environment upon microbial populations. Prereq: gen micr; organic chemistry. Lab. 4 cr.

708. MICROBIAL BIOGEOCHEMISTRY
Geochemical processes influenced by biochemical processes catalyzed by marine and terrestrial microorganisms; transformations of carbon, nitrogen, and other elements. Petroleum microbiology, natural gas production, sulfur formation, ferromanganese nodules, corrosion, and fossil microorganisms. Prereq: gen micr; organic chemistry. Lab. 4 cr.

710. MICROBIAL CYTOLOGY AND ELECTRON MICROSCOPY
Ultrasound and function in eukaryotes, prokaryotes, and viruses. The role of flagella, pili, cell walls, membranes, cytoplasmic inclusions, cell division, and sporulation will be discussed along with virus ultrastructure. Included are electron microscopic techniques for the study of microbial cytology; theory and uses of electron microscopes; sample preparation methods; photographic techniques, and interpretation of electron micrographs. Prereq: gen micr; permission. Lab. 4 cr.

795. PROBLEMS IN MICROBIOLOGY
Prereq: permission. 1–8 cr.

802. MICROBIAL PHYSIOLOGY
Means by which microorganisms survive: nutritional, chemical, physical factors; metabolism and its regulation; generation of cell ultrastructure; ecological interactions. Prereq: gen micr; gen bchm. Lab. 2 or 4 cr. (Not offered every year.)

804. ADVANCED MICROBIAL GENETICS
Advanced studies in expression, regulation, recombination, and transmission of genetic information in prokaryotic microorganisms. Prereq: Micr 704; permission. Lab. 4 cr. (Not offered every year.)

806. ADVANCED IMMUNOLOGY
Basic concepts in immunology including immunorecognition, effector systems, immunogenetics, immunopathology, and comparative immunology. Prereq: gen immunol; gen bchm; permission. Lab. 4 cr. (Not offered every year.)

851. CELL CULTURE
Theory and principles fundamental to culture of cells in vitro. Introduction to techniques of preparation and maintenance of animal, plant, insect, fish cell cultures. Application of cell culture to contemporary research in biological sciences. Prereq: gen micr; permission. (Also offered as ANSC 851 and Bot 851.) Lab. 4 cr.

893. ADVANCED PROBLEMS AND TECHNIQUES IN MICROBIAL CYTOLGY
Research with electron microscopy. Includes reading, organized seminars in microbial cytology, recent advances in electron microscopy, and laboratory project work. Prereq: Micr 710; permission. 1–4 cr. (May be repeated to a maximum of 8 cr.)

895. SPECIAL TOPICS IN MICROBIOLOGY
Advanced studies in specific areas. Prereq: permission. 1–4 cr. (May be repeated to a maximum of 8 cr.)

897. MICROBIOLOGY SEMINAR
Presentation and discussion of selected topics in microbiology. Required of all graduate students in microbiology. 1–2 cr. Cr/F. (May be repeated.)

899. MASTER'S THESIS
6–10 cr.

999. DOCTORAL RESEARCH

Music (Musi)

Chairperson: Keith Polk

PROFESSORS: Keith Polk; John E. Rogers; John D. Wicks

ASSOCIATE PROFESSORS: Ruth S. Edwards; Stanley D. Hettinger; Cleveland L. Howard; Christopher Kies; Mary H. Rasmussen; David E. Seiler; W. Niel Sir; Robert Stibilr; Peggy A. Vagts; Paul F. Verrette; Henry J. Wing, Jr.

ASSISTANT PROFESSORS: Leslie J. Hunt; Roy Mann, Jr.; Larry J. Veal

GRADUATE PROGRAM COORDINATOR: John D. Wicks

The Department of Music offers programs leading to the degrees of master of arts in music and master of science in music education. In both programs, at least one-half of the required credits are in courses intended for graduate students only.

Master of Arts
The degree of master of arts in music, while designed basically for students interested in broadening their knowledge of the history of music in all of its dimensions, has proven consistently valuable to students who wish to augment strong backgrounds in performance and/or education with more specialized studies in theory, literature, and performance/practice. The following courses (or their approved equivalents) are required: Musi 855, 856, 857, 858, 891, and 893 or 894. Courses at the 700 and 800 levels in music, or the 600, 700 and 800 level in other departments, may be elected, with the approval of the student’s adviser, to a minimum total of 30 credits. Completion of the program requires a written essay of substantive nature on a topic of the candidate’s special interest and a comprehensive oral exam. The latter includes analysis and historical discussion of scores from all periods of music. It is recommended that more than two semesters be allowed for completion of the degree. The cultural advantages of the city of Boston, 90 minutes away, are a valuable adjunct to the program.

A bachelor of arts degree in music or its equivalent from an accredited institution is required for admission to this program. A performance audition and a placement examination in theory, music history, and aural identification are normally required of all applicants and are taken in the semester preceding entrance into the graduate program. Students not meeting standards in the placement examinations will not be officially admitted to the Graduate School until such examinations are passed to the satisfaction of the department. A reading knowledge of both German and French is strongly recommended before entering the program; a German reading examination will be administered by the department. On recommendation of the graduate adviser, this requirement may be waived for students who do not plan further study beyond the M.A. degree.
Master of Science

The goal of the master of science in music education degree is to develop a broad knowledge at the graduate level in the fields of music education, performance, history, theory, and independent study. The following courses are required: MuEd 796; and 883 or 884; Musi 855; and 893 or 894. Also required are two courses in the Department of Education from courses such as the following: Edu 820, 827, 841, 853, 858, 861, 865, 883, 884, 886, and in special cases, 700, 701, and 705. Vocal or instrumental study at the 800 level is required to a minimum of 4 credits. A maximum of 9 credits is allowed if the graduate recital option is elected. Sufficient electives must be taken to total 30 credits. A comprehensive exam concerning the application of philosophical, sociological, psychological, and technical aspects of music education completes the program.

Admission to this program requires a bachelor's degree in music education or its equivalent from an accredited institution. A performance audition and a placement examination in theory, music history, and aural identification are normally required of all applicants and are taken in the semester preceding entrance into the graduate program. Students not meeting standards in the placement examinations will not be officially admitted to the Graduate School until such examinations are passed to the department's satisfaction.

History and Literature

707. MUSIC OF THE CLASSICAL PERIOD
Growth of musical styles and forms from early classicism through the high classicism of Haydn, Mozart, and the young Beethoven. 4 cr.

709. MUSIC OF THE ROMANTIC PERIOD
A survey of Romanticism in music from Beethoven's late period to the end of the 19th century. The works of Schubert, Berlioz, Schumann, Mendelssohn, Chopin, Wagner, Verdi, Brahms, Austrian symphonists, French pre-impressionists, and national styles in European music. 4 cr.

711. MUSIC OF THE 20TH CENTURY
Styles and techniques of composers from Debussy to the present. Special emphasis on tonal music before World War I; neoclassical trends; the emergence of atonality and serial techniques; antirationalist music; electronic music. 4 cr.

732. THE ART SONG
History and literature of the solo song with piano accompaniment. Survey of national styles of the 19th and 20th centuries and deeper study of the central core of the art song—the German Lied. 4 cr.

733. SURVEY OF OPERA
History of the genre from Monteverdi to the present. Representative masterpieces by Handel, Mozart, Beethoven, Weber, Wagner, Verdi, Massorgsky, Debussy, Berg, and others. 4 cr.

735. SURVEY OF PIANO LITERATURE
Keyboard literature from the baroque to the present. Analysis, discussion, and illustration of works by Bach, Haydn, Mozart, Beethoven, the romantic composers, and contemporary writers. 4 cr.

795. SPECIAL STUDIES IN MUSIC

855. INTRODUCTION TO BIBLIOGRAPHY
An intensive survey of basic reference works, music periodicals, collected editions, series, treatises, books on musical instruments and performance practice, and the important monographs on major composers from Machaut to Schoenberg. A reading knowledge of German and French is very useful. 3 cr.

856. READINGS IN MUSIC HISTORY: ANTIQUITY TO 1600
An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

857. READINGS IN MUSIC HISTORY: 1600–1820
An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

858. READINGS IN MUSIC HISTORY: 1820 TO THE PRESENT
An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

891. RESEARCH SEMINAR
Guidance in individual research projects. Prereq: permission. 1–4 cr.

895. INDEPENDENT STUDY IN THE HISTORY AND THEORY OF MUSIC
Opportunity for especially qualified students to investigate, with guidance, specific areas of their scholarly concern. Prereq: permission. 1–4 cr.

Theory and Composition

771-772. COUNTERPOINT
Contrapuntal techniques of tonal music. Melodic construction and dissonance treatment through work in species counterpoint and studies in harmonic elaboration and prolongation. Analysis of selected compositions emphasizes the connection between fundamental contrapuntal techniques and the voice-leading of composition. Prereq: music theory II or permission. 2 cr.

775-776. COMPOSITION
Construction of phrases, periods, and short compositions following classical models. Problems of text-setting. Prereq: music theory II or permission. 3 cr.

777. ADVANCED COMPOSITION
Continuation of Musi 776. Individual compositional projects. Prereq: Musi 776 and permission. May be repeated for credit. 3 cr.
779. ORCHESTRATION
Characteristics of band and orchestral instruments both individually and in small (homogeneous) and large (mixed) groupings. Students study scores, write arrangements, and have arrangements performed if at all possible. Some aspects of vocal writing. Prereq: music theory II or permission. 4 cr.

781. FORM AND ANALYSIS
Formal and textural elements; concepts and examples. Thorough analysis of smaller and larger masterworks from the standpoint of harmony, counterpoint, structural line, and formal articulation. Prereq: music theory II or permission. 4 cr.

785. ELECTRONIC SOUND SYNTHESIS
Part I: "traditional" or "analog" electronic sound synthesis; work with the Buchia Synthesizer in the electronic music studio. Part II: 1) elementary programming in FORTRAN; 2) the logic of computer sound synthesizes; and 3) programming in MUSIC 4BF. Students will have the opportunity to run programs on a DEC KL10 computer equipped with 4-channel digital-to-analog and analog-to-digital converters. Part III: completion of a major independent study project in electronic music. Prereq: permission. 4 cr.

795. SPECIAL STUDIES IN MUSIC
Refer to History and Literature section.

894. THEORY SEMINAR
Theory and practice from the Baroque to contemporary music. Performance practice in the Baroque and later periods. Score analysis. Prereq: permission. 3 cr.

895. INDEPENDENT STUDY IN THE HISTORY AND THEORY OF MUSIC
Refer to History and Literature section.

Performance

795. SPECIAL STUDIES IN MUSIC
Refer to History and Literature section.

841-851. APPLIED MUSIC FOR GRADUATE CREDIT
The following courses offer further development of technique, music interpretation, and repertory on the various instruments. Emphasis may also be directed toward the functional use of the instrument in the school room. Private lessons are based on a half-hour of individual instruction per week. One semester-hour credit may be earned with one lesson per week; 2 or 4 semester hours of credit may be earned with two lessons per week. Five one-hour practice periods are expected for each credit of private study. The special fee for a one-half hour lesson per week is $35 per semester in addition to normal tuition charges. The fee includes the use of a practice room for the required preparation. Prereq: student must exhibit sufficient proficiency to warrant graduate study and must have permission of the department chairperson and the student's graduate adviser. Audition required. A student may register for credit in the same course in successive semesters with the approval of the major adviser. 1, 2, or 4 cr.

841. GRADUATE VOICE
842. GRADUATE PIANO

843. GRADUATE HARPSICHORD
844. GRADUATE ORGAN
845. GRADUATE VIOLONCELLO, STRING BASS
846. GRADUATE VIOLIN, VIOLA
847. GRADUATE WOODWIND
848. GRADUATE BRASS
849. GRADUATE PERCUSSION
850. GRADUATE HARP
851. GRADUATE EARLY WIND INSTRUMENTS

Music Education (MuEd)

741-742. TECHNIQUES AND METHODS IN CHORAL MUSIC
Problems in the organization and performance of high school, college, and community choruses. Techniques of choral conducting and rehearsal, repertory, and materials. 2 cr.

743. MATERIALS AND METHODS IN PIANO MUSIC
Gives potential piano teachers a coherent but flexible approach to the instruction of students of different ages and levels of talent through evaluation of methods and materials and discussion of the role of the private teacher. 2 cr.

745-746. TECHNIQUES AND METHODS IN STRING INSTRUMENTS
Class and individual instruction. Four hours of practice per week required. Intensive training on the violin, viola, cello, and double bass enables participants to perform in string ensembles. Classroom procedures, establishment of string programs, and evaluation of available methods materials. 2 cr.

747-748. TECHNIQUES AND METHODS IN WOODWIND INSTRUMENTS
Basic fundamentals of performance, class instruction, associated acoustical problems, and study of woodwind literature. First semester: clarinet, flute, and saxophone. Second semester: double-reed instruments. 2 cr.

749. TECHNIQUES AND METHODS IN BRASS INSTRUMENTS
Basic course in embouchure formation, tone, tonguing, fingering, flexibility, accuracy, and range development as applied to the trumpet or baritone horn, French horn, and trombone; methods, studies, solos, and ensembles most likely to be useful with grade school, junior high school, and high school players of brass instruments. 2 cr.

751. TECHNIQUES AND METHODS IN PERCUSSION INSTRUMENTS
Basic performance skills on snare drum, timpani, mallet instruments, and other percussion instruments used in bands and orchestras. Materials and methods of instruction. 2 cr.
MUSIC FOR THE ELEMENTARY CLASSROOM TEACHER
Designed for the nonspecialist. Correlation and integration of music in the school curriculum, and basic skills and techniques necessary. 4 cr.

THE TEACHING OF ELEMENTARY AND MIDDLE SCHOOL MUSIC
Aims, scope, and organization of materials and activities in elementary and middle schools. Modern trends in educational philosophy; development of the child's voice; demonstration of materials and methods for the various grades. Observation and teaching in schools. 2 cr.

THE TEACHING OF SECONDARY SCHOOL MUSIC
Educational principles applied to music teaching and learning; curriculum organization for junior and senior high school. Adolescent voice, voice classification, selection of vocal and instrumental materials, and building unified concert programs. Problems of administration; management; relationship of the teacher to school and community. Observation of secondary school music programs. 2 cr.

SPECIAL STUDIES IN MUSIC EDUCATION
Allows upper-level students to explore individually or in groups areas related to their specific professional interests. Prereq: permission. 1-4 cr.

FOUNDATIONS AND PERSPECTIVES OF MUSIC EDUCATION
Philosophical, sociological, and psychological foundations and principles of music education and the relationship of these principles to music learning and teaching. 4 cr.

INSTRUMENTAL LITERATURE AND ITS PERFORMANCE
Exploration of representative solo and ensemble music for string, wind, and percussion instruments. Typical literature from each period of music is studied. As much as is possible, live performance is included; recordings are used as required. Detailed attention given to interpretation. Project required. 3 cr.

CHORAL LITERATURE AND ITS PERFORMANCE
Analysis, discussion, and conducting of excerpts from choral masterpieces from all major periods and styles. Students will have the opportunity to act as assistant conductors for some of the choral organizations on campus. Evaluation of current high school and college repertoires. 3 cr.

SPECIAL PROJECTS IN MUSIC EDUCATION
Independent study, investigation, or research in music education. Creative projects may be included. Prereq: permission. 1-4 cr.

ASSISTANT PROFESSORS: Cynthia D. Connelly; Susan B. Crowell; Margaret A. Crowley; Elizabeth Ely; Dona J. Lethbridge; Leslie Raelene; Zasowska; Mary Stanick; Joan J. Tomasi

GRADUATE PROGRAM DIRECTOR: Aloise A. Zasowska

The Department of Nursing offers the master of science degree in nursing. The master's program will prepare the student for advanced practice as a nurse specialist to assume a leadership role in nursing and the health care system through advanced preparation in nursing science and related disciplines. The master's prepared nurse specialist integrates a knowledge base that permits the identification of critical analysis of issues in nursing and health care delivery. The graduate is prepared to resolve identified problems through the formulation of creative and innovative approaches.

The master's prepared nurse promotes theory development in nursing by identification of phenomena and concepts relevant to the discipline. Using theory from nursing, the humanities, behavioral and social sciences, and the application of the research process, the graduate is able to advance and extend nursing knowledge. The research process directs the discovery, formulation, and testing of concepts and principles. Graduates serve in the role of principal investigator and/or facilitator of clinical studies to analyze and reformulate solutions to nursing care delivery problems.

Professional nursing is practiced within a societal context giving rise to those conditions that generate a need for nursing care. Inherent in this practice is the utilization of moral and ethical judgment, responsibility, accountability, and advocacy for members of society. The graduate values political activism to influence the formation of health care policy. Graduate study is characterized by the use of inquiry and a high level of self-direction, personal involvement, and a commitment to lifelong learning. The master's program serves as a foundation for doctoral study. Two specialty areas are offered: adult medical-surgical nursing and nursing administration.

Admission Requirements:
Applicants are evaluated on the basis of previous academic work and professional background. In addition to the materials required by the Graduate School, each applicant must include:
1) evidence of an earned baccalaureate degree with a major in nursing from a National League for Nursing (NLN) accredited program; 2) current R.N. license; 3) recent Graduate Record Examination (GRE) general test scores; 4) evidence of current work experience in nursing; 5) three letters of recommendation from persons who can speak to the applicant's potential for success in graduate work and leadership in nursing; 6) a course in elementary statistics; 7) evidence of basic nursing assessment skills; and 8) a written statement of goals and objectives. A cumulative undergraduate GPA of 3.0 is required for admission.

Program of Study:
The program for the master of science degree includes a total of 42 credits. It is designed to be completed in two academic years of full-time study. Individualized plans of study are available for those wishing to pursue part-time study. The program of study is designed as follows:

Chairperson: Juliette D. Petillo
PROFESSOR: Aloise A. Zasowska
ASSOCIATE PROFESSORS: Ann Kelley; Juliette D. Petillo; Raelene Shippee-Rice; Rosemary Y. Wang; Carol L. Williams

Nursing (Nurs)
1) core courses (19 credits). Courses required of all students include: a) foundation and role courses (15 credits: Nurs 806, Nursing Theory Development; Nurs 802, Advanced Concepts in Nursing Practice; Nurs 803, Issues in Nursing Care Delivery; Nurs 830, Role Theory Seminar; Nurs 831, Role Practicum; Nurs 832, Law and Ethics; and b) research courses (4 credits): Nurs 804, Research in Nursing; Nurs 805, Research in Nursing II.

2) Specialty courses (11 credits). Courses required for each area of specialization include, for adult medical-surgical nursing: Nurs 811, Pathophysiology; Nurs 813, Advanced Concepts in Adult Medical-Surgical Nursing; Nurs 814, Advanced Adult Medical-Surgical Nursing Practice; and Nurs 860, Seminar in Medical-Surgical Nursing; or, for nursing administration: Nurs 821, Labor and Organizational Perspectives; Nurs 823, Theory of Nursing Administration; Nurs 824, Resource and Financial Management in Nursing; and Nurs 863, Seminar in Nursing Administration.

3) elective courses (6 credits). Six credits of elective coursework are required. Elective credits are not restricted to nursing courses (6 credits). A thesis or scholarly paper is required of all students. Students selecting the thesis option are required to register for six credits of Master's Thesis (Nurs 899). Students selecting the nonthesis option are required to register for Master's Research Project (Nurs 898) for a minimum of 3 credits and take an additional 3 credit-hour elective.

801. NURSING THEORY DEVELOPMENT
Investigates the stages of classical theory development. The student will be encouraged to review current nursing theories and concept valuations in light of classical theory development in an effort to understand the process of theory development. Analysis of the implications of the application of theory in nursing practice is emphasized. Prereq: permission. 3 cr.

802. ADVANCED CONCEPTS IN NURSING PRACTICE
Focus on concepts critical to the delivery of nursing. Examination of current theoretical basis of selected concepts and their applicability to nursing practice. Students' experiences are designed to promote the development of a theoretical framework for individual nursing care delivery. Prereq: permission. 3 cr.

803. ISSUES IN NURSING CARE DELIVERY
Identification and examination of contemporary nursing care delivery issues and trends. Analysis of interactions of health organizations with political, economic, and other social systems. Analysis of ethical and legal influences in nursing care delivery with regard to patient rights, professional responsibility, and liability. Consideration of patient classification systems, reimbursement mechanisms, and quality assurance approaches. Prereq: permission. 2 cr.

804. RESEARCH IN NURSING I
The effective use of research in nursing. Topics include: the role of research within the discipline, the relationship of theory and research; examination of prevalent research methodologies including quantitative, qualitative, and historical approaches and philosophic inquiry; critical analysis and evaluation of current nursing research; ethical considerations of research; and identification of research questions. Prereq: permission. 2 cr.

805. RESEARCH IN NURSING II
Systematic investigation of each step in the development, design, and proposed implementation of a nursing research study. Instrumentation, methodology, and data analysis will be discussed as they relate to specific student projects. Development of a research proposal will be a goal of the course. Prereq: Nurs 804 or permission. 2 cr.

811. PATHOPHYSIOLOGY
Focus on alterations of normal basic cellular processes and the human body's adaptive and compensatory responses. Provides basis for nursing assessment and clinical decision making. Establishes foundation for pathophysiological components of nursing care. Prereq: permission. 3 cr.

813. ADVANCED CONCEPTS IN ADULT MEDICAL-SURGICAL NURSING
Examination of the relevance of selected concepts and theories in understanding and assessing human responses to health and illness for decisions in nursing practice. Designed to enhance the application of pathophysiology and physical assessment skills in clinical practice. Prereq: Nurs 811 or permission. 3 cr.

814. ADVANCED ADULT MEDICAL-SURGICAL NURSING PRACTICE
A holistic approach to the health care management of individuals. Focus on implications of acute, chronic, and terminal illnesses on individuals and families. Clinical experiences in selected acute, long-term, and ambulatory care settings. Prereq: Nurs 813 or permission. 3 cr.

821. LABOR AND ORGANIZATIONAL PERSPECTIVES
Focus on theories of human behaviors in organizations. Analysis of these theories as they apply to care management and their implications for labor relations issues in nursing organizational structure. Prereq: permission. 3 cr.

823. THEORY OF NURSING ADMINISTRATION
Theories and concepts involved in planning, organizing and directing, and managing nursing service activities. Concepts of administration are analyzed in relation to nursing's centrality in the overall health care system. Prereq: Nurs 821. 3 cr.

824. RESOURCE AND FINANCIAL MANAGEMENT IN NURSING
Focus on theories and concepts that promote the effective utilization of human and financial resources in nursing organizations. Introduction to principles of budgetary and financial planning needed for effectiveness in nursing administration. Analysis of concepts and principles of administration, supervision, and consultation. Prereq: Nurs 823. 3 cr.

830. ROLE THEORY SEMINAR
Examination of theories relevant to the development of leadership roles in nursing. Theories of organizations, change, role development, and leadership are studied. Educational and consultation components of advanced roles are examined. Concepts in working with groups as they relate to delegation accountability and quality assurance. Prereq: permission. 2 cr.

831. ROLE PRACTICUM
Opportunity to apply theoretical constructs to the development of a specific role. Collaboration and
consultation form the base for advanced nursing role practice. Opportunity for nurse clinical specialist or nurse administrator role development in a variety of settings. Prereq: Nurs 830 or permission. 2 cr.

832. LAW AND ETHICS
Analysis of the ethical and legal trends in health care delivery with regard to patient rights, professional responsibilities, and institutional liability. Prereq: permission. 3 cr.

860. SEMINAR IN MEDICAL-SURGICAL NURSING
Emphasis on issues in clinical practice. Focus on synthesis of knowledge from nursing and the analysis of the role of the clinical nurse specialist in a medical-surgical setting. Prereq: Nurs 814 or permission. 2 cr.

863. SEMINAR IN NURSING ADMINISTRATION
Selected topics include quality assurance, cost containment, political realities, and implications of organizational structures in different nursing agencies. Prereq: Nurs 824. 2 cr.

894. SPECIAL TOPICS
Formal courses given on selected topics or special interest subjects. Several topics may be taught in one year or semester. May be repeated. Prereq: permission. 1–3 cr.

896. INDEPENDENT STUDY
Opportunity for study and/or practice in an area of choice. Objectives are developed by students and must be approved by faculty. May be repeated for a maximum of 6 credits. Prereq: permission. 1–3 cr.

898. MASTER’S RESEARCH PROJECT
Discussion of nursing research studies. Students must develop and present scholarly paper to faculty and peers. May be taken for up to 6 credits. Prereq: Nurs 805 or permission. 3 cr. Cr/F.

899. MASTER’S THESIS
Prereq: permission. 6 cr.

Ocean Engineering (O E)

Coordinator: Donald W. Melvin

PROFESSORS: Paul L. Bishop; Fletcher A. Blanchard, Jr.; Robert W. Corell; Stephen S.T. Fan; Albert D. Frost; David E. Limbert; Godfrey H. Savage; Kondagunta Swapprasad

ASSOCIATE PROFESSORS: Wendell S. Brown; Barbaros Celikkol; Pedro De Alba; David L. Gress; Donald W. Melvin; M. Robinson Swift

ASSISTANT PROFESSORS: Kenneth C. Baldwin; Thomas P. Ballesteros; Jean Benoit; Nancy E. Kinler

RESEARCH ASSOCIATE PROFESSOR: James D. Irish

The interdisciplinary Ocean Engineering Program offers graduate work leading to the degree of master of science in ocean engineering. The general purpose of this program is to prepare engineering students for professional careers in ocean-related fields. Students admitted to the program should have completed a baccalaureate degree in either chemical, civil, electrical, or mechanical engineering or have an equivalent background.

Each student in the program will be required to take ESci 758 (Physical Oceanography) and O E 890, 891 (Ocean Engineering Seminar I, II). In addition, each student must select three of the following six courses: O E 781 (Physical Instrumentation), O E 761 (Materials in the Ocean), O E 753 (Ocean Hydrodynamics), O E 754 (Ocean Waves), O E 785 (Underwater Acoustics) and ESci 859 (Data Analysis Methods in Ocean and Earth Sciences). Students will also be required to take a minimum of 12 credits of additional coursework and a 6-credit thesis/project. Normally the additional courses would be in the student’s field of engineering.

710. OCEAN MEASUREMENTS LABORATORY
Measurements of fundamental ocean processes and parameters. Emphasis on understanding typical offshore measurements, their applications, and the use of the acquired data. The latter is in terms of the effects on structures and processes in the ocean. 3 cr.

751. NAVAL ARCHITECTURE IN OCEAN ENGINEERING
Selected topics in the fundamentals of naval architecture pertinent to ocean engineering; including hydrostatic characteristics; basics of resistance and propulsion; and rules and regulations for surface, semisubmersible, and submersible marine vehicles. Computer applications. Prereq: fluid dynamics; mechanics; or permission. (Also offered as M E 751.) 4 cr.

752. SUBMERSIBLE VEHICLE SYSTEMS DESIGN
Conceptual and preliminary design of submersible vehicle systems; submersibles, environmental factors, hydromechanic and structural principles, materials, intra/extravehicle systems, operating considerations, predesign and design procedures. Design projects selected and completed by student teams. Prereq: permission. (Also offered as M E 752.) 4 cr.

753. OCEAN HYDRODYNAMICS
Fundamental concepts of fluid mechanics as applied to the ocean; continuity; Euler and Navier-Stokes equations; Bernoulli equation; stream function; potential function; momentum theorem; turbulence and boundary layers are developed with ocean applications. Prereq: permission. 3 cr.

754. OCEAN WAVES
Introduction to water waves; linear small-amplitude wave theories; finite-amplitude wave theories; long-wave theory; wave motion as a random process; interaction of waves with structures; similitude and scale-model technology. Prereq: permission. 3 cr.

757. COASTAL ENGINEERING AND PROCESSES
Introduction to small-amplitude and finite-amplitude wave theories. Wave forecasting by significant wave method and wave spectrum method. Coastal processes and shoreline protection. Wave forces and wave structure interaction. Introduction to mathematical and physical modeling. Prereq: fluid dynamics or permission. (Also offered as Civ E 757; M E 757.) 3 cr.

95
761. MATERIALS IN THE OCEAN
Introduction to mechanical properties of materials; ferrous metals; nonferrous metals; concrete, plastic, wood, etc.; corrosion of metals; corrosion control; durability of cementitious materials; degradation of plastics, wood, etc. in marine environment; proper materials selection for a marine environment. Prereq: permission. 3 cr.

781. PHYSICAL INSTRUMENTATION
Analysis and design of instrumentation systems. Sensors, circuits, and devices for measurement and control. Elements of probability and statistics as applied to instrument design and data analysis. Transmission, display, storage, and processing of information. The design, implementation, testing, and evaluation of an instrument system is an integral part of the course. Prereq: permission. (Also offered as E E 781.) 4 cr.

785. UNDERWATER ACOUSTICS
Vibrations; propagation; reflection; scattering; reverberation; attenuation; sonar equations; ray and mode theory; radiation of sound; transducers; and small- and large-signal considerations. Prereq: permission. (Also offered as E E 785.) 4 cr.

795. SPECIAL TOPICS IN OCEAN ENGINEERING
New or specialized courses and/or independent study. May be repeated for credit. 2-4 cr.

837. ADVANCED HYDRODYNAMICS
Continuum approach to the analysis of ocean circulation problems. Shallow and deep water modeling to include temperature, salinity, and species distributions in time and space. Air-sea interaction, energy transport phenomena, internal currents, and the effect of coastal geometry on wave reflection and resonant phenomena. Fundamental data acquisition and analysis techniques. Prereq: permission. 4 cr.

890, 891. OCEAN SEMINARS I, II
Various topics, including marine systems design, marine vehicle operation, data collecting and processing, and marine law. 2 cr.

898. INDEPENDENT STUDY
Independent theoretical and/or experimental investigation of an ocean engineering problem under the guidance of a faculty member. 1-4 cr.

899. MASTER'S THESIS
6 cr.

Physical Education (PhEd)

Chairperson: Walter E. Weiland

ASSOCIATE PROFESSORS: Katherine Amsden; Gavin H. Carter; Phyllis A. Hoff; Robert Kertzner; D. Michael McKeeough; D. Allan Waterfield; Robert E. Wear; Walter E. Weiland

ASSISTANT PROFESSOR: Neil B. Vroman

GRADUATE PROGRAM COORDINATOR: Katherine Amsden

The Department of Physical Education offers a graduate program leading to the master of science degree in physical education, with the following areas of concentration: exercise specialist and sport studies. Admission is based on undergraduate preparation, academic record, Graduate Record Examination general test scores, and letters of recommendations. Applicants must be above-average students and show adequate preparation in the basic support courses of the selected concentration area. Applicants who have not met specific course prerequisites should expect to take additional undergraduate work without receiving graduate credit.

Students in the exercise specialist concentration must follow the thesis plan; students in the sport studies concentration may follow either the thesis or the nonthesis plan. All degree candidates will be required to take PhEd 800, PhEd 801, and the designated concentration core. Exercise specialist core: PhEd 722, PhEd 732, PhEd 833. Sport studies core: PhEd 741, PhEd 760, PhEd 780. In addition, the exercise specialist students will be required to take PhEd 802, Colloquium, for two semesters. All remaining coursework in both concentrations may be taken within the Department of Physical Education; however, approval may be granted to take relevant courses outside the department.

Thesis plan: A minimum of 30 approved graduate credits including a thesis (24 graduate course credits plus 6 thesis credits) is required in the thesis plan, plus an oral defense of the thesis.

Nonthesis plan: A minimum of 8 approved graduate courses (with a minimum of 30 credits) is required in the nonthesis plan. Four credits of PhEd 895, Advanced Studies, are required. A student may take PhEd 895 only after completing at least three approved graduate courses, including PhEd 801.

702. ADVANCED ATHLETIC TRAINING
Assessment, rehabilitative treatment, preventive strapping, and protective equipment used in athletic training. Administration of a training room facility. Prereq: basic athl train. Lab. 4 cr.

703. LABORATORY PRACTICE IN ATHLETIC TRAINING
150 hours of experience in UNH athletic training room under N.A. T.A. certified trainer. Prereq: basic athl train. (Only two credits may be applied toward master’s degree requirement.) 2 cr.

710. UNDERWATER RESEARCH METHODS
Lecture, open water, and pool instruction in underwater research techniques and hyperbaric physiology lab. Prereq: basic certification; permission. Fee. 4 cr.

722. GRADED EXERCISE TESTING AND EXERCISE PRESCRIPTION
Graded exercise testing and its application to the prescription of exercise. Special emphasis on the patient with cardiovascular disease. Prereq: physiology of exercise; permission. 4 cr.

732. ELECTROCARDIOGRAPHY
Introduction to electrocardiographic interpretation. Prereq: physiology of exercise or equivalent; permission. 4 cr.

740. PERCEPTUAL MOTOR DYSFUNCTION
Theoretical rationale and clinical perceptual-motor training programs of Ayres, Kephart, Cratty, Barsch, and Getman, as they relate to sensory-
motor integration and the remediation of learning disabilities. Prereq: PhEd 775 or permission. 4 cr.

741. SPORT IN SOCIETY
An investigation into interrelationships among sport, culture, and society in an attempt to understand better the role and function of sport in contemporary society. Broad overview of selected sociocultural factors that influence participation and result from participation in sports. Prereq: introductory sociology or permission. 4 cr.

750. ANALYZING TEACHING IN PHYSICAL EDUCATION
Examination of teaching practices, theories, and research implications. Varied approaches to the study and improvement of teaching, including analysis of films and tapes. Prereq: theory of teach phys ed in sec school; theory of teach phys ed in elem school; or permission. 4 cr.

760. APPLICATION OF RESEARCH TO TEACHING AND COACHING
The application to coaching and teaching physical education of pertinent research findings in sport psychology, sport sociology, exercise physiology, biomechanics and kinesiology, and motor learning and development. Prereq: measurement procedures in physical education or equivalent; permission. 4 cr.

775. PERCEPTUAL MOTOR LEARNING
Variables affecting the learning and performance of skilled activity; ability and motivational characteristics of the learner; processes for skill acquisition. Prereq: intro to psych. Lab. 4 cr.

780. PSYCHOLOGICAL FACTORS IN SPORT
Factors of outstanding athletic achievement; psychological variables in competition; the actions and interactions of sport, spectator, and athlete. Prereq: intro to psych; /or PhEd 775. 4 cr.

791. HISTORY OF PHYSICAL EDUCATION
From ancient Egypt to modern times. Influences of Greece, Rome, the Renaissance and Reformation periods, and modern European nationalism. Analysis of events and the beliefs of leaders in the development of systems of physical education. 4 cr.

795. SPECIAL TOPICS
New or specialized courses not normally covered in regular course offerings. Prereq: permission. May be repeated up to 8 cr. 2-4 cr.

800. APPLIED STATISTICS
Statistical procedures and associated elements of basic research design with direct, practical application to areas within physical education and other health disciplines. Prereq: measurements procedures or equivalent. 4 cr.

801. ANALYSIS OF PROFESSIONAL LITERATURE
Critical interpretation of professional literature. 4 cr.

802. COLLOQUIUM
A seminar format involving presentation and discussion of current topics in exercise physiology. Two semesters are required for students in the exercise specialist concentration. 1 cr. Cr/F.

803. INTERNSHIP
Clinical work, normally in a hospital or laboratory setting, involving exercise physiology, graded exercise testing, exercise prescription and/or cardiac rehabilitation. Open only to exercise specialist students who have completed all required coursework except thesis. 4 cr.

833. ENVIRONMENTAL PHYSIOLOGY
The human physiological response to both the acute and chronic effects of various environmental conditions, such as heat, cold, altitude, and air pollution. Prereq: physiology of exercise; /or permission. 4 cr.

895. ADVANCED STUDIES
Independent study problems. Prereq: permission of graduate adviser. May be repeated up to 8 cr. 2-4 cr.

899. MASTER'S THESIS
6 cr.

Physics (Phys)

Chairperson: Harvey K. Shepard

PROFESSORS: Roger L. Arnoldy; L. Christian Balling; John R. Calarco; Edward L. Chupp; John F. Dawson; Lennard A. Fisk; Jochen Heisenberg; Robert E. Houston, Jr.; Richard L. Kaufmann; Robert H. Lambert; John A. Lockwood; Lyman Mower; John E. Mulhern, Jr.; Harvey K. Shepard; William R. Webber; John J. Wright

ASSOCIATE PROFESSOR: Robert E. Simpson
ASSISTANT PROFESSOR: F. William Hersman
RESEARCH PROFESSOR: Joseph V. Hollway
RESEARCH ASSOCIATE PROFESSORS: Martin A. Lee; David J. Forrest
RESEARCH ASSISTANT PROFESSOR: James M. Ryan

GRADUATE PROGRAM COORDINATOR: Richard L. Kaufmann

The physics department offers courses leading to the master of science for teachers, and the master of science and doctor of philosophy degrees in physics. Graduate students entering the master of science and doctor of philosophy programs are expected to demonstrate a proficiency in undergraduate work equivalent to that of University of New Hampshire bachelor of science graduates.

Master of Science for Teachers

The degree of master of science for teachers is offered for candidates who satisfy the general admission requirements (see page 13) or who hold secondary school teacher certification in physics or in general physical science. The courses leading to this degree will be chosen to improve candidates' ability to teach physics or general physical science at the secondary school level. These courses should total at least 30 semester hours and should be chosen in consultation with the graduate adviser in physics.

M.S.T. students are not required to take the qualifying examination. Teaching experience is required for this degree. Persons interested in this degree should confer with the graduate adviser.
Master of Science
For admission to graduate study leading to a master of science degree, students should have completed 24 to 30 semester hours in physics, or physics and closely allied fields. The courses required for the master of science in physics include Phys 831, 833, 839, 841, and 843. Candidates may select one of the following plans:
1) Complete 30 semester hours of courses chosen in consultation with the graduate adviser.
2) Complete 24 semester hours of courses chosen in consultation with the graduate adviser, complete a thesis representing the equivalent of six semester hours' work, and pass an oral examination on the thesis.

Doctor of Philosophy
For admission to graduate study leading to a doctor of philosophy degree, students should satisfy the same general requirements as for a master of science degree. Admission to candidacy for the degree is based primarily upon demonstrated ability in formal coursework; experience in teaching, equivalent to at least half time for one year; and passing a written qualifying examination. This examination is normally taken during the second year. Exceptions to the timing are possible only by petition. Students are allowed a total of two attempts to achieve candidacy. Finally, upon completion of a thesis, doctoral candidates will take an oral examination based upon the area of their research. The courses required for a doctor of philosophy degree in physics are: 1) 831-832, 833, 835, 839, 841-842, 843-844; and 2) any additional five full courses at the 800 level, excluding 869, 889, 897, 899, and 999. (For students doing Ph.D. research in astrophysics or space physics, one of these five courses must be 850 or 852.)

Interdisciplinary Research
The department encourages research in areas related to physics or applied physics. Should students desire to do research in a field related to physics, special permission may be made. A cooperative program with the Department of Electrical and Computer Engineering is available to master's students in physics. Contact the department chairperson or graduate adviser for details.

701-702. INTRODUCTION TO QUANTUM MECHANICS I AND II
Modern physics, nonrelativistic Schrödinger equation, the hydrogen atom, applications to atomic and molecular structure. Prereq: diff eqns; multivariable calculus; or permission. Intro mathematical physics course desirable. 4 cr.

703-704. ELECTRICITY AND MAGNETISM I AND II
Foundation of electromagnetic theory; electrostatics, dielectric theory, electromagnetism, magnetic properties of matter, alternating currents, Maxwell's field theory. Prereq: diff eqns; multivariable calculus; or permission. Intro mathematical physics course desirable. 4 cr.

710. INTRODUCTION TO ASTROPHYSICS
Review of the sun, stars, Milky Way, external galaxies, and expansion of the universe. Recent discoveries of radio galaxies, quasi-stellar objects, cosmic black-body radiation, X-rays, and gamma rays precede a discussion of Newtonian and general relativistic cosmological models, steady-state/big-bang theories, and matter-antimatter models. Prereq: physh physics; diff eqns; or permission. 4 cr.

718. INTRODUCTION TO SOLID STATE PHYSICS
Theory underlying the behavior of solids. Transport theory and the interaction of radiation and matter. Operation of semiconducting and superconducting devices and lasers. Prereq: physical mechanics, intro quantum mechanics; diff eqns, multivariable calculus. 4 cr. (Offered with sufficient demand.)

795. INDEPENDENT STUDY
Individual project under direction of a faculty adviser. Prereq: department permission. 1–8 cr.

831-832. MATHEMATICAL PHYSICS
Complex variables, differential equations, asymptotic methods, integral transforms, special functions, linear vector spaces and matrices, Green's functions, and additional topics selected from integral equations, variational methods, numerical methods, tensor analysis, and group theory. 3 cr.

833. EXPERIMENTAL PHYSICS
Modern research techniques, including discussion and laboratory exercises in nuclear and atomic phenomena. Prereq: passing an electronics proficiency test or basic experimental physics. May be repeated to 6 credits. 3 cr.

835-836. STATISTICAL PHYSICS I AND II
Review of thermodynamics and kinetic theory, followed by an introduction to classical and quantum statistical mechanics. Microcanonical, canonical, and grand canonical ensembles; ideal Fermi and Bose gases and applications of statistical mechanics to selected physical problems. Prereq: for Phys 835: Phys 831; Phys 845; or permission; for Phys 836: Phys 844. 3 cr. (Phys 836 offered on request.)

839. THEORETICAL MECHANICS
Newtonian, Lagrangian, and Hamiltonian formulation of the classical mechanics of particles and rigid bodies, with particular attention to those topics that serve as background for the study of modern physical theories. 3 cr.

841-842. ELECTROMAGNETIC THEORY
The formulation and detailed application of electromagnetic theory to physical problems. Prereq: permission. 3 cr.

843-844. QUANTUM MECHANICS
Wave mechanical and Dirac formulations of nonrelativistic quantum mechanics. Prereq: permission. 3 cr.

850, 852. PLASMA PHYSICS I AND II
Topics to be discussed will be selected from the following: magnetohydrodynamics, plasma waves, shocks and discontinuities, instabilities, turbulence, diffusion, adiabatic motion of charged particles, nonlinear plasma phenomena, and kinetic theory of plasmas. Prereq: Phys 835; or permission. 3 cr. (Offered on request.)

853. SOLAR MAGNETOHYDRODYNAMICS
Introduction to solar physics, with emphasis on gas dynamics and magnetic fields. Interior structure, the theory of convection, wave motions in the pres-
ence of magnetism and gravity, coronal heating theories, steady and nonsteady flows, dynamo theory, and the theory of solar flares and other transient phenomena. Salient observational data will be reviewed. Prereq: permission. 3 cr. (Not offered every year.)

854. SOLAR WIND AND COSMIC RAYS
The solar wind and its effects on cosmic rays. The basic equations of the solar wind: mass, momentum, angular momentum, and energy balance. CGL theory, Transport processes, Waves, shocks, and instabilities in the solar wind. The basic equations of cosmic ray transport. Solar modulation of solar and galactic cosmic rays. Interaction of cosmic rays with shock waves. Salient data will be reviewed. Prereq: permission. 3 cr. (Not offered every year.)

861-862. ADVANCED QUANTUM MECHANICS
Relativistic wave equations, propagator theory and Feynman diagrams, quantum theory of radiation, second quantization, introduction to quantum field theory and related topics. Prereq: Phys 839; Phys 844. 3 cr. (Not offered every year.)

863-864. NUCLEAR PHYSICS
Introduction to nuclear processes including nuclear forces, nuclear structure and models, static properties, beta and gamma emission, and nuclear reactions. Selected topics in experimental methods. Prereq: Phys 844. 3 cr. (Not offered every year.)

865-866. SOLID STATE PHYSICS
Development of quantum mechanical theory of solids, transport phenomena, etc. Prereq: Phys 843; Phys 835. 3 cr. (Not offered every year.)

869. NUCLEAR PHYSICS SEMINAR
Lectures and discussion of current topics in nuclear and particle physics. 1–3 cr.

887, 888. INTRODUCTION TO SPACE SCIENCE I AND II
Topics will be selected from the following: ionospheric physics; magnetospheric physics; interplanetary physics; solar physics; cosmic-ray physics; radio, x-ray, and gamma-ray astronomy; motion, transport, energy loss, origin, and acceleration of charged particles in the magnetosphere; interplanetary medium and galaxy; cosmological problems. 3 cr. (Not offered every year.)

889. SPACE PHYSICS SEMINAR
Lectures and discussions of current research in the physics of fields and particles in space. May be repeated to 6 credits. 1–3 cr.

891. PROBLEMS IN THEORETICAL PHYSICS
May be repeated to six credits. 1–3 cr. (Offered on request.)

893. PROBLEMS IN EXPERIMENTAL PHYSICS
May be repeated to six credits. 1–3 cr. (Offered on request.)

895. SPECIAL TOPICS
Any special fields of study not covered by the above courses may be included. Topic choices in previous years: astrophysics; elementary particles; lasers/masers; many-body theory; general relativity and cosmology; group theory; atomic physics; quantum theory of light, nonlinear equations, and chaos. May be taken more than once. 1–3 cr.

897. COLLOQUIUM
Required of all graduate students. Topics to be selected. 0 cr.

899. MASTER'S THESIS
6 cr.

999. DOCTORAL RESEARCH

Plant Science (PLSc)

Chairperson: Owen M. Rogers

PROFESSORS: George O. Estes; Yun-Tzu Kiang; David W. Koch; J. Brent Loy; Lincoln C. Percival; J.C. Routledge

ASSOCIATE PROFESSORS: James R. Mitchell; James E. Pollard; John M. Roberts; Otho S. Wells

ASSISTANT PROFESSOR: Thomas M. Davis

GRADUATE PROGRAM COORDINATOR: Lincoln C. Peirce

The graduate research program in plant science is concerned with solving basic and applied problems associated with growth of crop plants and their response to the environment. Facilities include laboratories, greenhouses, growth chambers, and two experimental farms.

The program emphasizes two principal disciplines: 1) breeding and genetics; and 2) physiology and biochemistry. Research and teaching in plant genetics, cytogenetics, and plant breeding are major strengths complemented by University programs in genetics and statistics. A strong research and teaching program is also available in plant physiology, including advanced courses in plant nutrition, metabolism, and growth and development.

Undergraduates should obtain adequate background in the biological and physical sciences, including botany and chemistry. Students lacking these requirements may be admitted on condition that certain courses be completed without graduate credit. The general section of the Graduate Record Examination is required for application.

Candidates for the master of science degree will be required to prepare a thesis and to pass an oral examination. Candidates for the Ph.D. degree must take a written and/or oral qualifying examination and a final oral examination on the dissertation, in which the student must demonstrate ability to do original research in the area of specialization. Supervised teaching or its equivalent is required for each master's and doctoral student.

Advanced Plant Physiology

708. PLANT NUTRITION
Nutritional aspects of higher plants; uptake and assimilation, metabolic roles and growth response. Fertilizers: sources, manufacture, application, and energy dependence. Prereq: chemistry. Lab. 4 cr. (Not offered every year.)
762. **PLANT METABOLISM**

Function, occurrence, synthesis and degradation of plant constituents; respiration and photosynthesis; metabolism of nitrogenous and aromatic compounds; biochemical mechanisms in seed dormancy, fruit ripening, and disease resistance. Prereq: general biochemistry or Bchm 731. 2 cr. (Not offered every year.)

### 803. TOPICS IN DEVELOPMENTAL PLANT PHYSIOLOGY

A) Fungal Physiology: physiology and biochemistry of nutrition, metabolism, and growth in the fungi; physiology of reproduction and sporulation, spore formation, and germination.  
B) Nitrogen Fixation: nomenclature and distribution of N<sub>2</sub> fixing organisms; symbiotic relationships of Rhizobium; mechanisms of N<sub>2</sub> fixation; genetic regulation of N<sub>2</sub> fixation.  
C) Genetic Engineering in Plants: theory and techniques of genetic manipulation in plants; mechanism of gene expression; gene vectors; somatic cell genetics; potentials and limitations of the techniques.  
D) Photomorphogenesis: photoreceptors and response systems in plants; chemistry and biological action of phytochrome; biochemistry of photomorphogenesis. E) Plant Hormones: chemical nature, uptake, translocation, biosynthesis, and metabolism of plant hormones; mechanism of hormone action; stress physiology; physiological effects of environmental stress (heat, cold, drought, air pollution, etc.) on plant growth and metabolism.  
G) Genetic Control of Plant Development: control of cell division and cell elongation; regulation of flowering and sex expression; mutants and plant productivity.  
H) Regulation of Gene Activity: transcription, regulation of synthesis and processing of RNA in plants; regulation of protein synthesis; chromosomal differentiation; organization of chromosomes; chromosomal proteins and gene regulation.  
I) Metabolic Control Mechanisms in Plants: photosynthetic and catabolic carbon pathways, plant senescence, and nitrogen metabolism. A series of seven-week, 2-credit, in-depth modules covering recent advances in plant physiology and development. Two to three modules per semester. Prereq: permission. (Also offered as Bot 803.) 2 cr.

**Advanced Genetics (See Genetics Program)**

### 705. POPULATION GENETICS

Population growth and regulation; genetic variation; factors affecting gene frequency; ecological genetics. Prereq: prin of genetics or permission. (Also offered as Gen 705.) 4 cr. (Not offered every year.)

### 740. EVOLUTIONARY BIOLOGY

Origin as a source of genetic variation; population structure, mechanisms of evolution; molecular evolution; ecological adaptation in animals, plants, and humans; community structure and evolution. Prereq: prin of genetics or permission. (Also offered as Gen 740.) 4 cr. (Not offered every year.)

### 773. BREEDING IMPROVED VARIETIES

Techniques for creating new varieties of crop and ornamental plants. Prereq: genetics. Coreq: PLSc 873. 3 cr.

### 780. BIOTECHNOLOGY AND PLANT GENETICS

Plant cell culture techniques; characterization of economically important traits at the molecular level; approaches to induced mutation, in vitro selection, and introduction of foreign DNA into plants; transposable elements and transformation vectors; new ideas in plant biotechnology; social implications. Prereq: course in genetics; plant biology. Lab. 4 cr. (Not offered every year.)

### 851. PLANT GENETICS

Euploidy, aneuploidy, cytoplasmic inheritance, somatic cell genetics, and genetics of disease resistance. Prereq: intro genetics. 3 cr. (Not offered every year.)

### 853. CYTOGENETICS

Chromosome structure, function, and evolution. Eukaryotic genome organization. Theory of, and laboratory techniques in, cytogenetic analysis of plants and animals. Prereq: prin of genetics. Lab. 3 cr. (Not offered every year.)

### 873. TOPICS IN CROP IMPROVEMENT

Discussion and assigned readings in crop breeding. Coreq: PLSc 773. 1 cr.

#### General Offerings and Independent Studies

### 720. LABORATORY TECHNIQUES IN PLANT SCIENCES

Use of laboratory instruments and techniques including extraction procedures, spectrometry, fluorometry, electrophoresis, chromatography, atomic absorption spectrometer, measurement of respiration and photosynthesis, photography, use of microscopes, and use of instruments for monitoring the environment. Prereq: chemistry (three semesters) or permission. 3 cr. Cr/F.

### 750. TOPICS IN AGRICULTURAL APPLICATIONS OF STATISTICS AND COMPUTING

Two-credit, seven-week modules offered in the middle of the spring semester. A) Current Application of Computers in Agriculture; B) Development of Computer Applications in Agriculture; C) Simulation of Crop Development; D) Agricultural Systems; E) Techniques for Field Experiments. Consult department for current offering. Prereq: permission. 2–10 cr.

### 776. RADIOISOTOPE TECHNIQUES FOR LIFE SCIENCES

Application of radioisotopes to biological systems; characteristics, detection, measurement, and tissue distribution of radioisotopes. Prereq: chemistry. Lab. 4 cr.

### 795, 796. ADVANCED TOPICS IN PLANT SCIENCE

A) Physiology; B) Genetics; C) Plant Utilization; D) Microscopy. Independent research, study, or group discussion. Prereq: permission. 2 or 4 cr.

### 801. THE RESEARCH PROCESS

For first-year M.S. and Ph.D. program students in biological sciences. Philosophy, logic, ethics in science; techniques of organization and design of research and data presentation. 2 cr. Cr/F.

### 802. DESIGN OF EXPERIMENTS

Practical application of common experimental designs to research problems: the use of design to compensate for interfering factors, treatment selection, (particularly when several factors are suspected of having an influence on response), and
computer-aided analysis of results. Prereq: statistics. (Also offered as Gen 802.) 4 cr. (Not offered every year.)

877. SUPERVISED TEACHING FOR GRADUATE STUDENTS
Planning and presenting classroom and laboratory material. Biweekly seminars discuss teaching technique and problems. One credit or its equivalent required of each plant science major's and Ph.D. candidate. Plant science graduate students only. Prereq: permission. 1 cr. Cr/F.

895, 896. RESEARCH IN PLANT SCIENCE
Advanced investigations in a research subject, exclusive of thesis. 1–4 cr.

897, 898. GRADUATE SEMINAR
Library research and discussion of current topics of plant science. Required of all graduate students majoring in plant science. 1 cr.

899. MASTER'S THESIS
6–10 cr.

999. DOCTORAL RESEARCH

Political Science (Polt)
Chairperson: David W. Moore

PROFESSORS: Robert B. Dishman; Bernard K. Gordon; George K. Romoser
ASSOCIATE PROFESSORS: Warren R. Brown; Robert E. Craig; John R. Kayser; David L. Larson; David W. Moore; Lawrence W. O'Connell; B. Thomas Trout; Susan O. White; Clifford J. Wirth
GRADUATE PROGRAM COORDINATOR: David W. Moore

Candidates for admission to graduate study in the Department of Political Science normally are expected to have majored either in political science or a field closely related and to have achieved an undergraduate academic record of some distinction. In unusual and exceptional cases and where undergraduate preparation has been insufficient, candidates may be admitted provided that they follow without credit a program of study approved by the chairperson. In all cases the Graduate Record Examination is required of candidates who seek to be considered for admission. The department offers the master of arts in political science and the master of public administration.

Master of Public Administration
The master of public administration is an interdisciplinary degree designed principally for individuals intending to pursue careers in local, state, or national government service in the U.S. or other countries. Candidates will be expected to complete eight full courses (32 credits) and a four-credit internship program (Polt 870, Administrative Internship) for a total of 36 credits. Candidates who have had appropriate responsibility in public administration may be exempted from the internship upon petition for such exemption. Such candidates will be required to undertake independent research on an approved topic related to public administration (Polt 895 or 896, four credits). A recreation and parks concentration, which draws upon the resources of that department, is offered as an interdisciplinary program for the degree. Students pursuing this concentration are held to the general degree requirements and usually take courses in recreation and parks to fulfill the requirements for work outside the political science department. The internship is served with an appropriate recreation and parks agency.

Of the eight courses, at least three shall be chosen from the courses and seminars in public administration offered by the department (Polt 805, Methods of Policy Analysis; Polt 806, Theories and Processes of Public Administration; and Polt 807, Cases in Public Management), and two from other political science courses offered by the department according to the needs and interests of the candidate. The remaining three courses may be chosen from outside the department in such related fields as economics, administration, resource economics, sociology, and recreation and parks.

The program is offered for full- and part-time students. The full-time program can be completed during one academic year (four courses each semester) plus one summer (internship). The part-time program designed for working professionals can be completed during late afternoon or evenings over a two-year period (four semesters, two summers).
American Politics and Public Administration

701/801. COURTS AND PUBLIC POLICY
Impact of judicial decisions on public policy at federal, state, local, and regional levels. 4 cr.

702/802. PUBLIC PLANNING AND BUDGETING
Analysis, goal setting, and strategic planning in a governmental setting, with particular emphasis on budgetary processes as a means for controlling policy effectiveness. 4 cr.

703/803. URBAN AND METROPOLITAN POLITICS
Planning and management of the urban community, intergovernment relations, administrative functions, and general urban problems. 4 cr.

704/804. POLICY AND PROGRAM EVALUATION
Policy and program evaluation of federal, state, and local governmental enterprise; focuses on the politics, practices, and methods of evaluative investigation. Evaluation as a technique for providing rational information for budgetary and policymaking decisions. 4 cr.

797, 798/897, 898. SECTION B: SEMINAR IN AMERICAN POLITICS
Advanced analysis and individual research. 4 cr.

797, 798/897, 898. SECTION F: SEMINAR IN PUBLIC ADMINISTRATION
Advanced analysis and individual research, including opportunities for direct observation of governmental administration. 4 cr.

805. METHODS OF POLICY ANALYSIS
Research design, survey methods, experimental techniques, and aggregate data analysis applied to public policy settings. 4 cr.

806. THEORIES AND PROCESSES OF PUBLIC ADMINISTRATION
Theories of organization and bureaucracy, the implications of bureaucratization, and the major processes of public administration including budgeting, personnel, policy making, as well as attention to contemporary policy issues including collective bargaining, affirmative action, citizen participation. 4 cr.

807. CASES IN PUBLIC MANAGEMENT
Policy case studies emphasizing politics, organizational structure, and interorganizational behavior; management case studies emphasizing behavior, human relations, personality, and intraorganizational dynamics; and simulation and role-playing exercises. 4 cr.

Political Thought

720/820. PERSPECTIVES ON POLITICAL SCIENCE
Different views on the study and meaning of politics. Perspectives of political scientists, political philosophers, and political activists. 4 cr.

721/821. POLITICS AND ECONOMICS: POLITICAL ECONOMY AND THE MODERN STATE
The modern state and issues of political economy; treatments of Adam Smith, David Ricardo, Karl Marx, Max Weber, John Maynard Keynes, and Joseph Schumpeter. Issues of "supply-side" economics, private and public planning priorities, and current criticism of the welfare state. 4 cr.

797, 798/897, 898. SECTION I: SEMINAR IN POLITICAL THOUGHT
Advanced treatment and individual research. 4 cr.

Comparative Politics

741/841. POLITICS OF INDUSTRIALIZED STATES
Impact of modern industrialism and its organization upon political life and the conduct of government. 4 cr.

742/842. COMPARATIVE COMMUNIST SYSTEMS
Interests, demands, and decision making in communist governments. Ideological issues, political behavior within communist international organizations, intraparty relations, distinctions between ruling and nonruling communist parties. 4 cr.

International Politics

760/860. THEORIES OF INTERNATIONAL POLITICS AND INTEGRATION
General explanations of the behavior of nations; theory and practice of supra-national integration; theories of peace and security and community building at the international level; concepts and experience in arms limitations and conflict resolution. 4 cr.

761/861. INTERNATIONAL LAW
Formalized processes for regularizing state behavior; development of norms based on custom, precedent, and formal institutions, as in treaties and cases. Arms reduction and limitation arrangements; inspection, and other formal procedures designed to preserve peace. 4 cr.

762/862. POLITICS OF INTERNATIONAL TRADE AND DEVELOPMENT
Explores the postwar global trade system against the background of calls for increased protectionism. Emphasis given both to domestic as well as international political considerations. 4 cr.

778/878. INTERNATIONAL ORGANIZATION
Collective security and other forms of cooperation among nations through international organizations such as the United Nations and its predecessors, and through regional bodies. 4 cr.

797, 798/897, 898. SECTION E: SEMINAR IN INTERNATIONAL POLITICS
Advanced analysis and individual research; emphasis on developments in theory. 4 cr.
General Courses

870. ADMINISTRATIVE INTERNSHIP
Practical administrative experience in an area of professional interest. Prereq: M.P.A. candidate. 4 cr.

895, 896. READING AND RESEARCH IN POLITICAL SCIENCE
A) American Politics; B) Comparative Politics; C) International Politics; D) Political Thought; E) Public Administration; F) Public Policy. The graduate student will engage in independent study under the direction of one of the members of the department. Requires approval of the graduate committee. 1-4 cr.

899. MASTER'S THESIS
Each student will carry out original research that culminates in a master's thesis. Must be taken 4 cr. per semester in each of two semesters, or 8 credits in one semester. 8 cr. required. Cr/F.

Related Courses in Recreation and Parks
For information, contact Associate Professor Gus Zaso, Department of Recreation and Parks

885. COMPREHENSIVE PLANNING
Leisure and tourist planning—local, county, and regional. Recreation programming and resource development. Legislative aspects, court decisions, administrative organization, zoning, land use, and other master planning considerations. Prereq: permission. 4 cr.

890. SPECIAL TOPICS AND PROJECTS
Advanced study in specific areas; may involve formal classes, seminars, or independent projects. Prereq: permission. 4 cr.

Psychology (Psyc)

Chairperson: Earl C. Hagstrom

PROFESSORS: Raymond L. Erickson; Gordon A. Haaland; John A. Nevin
ASSOCIATE PROFESSORS: William M. Baum; Victor A. Benassi; Ellen S. Cohn; Peter S. Fernald; Kenneth Fulld; Earl C. Hagstrom; David E. Leary; John E. Limber; Carolyn J. Mebert; Daniel C. Williams; William R. Woodward
ASSISTANT PROFESSORS: Esther Goldminz; William Stine; Rebecca M. Warner
GRADUATE PROGRAM COORDINATOR: Kenneth Fulld

Doctor of Philosophy
The Department of Psychology offers a four-year program of study leading to the doctor of philosophy degree. The basic goal of the program is the development of behavioral scientists who can both carry out sound research in an area of specialization and teach effectively. Integral to the program is the development of specific skills required by the research psychologist who intends to become a college or university teacher. In order to develop these skills, each year the program required of all students includes a variety of research and instructional activities in addition to the usual academic work. In the first two years, students register for at least 12 credits each semester. In the third year, each student teaches small sections of introductory psychology under close staff supervision while concurrently enrolled in a teaching seminar that has among its objectives an increased appreciation of the goals and problems of teaching.

Areas in which the student may specialize are: history, learning, perception, cognition, developmental, physiological, and social psychology. The student's adviser will help the student to plan an effective graduate program. Core courses taken by all students include methodology, statistics, and the seminar and practicum in the teaching of psychology. Work outside the department also is included in each student's program. Depth in a particular area is obtained through participation in several of the advanced seminars listed below and by independent study and research conducted under the supervision of a staff member.

Prior to the doctoral dissertation, the student will carry out original research that culminates either in a master's thesis or a paper of publishable quality. A master's degree may be awarded upon the successful completion of a program approved by the department and dean of the Graduate School including original research at the master's level. Details concerning the qualifying examination for advancement to candidacy for the Ph.D. degree and other requirements can be obtained from the department.

A student admitted to graduate study must meet the requirements for admission to the Graduate School. In applying for admission to the department's program, candidates must submit Graduate Record Examination scores on the verbal, quantitative, and analytical sections of the general test and the score on the subject test in psychology.

To be accepted into the program, the applicant must desire to pursue the doctoral degree and be deemed qualified to do so on the basis of initial selection procedures. The applicant need not necessarily have been an undergraduate major in psychology. However, before beginning a graduate career proper, the applicant must have completed a minimum of 15 undergraduate credits in psychology, including courses in elementary statistics and experimental psychology.

The courses and seminars listed below provide the general framework within which the student will develop, with the counsel of the adviser, a program of research and study leading to the doctoral degree. The range and sequence of courses vary to some extent with the student, though there will be features common to all programs. All advanced seminars may be repeated for credit.

Graduate courses are offered whenever possible in a two-year cycle. Consult the department for exact schedule. Approval of the instructor is required before registering for any graduate course.

801-802. GRADUATE PROSEMINAR
Students and graduate faculty in psychology meet every two weeks for a mutual exchange on current issues in psychology. 0 cr. Cr/F.

805-806. RESEARCH METHODOLOGY AND STATISTICS I-II
A consideration of research techniques and problems of methodology in psychology. The first semester stresses the principles of statistical inference, correlational approaches, and their interrelatedness in design. Topics considered include probability theory, linear regression, function-free prediction,
the theory underlying statistical inference, parametric and nonparametric tests of significance, and principles of analysis of variance. The second semester extends the correlational approach to the techniques and methodology of multiple regression and considers the appropriate use and theoretical bases of complex designs. Prereq: undergraduate statistics and experimental psychology. 4 cr.

807. RESEARCH METHODS AND STATISTICS III
The application of multivariate methods of data analysis in psychological research: multiple regression, analysis of covariance, Hotelling's $T^2$, multivariate analysis of variance, path analysis, discriminant functions, canonical correlation, factor analysis. 4 cr.

808. ADVANCED SEMINAR IN QUANTITATIVE AND ANALYTIC METHODS
Advanced treatment of methodological topics of current interest. Content varies: representative topics include field research, surveys, time series, causal analyses, log-linear models, formal and mathematical models, and computer simulation. 4 cr.

810. VISUAL PERCEPTION
Anatomy, physiology, psychophysics, and perceptual processes of vision. Topics include physics of light, psychophysics, color, pattern and form, depth, motion, eye movements, visual learning and development, and constancy. 4 cr.

811. SENSATION AND PERCEPTION
Anatomy, physiology, psychophysics, and perceptual processes of the visual, auditory, gustatory, olfactory, and cutaneous senses. Topics include stimulus definition, psychophysics, sensory transduction, sensory and perceptual adaptation, and neural coding of space, time, magnitude, and quality. 4 cr.

812. PSYCHOLOGY OF LANGUAGE
Theories of language structure; functions of human language; meaning; relationship of language to other mental processes; language acquisition; indices of language development; speech perception; reading. 4 cr.

813. COGNITION
Complex mental activities; consciousness and attention; concept formation; reasoning; problem solving; creative thinking; relationship between cognition and affective behavior. 4 cr.

814. ADVANCED SEMINAR IN COGNITION
An in-depth examination of one or more specific topics in cognition; including, for example, issues in memory, attention, the use and development of language, and cognitive science. 4 cr.

817. ADVANCED SEMINAR IN SENSORY AND PERCEPTUAL PROCESSES
A comprehensive examination of a specific topic in sensory and perceptual processes. 4 cr.

821. THE EXPERIMENTAL ANALYSIS OF BEHAVIOR
Environmental and biological determiners of behavior. Theory, research methods, and applications. Major concepts and recent research. 4 cr.

831. BRAIN AND BEHAVIOR
Relationships between the nervous system and behavior. Physiological, neural, and biochemical mechanisms underlying instinct, memory, learning, emotion, and consciousness in humans; evolution of these functions in lower animals. 4 cr.

832. COMPARATIVE PSYCHOLOGY
Comparisons of the basic processes of sensation, motivation, learning, and social behavior in different species. Contemporary theories of behavior formulated by ethologists and ecologists contrasted and compared with current theories in psychology. 4 cr.

833. ADVANCED SEMINAR IN PHYSIOLOGICAL PSYCHOLOGY
In-depth examination of a specific topic in the neurosciences. Topics vary depending upon interests of instructor and students. Prereq: Psyc 831 or permission. 4 cr.

845. ADVANCED SEMINAR IN LEARNING AND BEHAVIOR ANALYSIS
Current empirical and theoretical issues in learning and the analysis of behavior. 4 cr.

852. ADVANCED SOCIAL PSYCHOLOGY
Survey of current research and major theories; in-depth critical analysis of topics such as attribution theory, social cognition, and theories of aggression. 4 cr.

854. ADVANCED SEMINAR IN SOCIAL PSYCHOLOGY
Intensive coverage of the experimental and theoretical literature in a selected area of basic or applied social psychology. Students will participate directly in the conduct of the seminar by means of individual topical discussions, development and/or execution of research designs, and critical assessment of the current state of the topic area under discussion. Illustrative topics: political behavior, paralinguistics and nonverbal communication, ethnic and racial prejudice, and environmental psychology. May be repeated for credit. Prereq: Psyc 852. 4 cr.

861. ABNORMAL BEHAVIOR
Disturbing behaviors; historical developments; viewpoints of etiology; identifying and understanding disruptive behavior; diagnostic implications for treatment as a function of varying theoretical viewpoints. 4 cr.

862. ADVANCED SEMINAR IN ABNORMAL PSYCHOLOGY I
An in-depth examination of topics in abnormal, clinical, and counseling psychology. 4 cr.

870. HISTORY OF PSYCHOLOGY
History of psychology up to the 20th century. Major figures, theories, and developments. Relationship to developments in cultural history, philosophy, and the natural sciences. Beginnings of modern scientific psychology. 4 cr.

871. PSYCHOLOGY IN 20TH-CENTURY THOUGHT AND SOCIETY
Reassesses, extends, and integrates knowledge of 20th-century psychology within the historical perspective. Major figures, schools, systems, theories. Social, institutional, and international developments since the 19th century. Review of major fields of psychology. 4 cr.
873. METHODS AND THEORIES IN HISTORICAL RESEARCH ON THE BEHAVIORAL SCIENCES
Major methods and theories used in historical research applied to the study of the behavioral sciences. Prereq: Psyc 870 or 871 or permission. 4 cr.

874. PROBLEM AREAS IN THE HISTORY OF PSYCHOLOGY
In-depth studies of particular individuals, movements, and/or subfields. Each student pursues own research project. May be repeated for credit. Prereq: Psyc 870 or 871 or permission. 4 cr.

875. ADVANCED TOPICS IN THE HISTORY OF PSYCHOLOGY
Topic to be determined when course is offered. May be repeated for credit. Prereq: Psyc 870 or 871 or permission. 4 cr.

881. DEVELOPMENTAL PSYCHOLOGY
Current research and major theories; cognitive, personality, learning, and emotional development. 4 cr.

882. ADVANCED SEMINAR IN DEVELOPMENTAL PSYCHOLOGY
In-depth analysis of one or several specific topics or issues in developmental psychology. 4 cr.

891-892. PRACTICUM AND SEMINAR IN THE TEACHING OF PSYCHOLOGY
Practicum offers the student an opportunity to teach introductory psychology under close supervision from the staff. The seminar is coordinated with this experience and focuses on both practical and theoretical issues of significance in the teaching/learning process at the college level. Required of all doctoral students during the third year. 5 cr.

894. ADVANCED RESEARCH IN PSYCHOLOGY
Student designs and conducts original research that culminates in a paper of publishable quality. Completion of either this course or Psyc 899 will satisfy the department’s research requirement for the master’s degree. May be taken for 4 cr. per semester in each of two semesters or 8 cr. in one semester. Maximum 8 cr. Cr/F.

895. READING AND RESEARCH IN PSYCHOLOGY
A) Physiological; B) Perception; C) History and Theory; D) Learning; E) Social; F) Cognition; G) Statistics and Methodology; I) Developmental; J) Psychopathology. As part of the development as an independent scholar, the student is encouraged to plan: 1) broad reading in an area; 2) intensive investigation of a special problem; or 3) experimental testing of a particular question. Requires approval of both adviser and staff member directing project. May be repeated. 1–4 cr.

898. PROBLEMS AND ISSUES IN PSYCHOLOGY
Seminar on a problem that has been the subject of specialized research and study by a member of the staff. Topic and instructor vary. May be repeated for credit. 4 cr. (Not offered every year.)

899. MASTER’S THESIS
4 cr. per semester in each of two semesters or 8 cr. in one semester. Maximum 8 cr. Cr/F.

999. DOCTORAL RESEARCH

Resource Economics (REco)
Chairperson: Edmund F. Jansen, Jr.
PROFESSORS: John E. Carroll; William H. Drew; Owen B. Burgin; Edmund F. Jansen, Jr. ASSOCIATE PROFESSORS: Bruce E. Lindsay; Albert E. Luloff; Douglas E. Morris
ADJUNCT ASSOCIATE PROFESSORS: Betty Holroyd Roberts; Charles F. Tucker
GRADUATE PROGRAM COORDINATOR: Edmund F. Jansen, Jr.

The Department of Resource Economics and Community Development offers two master’s degrees.

Resource economics: Agricultural economics; community development; regional economics; land and water economics; and rural manpower.

Resource administration and management: Management of publicly and privately owned natural resources; administration of natural resource laws and policies.

Admission Requirements
Students admitted to these programs are expected to have completed either an undergraduate degree in the field in which they plan to specialize or show adequate preparation in the basic support courses of the field. Students with good undergraduate records who lack a background in a particular field may be admitted to a program, provided they are prepared to correct the deficiencies. The Graduate Record Examination general test is required of all applicants.

Resource economics: Students planning for the resource economics degree will need satisfactory undergraduate training that would usually be expected to include four or more courses in economics or resource economics.

Resource administration and management: Students interested in the resource administration and management degree are expected to have had a minimum of three courses in the areas of ecology or natural resources and resource economics, or be expected to make up this deficiency. Persons having professional experience in resource administration, management or related areas will receive priority for admittance to the program. An applicant is required to submit an essay of up to 5,000 words describing his or her background and goals.

Academic Requirements
The master of science degrees in resource economics and resource administration and management are conferred upon successful completion of the following:

1) A program amounting to not less than 30 credits (34 credits for resource administration and management), including the following course requirements or equivalent: REco 893-894, Seminar, 2 cr.; REco 803, Approach to Research, 2 cr.; quantitative methods or analytical techniques, 3–4 cr.; either REco 706, Economics of Resource Development or REco 708, Environmental Economics, and REco 898, Directed Research, 4–6 cr., or REco 899, Thesis, 6–10 cr. In addition, the re-
source administration and management student must take REco 812, Administration of Resource Laws and Policies.

2) A final oral and/or written examination.

701. STATISTICAL METHODS I
Analysis of variance and general linear models; measured numbers, nature of statistical evidence, sampling distributions, and principles of statistical inference; application of specific linear models to given sets of data. 4 cr. (Not offered every semester.)

702. NATURAL RESOURCES POLICY
Contemporary issues in the management and allocation of natural resources; effect of humans on agricultural and forest lands, water, wildlife, fisheries, and minerals; historical perspective of current resource policies. 4 cr.

705. PLANNED CHANGE IN NONMETROPOLITAN COMMUNITIES
Discussion and application of community development theory and principles using appropriate research methodologies. Areas of study chosen from: population growth, community planning and development, provision and distribution of services, rural-urban difference, and systems management. Emphasis on empirical research studies. Students may participate in community development activities. May include placement in field agency. Prereq: applied community development; statistics; permission. 4 cr. (Not offered every year.)

706. ECONOMICS OF RESOURCE DEVELOPMENT
Resource scarcity and theories of economic development; major resource development problems of land and natural resources, urban-rural conflicting demands, and conservation and water supply; capital needs, externalities, and market failure. Prereq: intermediate economic theory. 4 cr. (Offered every third semester.)

708. ENVIRONMENTAL ECONOMICS
Environmental pollution, the market economy, and optimal resource allocation; alternative control procedures; levels of environmental protection and public policy; property right issues. Prereq: intermediate microeconomic theory; permission. 4 cr. (Offered every third semester.)

710. RESOURCE ECONOMICS SEMINAR
A) Agricultural Economics and Food Policy; B) Rural Development; C) Marine Economics; D) Community Economics; E) Land and Water Economics; F) Quantitative Methods; G) Recreation Economics. In-depth treatment of area, including classic works. Seminars arranged to students' needs and offered as demand warrants. May be repeated. 2-4 cr.

717. LAW OF COMMUNITY PLANNING
Common law and the Constitution with respect to property law, including eminent domain, land-use planning, urban renewal, and zoning. Makes the nonlawyer aware of the influence and operation of the legal system in community development. 4 cr.

718. LAW OF NATURAL RESOURCES AND ENVIRONMENT
For resource managers: the legal system pertaining to resource management, protection of the environment, and possibilities for future action. Prereq: contempt consery issues, or land economics and use, or permission. 3 cr.

756. REGIONAL ECONOMIC ANALYSIS
Concepts and methods of delineating regional economies, methods of measuring activity, regional development, and public policies. Emphasis on empirical research studies. Prereq: intermediate economic theory; (or permission. 4 cr. (Offered every third semester.)

795. INVESTIGATIONS IN RESOURCE ECONOMICS
A) Agricultural Marketing; B) Agricultural Production and Farm Management; C) Community Development; D) Economics of Human Resources; E) Economics of Population and Food; F) Land Economics; G) Marine Economics; H) Rural Economic Development; I) Regional Economics; J) Water Economics. Special assignments in readings, investigations, or field problems. May be repeated. Prereq: permission. 2-4 cr.

803. APPROACH TO RESEARCH
The meaning of science and the application of logic in the scientific method. Principles and techniques of scientific research. Survey of experimental design procedures. Organization of investigative work, problem analyses, working plans, and scientific writing. (Also offered as FoRs 803.) Prereq: permission. 2 cr.

804. APPLIED ECONOMICS OF RESOURCE USE
The theory of resource allocation used in solving public and private economic problems. Resource-product relationships, nature of cost, returns to scale, factor valuation and pricing, and uncertainty are analyzed with appropriate methodology. Primary emphasis will be placed on empirical research studies and their implications. Prereq: applied statistics; intermediate microeconomic analysis. 4 cr. (Not offered every year.)

809. AGRICULTURAL ECONOMICS
Analysis of supply, demand, and price relationships. Appraisal of the economic theory relevant to decision making in food production, marketing, and consumption; the competitive structure of the food industry. 4 cr. (Not offered every year.)

811. NATURAL AND ENVIRONMENTAL RESOURCE MANAGEMENT
Fundamental scientific, aesthetic, and ethical principles involved in the management of renewable natural resources and ways to apply these principles in the formulation and evaluation of resource-management policies including the identification of unifying concepts in the management of specific renewable resources, soils, water, forests, and wildlife. Prereq: permission. 4 cr.

812. ADMINISTRATION OF RESOURCE LAWS AND POLICIES
Legal and political science aspects of natural and community resource administration; concepts of private property, home rule, social value, tradeoffs, and bureaucracy as elements in administration. Transportation fee. Prereq: permission. 4 cr.

815. LINEAR PROGRAMMING METHODS
Setting up and solving problems by the simplex and distribution methods; variation in linear programming methods with applications; nonlinear programming, discrete programming; and solving
input-output and game-theory problems. Prereq: elem matrix alg or permission. 2 cr.

893, 894. NATURAL AND ENVIRONMENTAL RESOURCES SEMINAR
Presentation and discussion of recent research, literature, and policy problems in the natural and social sciences influencing resource use. (Also offered as FoRs 893, 894.) 1 cr. Cr/F.

895. INVESTIGATIONS IN RESOURCE ECONOMICS
A) Agricultural Marketing; B) Agricultural Production and Farm Management; C) Community Development; D) Economics of Human Resources; E) Economics of Population and Food; F) Land Economics; G) Marine Economics; H) Rural Economic Development; I) Regional Economics; J) Water Economics. Special assignments in readings, investigations, or field problems. May be repeated. Prereq: permission. 2–4 cr.

896. INVESTIGATIONS IN RESOURCE MANAGEMENT AND ADMINISTRATION
A) Resource Administration; B) Resource Management; C) Resource Policy; D) Public Laws and Resources. May be repeated. Prereq: permission. 2–4 cr.

898. DIRECTED RESEARCH
Hours and credits to be arranged. Not available if credit obtained for Reco 899. A year-long course; an "A" grade (continuous course) given at the end of the first semester. Prereq: permission. 2–6 cr. Cr/F.

899. MASTER'S THESIS
6–10 cr.

Sociology (Soc)
Chairperson: Peter Dodge
PROFESSORS: Melvin T. Bobick; Walter F. Buckley; Bud B. Kliifeld; Arnold S. Linsky; Stuart H. Palmer; Solomon Poll; Fred Samuels; Murray A. Strauss
ASSOCIATE PROFESSORS: Charles Bolian; Peter Dodge; Richard E. Downs; Lawrence C. Hamilton; Barbara K. Larson; Stephen P. Reyna; Sally K. Ward; Kirk Williams; Deborah Winslow
GRADUATE PROGRAM COORDINATOR: Sally K. Ward

The Department of Sociology and Anthropology offers M.A. and Ph.D. degrees in sociology. The master's degree program emphasizes theory and methodology. Students in the doctoral program are expected to select from the areas of departmental specialization one major area—and from the areas of expertise found among the faculty, one minor area—for intensive study and examination. There are five major substantive areas for possible specialization: deviance, conflict, and control; social psychology; comparative institutional analysis; family; and social differentiation. Students may pursue specialties within or across the major areas of specialization or propose to the Graduate Committee other major areas of specialization that fall within the faculty's competence.

Students' proficiency in theory, statistics, and methods, and in the major and minor areas of study, is determined by written examinations. Details about the examinations can be found in the Graduate Student Handbook, which is sent to all students requesting information about the program. Within the context of a curriculum organized largely in the form of seminars and research, students may design, with the approval of advisers and the Graduate Committee, curricula suitable to their experience and intellectual goals. In line with this flexibility, choice may include courses in the fields of specialization or other courses from outside the department. Selection of thesis and dissertation topics is limited only by the areas of expertise available among departmental faculty members.

Upon establishing residence, students will be responsible for remaining informed about any modifications in the requirements of the degree program in which they are enrolled.

Master of Arts
To be awarded the master of arts degree the candidate must fulfill the following requirements: 1) Complete satisfactorily at least one full year (24 credit hours) of graduate-level course work in sociology including Sociological Methods I (801), and either 802, 803, or 804; and Sociological Theory I (811). 2) Register for one credit of thesis work during the second semester of residence and submit a draft of a proposal to the thesis committee by the end of the semester. The proposal or abstract must be circulated to all department faculty. 3) Submit for approval a report of a research endeavor to the thesis committee. This report may be in the form of either a thesis or a publishable paper in the form outlined in the publication format of any major sociological journal.

Students interested in nonacademic employment after completing a degree in sociology should take as one of their electives a field experience or internship course involving experience in a nonacademic setting. This can be done under Sociology 898, by arrangement among the student, a faculty member, and the organization in which the field experience/internship will be located. Experience of this type is extremely important for placement in nonacademic positions. The expectation is that an academic paper will be required in conjunction with the field experience.

Doctor of Philosophy
To be awarded the doctor of philosophy degree, the candidate must fulfill the residence requirement of three years' work after the bachelor's degree including: 1) a minimum of 12 courses in sociology (at least 8 as seminars), other than thesis or dissertation research, including Sociological Theory I and II (811 and 812), Sociological Methods I and II (801 and 802), and one other course in methods or statistics (803 or 804), three courses in a major area, and two in a minor area of sociology; 2) a second minor consisting of three related courses whether or not sociological in content—no preliminary examination is required; 3) passing written examinations in the major and minor areas of sociological specialization and in advanced theory and methodology; 4) demonstrating reading level proficiency in one foreign language appropriate to the overall program of the student (the research tool option must not be part of the other degree requirement for graduate students in sociology; examples of appropriate research tools.
include computer programming, symbolic logic, historiography, econometric techniques, and mathematical statistics. At the time they are admitted to the Ph.D. program, students must submit, for approval by the Graduate Committee, a statement indicating how they intend to meet the language/research tool requirement; 3) fulfilling the research and/or teaching requirement described below; 6) writing and defending an acceptable doctoral dissertation.

General Academic Policies
In planning the program of study, the student will be advised at first by an assigned faculty member and, subsequently, in the case of doctoral students, by a guidance committee. Specially appointed committees will be organized for the direction and assessment of the thesis and dissertation. Under such supervision, students are expected to go considerably beyond the minimum common requirements of the graduate program to establish the knowledge ability and competency peculiarly their own, and they will be permitted to take courses outside the department or below the 700 level within the department only with the express permission of their advisers.

Students are permitted to register for Reading and Research in Sociology and Anthropology (895, 896) to pursue their individual interests. Upon completion, work done under this rubric will be reported, in writing, to the Graduate Committee and the student's adviser by the faculty member who assumes the responsibility for supervising such activities.

In all cases, students having knowledge equivalent to any of the required courses may substitute an examination to be given by the faculty member responsible for the course. Full credit for the fulfillment of requirements may be given to equivalent courses taken elsewhere.

An important part of the graduate program is the opportunity to learn from participation in the teaching and research activities of the department faculty. All candidates for doctoral degrees are therefore expected to assist a member of the department in teaching and/or research. Assignments to work with a specific member will be made by the Graduate Committee on the basis of students' experience, the needed areas of training, and the interests and preferences expressed by the students and faculty members.

Admissions Requirements
To be accepted as a graduate student in sociology, applicants must present, in addition to meeting the general Graduate School requirements, Graduate Record Examination scores on the general test, and the subject test in sociology. Undergraduate majors in other fields may be admitted, in which case subject tests in their majors may be required. However, if the student's undergraduate work has not included an introductory course in sociological theory, research methods, statistics, and two other sociology courses, these five courses must be taken—or equivalent knowledge demonstrated through examination—in addition to the requirements outlined above.

All students entering the program must complete the M.A. before admission to the Ph.D. program. The department welcomes both applicants who plan to continue for the Ph.D. as well as students planning for the M.A. only.

715. SOCIOLOGY OF CRIME AND JUSTICE
Seminar devoted to analyses of the relationships between violent, property, and "victimless" crime on the one hand and the police, judicial, and correctional components of criminal justice systems on the other. Prereq: intro criminology or permission. 4 cr.

720. CURRENT DEVELOPMENTS IN SOCIOLOGY OF THE FAMILY
A current topic will be selected each semester, such as stratification and the family, intrafamily communication, power structure of the family, kinship in modern societies. Critical review of the literature; class or individual research project usually will be carried out. Prereq: 8 credits of sociology; a family course recommended. 4 cr.

721. FAMILY INTERACTION
Analysis of family interaction from a sociological perspective. Consideration of individual family members, relationships, and the family as a unit using a social systems approach. Prereq: intro soc or permission. 4 cr.

735. COMPLEX ORGANIZATIONS
Comparative study of the structure and dynamics of complex, formal organizations (business, military, governmental, educational, medical). Power and social control in formal systems; organizational processes, performances, and effectiveness; effect of complex, formal organizations on persons and societies. Prereq: permission. 4 cr.

740. CULTURE CHANGE
Various types of society; development of theory. Descriptive studies of institutional as well as theoretical materials selected from the writings of Comte, Marx, Spencer, Durkheim, Spengler, Sorokin, Redfield, and others. 4 cr.

741. SOCIAL CHANGE AND SOCIOECONOMIC DEVELOPMENT
Comparative, interdisciplinary approach. Interrelationships among economic, political, and social factors in determining the structure, dynamics, character, and level of development of societies. Prereq: permission. Soc 740 recommended. 4 cr.

745. SOCIAL STRATIFICATION
Pattern of distribution of economic, honorific, and political variables within the populations of complex societies; allocation of personnel to the roles in question, notably through occupational mobility; and the impact of such processes upon behavior, both individual and social. Prereq: intro soc or social institutions. 4 cr.

750. THE MIDDLE EAST: ISSUES OF ETHNICITY, WORK, AND IDENTITY
Community studies approach to such topics as: ethnicity and identity in the interrelationship of language, religion, and corporate membership in a community; social division of labor; work, pluralism, and family networks; mobility and immobility; estates vs. classes. 4 cr.

757. SOCIAL INSTITUTIONS OF LATIN AMERICA AND THE CARIBBEAN
Selective analysis of distinctive institutions and social systems, with particular attention to social aspects of the process of modernization. Prereq: permission. 4 cr.
761. POPULATION DYNAMICS
Major population trends including changes in birth and death rates, population characteristics, mobility, migration, world population growth, population problems, and policies of countries at different stages of economic development. Interrelationship of population and society. 4 cr.

770. CULTURE, PERSONALITY, AND SOCIETY
A cross-cultural view of the development of personality as emergent from genetic, situational, and sociocultural determinants; analysis of the dynamic interplay of sociocultural and psychological behavior systems. Prereq: prior courses in sociology, anthropology, or psychology. 4 cr.

780. SOCIAL CONFLICT
Nature of social conflict, especially war. Setting and initiation of conflict, its dynamics, and factors affecting its course and outcomes. Prereq: permission. 4 cr.

785. THE STUDY OF WORK
Understanding society through the structure of work. Case studies, in an ethnographic manner, of high-status and low-status occupations to provide understanding of social processes and interrelationships in the social structure. 4 cr.

790. APPLIED SOCIOLOGY
1) Current level of use of sociological knowledge; 2) the advocate, consultant, and researcher roles in applied settings; 3) techniques of applied research; 4) implications of applied sociology, including ethical problems. Each student will focus on a social problem and write a paper covering the above issues. Applied projects where possible. Prereq: meth of soc res. 4 cr.

794. EVALUATION OF SOCIAL PROGRAMS
Evaluation research defined: purposes of evaluation; design of evaluation studies; setting of programs; utilization of evaluation results. Examination of case studies of evaluations of social programs. Students are responsible for designing an evaluation study in their chosen substantive area. Prereq: meth of soc res. 4 cr.

795, 796. READING AND RESEARCH IN SOCIOLOGY
A) Communications; B) Criminology; C) Culture Change; D) Culture and Personality; E) Deviant Behavior; F) Family; G) Population; H) Rural-Urban; I) Social Control; J) Social Differentiation; K) Social Movements; L) Social Psychology; M) Social Research; N) Social Theory. Prereq: 12 credits of sociology or permission. 2–8 cr.

797. SPECIAL TOPICS IN SOCIOLOGY
A) Criminal Justice Field Work; B) Sociology of Crime and Justice; C) Sociology of Mental Health and Illness; D) Illness and Society; E) The Holocaust; F) Socio-Linguistics; G) Social Class and Family Patterns; H) Measurement in Sociology; I) Violence in the Family; J) Post-Industrial Society; K) Political Sociology; L) Bio-Sociology; M) Social Evolution; N) Social Differentiation; O) Modernization; P) Blacks in the Americas; Q) Religious Movements in America; R) States and Regions. New or specialized courses presenting material not normally covered in regular course offerings. May be repeated, but not in duplicate areas. Course descriptions and prerequisites on file in department office during registration. 4 cr.

801. SOCIOLOGICAL METHODS I: INTERMEDIATE SOCIAL STATISTICS
Application of statistical methods to the analysis of social data, with particular emphasis on multiple regression and related topics. 4 cr.

802. SOCIOLOGICAL METHODS II: RESEARCH DESIGN
Systematic investigation of each step in the design and implementation of sociological research. Selected techniques of data collection and analyses will be pursued. Prereq: meth of soc res; soc stat; or their equivalents; or permission. 4 cr.

803. SOCIOLOGICAL METHODS III: SPECIAL PROBLEMS IN METHODS AND STATISTICS
Course alternates among special problems, such as measurement, and advanced statistics. 4 cr.

804. SOCIOLOGICAL METHODS IV: FIELD WORK
Training for participant observation in the manner of an anthropologist or Chicago-school sociologist. Students write and discuss field notes and become familiar with case studies, content analysis, and relevant issues. Field notes, basis for a term paper. 4 cr.

811. SOCIOLOGICAL THEORY I
The content, presuppositions, and implications of the body of sociological theory, exemplifying the full range of sociological inquiry. Prereq: hist of soc theory; contemp soc theory; or their equivalents. 4 cr.

812. SOCIOLOGICAL THEORY II
The content, presuppositions, and implications of contemporary sociological theory. Students will engage in theory construction and analysis and in this endeavor will be encouraged to develop their particular interests in substantive areas. Prereq: Soc 811. 4 cr.

813. SOCIOLOGICAL THEORY III
A seminar of intensive study of topics in sociological theory. Sample topics include: exchange theory, functionalism, systems theory, theory construction, pioneering theorists. Prereq: hist of soc theory; contemp soc theory; or their equivalents. 4 cr.

821. DEVIANT BEHAVIOR
Relationships among cultural, subcultural, and personality variables and deviant behavior; forms of deviant behavior: invention, crime, alcoholism, and emotional illness. Prereq: permission. 4 cr.

830. THE SMALL GROUP
Sociological and social psychological perspectives on interaction within small groups. Prereq: courses in sociology and social psychology, or permission. 4 cr. (Not offered every year.

832. FAMILY INTERVENTION
Application of sociological and social psychological theory and technique to clinical intervention in families; principles of problem formulation and resolution in family intervention; therapy for differing family units: individuals, relationships, subgroups, and whole families; consideration of types of change that occur in family therapy, both planned and spontaneous; strategies of intervention; and practical issues involved in family intervention. Selected attention to specific problems
such as separation and loss, drug abuse, and violence. Prereq: permission. 4 cr.

838. SOCIOLOGY OF EDUCATION; SOCIAL ORGANIZATION OF SCHOOLS AND COMMUNITY
Schools in their sociocultural contexts and as part of the institutional network of society. Relation to stratification and social control. Teaching as a religious occupation and as an emergent profession. 4 cr.

842. SOCIOLOGY AND SOCIAL POLICY
Social policy and public policy defined: description of the policy-making process. The political sociology of the policy-making process; who makes policy and who influences policy, under what conditions, and with what effect. Definition of social policy research and the various roles social scientists can adopt for policy-relevant work. Students are responsible for critiquing the readings and for preparing a substantial research paper. 4 cr.

850. METHODS OF PSYCHOLOGICAL ANALYSIS
The logic, inferential strength, and potential bias of the various methodologies for studying social behavior. Experimental and nonexperimental designs, the social-psychological aspects of laboratory and field research, the nature of artifacts, etc. Emphasis is on research design rather than statistical analysis, but graduate-level sophistication in statistics is assumed. 4 cr.

851. SEMINAR IN SOCIAL PSYCHOLOGY
Some of the major themes in social-psychological theory, including social structure and personality, socialization, small-group processes, and interaction analysis. Students will be expected to read and evaluate selected empirical research. 4 cr.

852. SOCIALIZATION AND ABNORMAL BEHAVIOR
Orientations that relate socialization to abnormal behavior; synthesizes the major concepts into current sociological and social psychological frame of reference. Prereq: at least one course in social psychology or permission. 4 cr.

854. SOCIOLOGY OF RELIGION
The reciprocal relationship of religion and culture; the function of religion in society; the contributions of sociological research; the relationship between religion and other social institutions; religion and social change; and the problem of church and state. 4 cr.

861. DEMOGRAPHY
Current problem areas in demography including population theory, formal demography, social epidemiology, social indicators, use of demographic sources and techniques in sociological investigation. Prereq: Soc 761 or permission. 4 cr.

870. COMPARATIVE INSTITUTIONAL ANALYSIS
Theory and methods of cross-national approaches, including: history, variations in objectives and methods, problems of translation and conceptual equivalence of behaviors and indexes, and field techniques. Prereq: permission. 4 cr.

875. SOCIOLOGY OF THE FAMILY
Major approaches in the sociological study of families. Individuals in families, family relationships, and families as groups, and the interrelationships among these levels. Interactional and systemic properties of marriage, parent-child relations, and extended family relations. 4 cr.

880. SOCIAL DIFFERENTIATION
Seminar allowing intensive examination of selected topics in differentiation and personnel allocation, with sections rotated among faculty members, in 1) social stratification, 2) race and ethnic relations, and 3) age and sex. Prereq: social stratification and either race and ethnic relations or female, male, and society. 4 cr.

885. OCCUPATIONS AND PROFESSIONS
Professionalization as adult socialization, an acquisition of a new identity. Professions as ideologies, markets, and extended families. Research perspective of the Chicago School of Sociology. 4 cr.

888. SOCIOLOGY OF EDUCATION: THE CULTURES OF POVERTY AND AFFLUENCE
The schooling of "culturally deprived" and "culturally endowed" pupils. Problems of social and geographic mobility and immobility. Rise of the counseling and healing trades. 4 cr.

889. SOCIOLOGY OF EDUCATION: RACE AND ETHNIC RELATIONS IN SCHOOLS AND SOCIETY
Ethnic stratification inside and outside the school. The schooling of whites and non-whites. Issues of bilingualism, culture, and identity. 4 cr.

895, 896. READING AND RESEARCH IN SOCIOLOGY AND ANTHROPOLOGY
A) Communications; B) Criminology; C) Cultural/ Social Anthropology; D) Cultural/ Social Change; E) Culture and Personality; F) Deviant Behavior; G) Prehistoric Archaeology; H) Family; I) Population; J) Rural-Urban; K) Social Control; L) Social Differentiation; M) Social Movements; N) Social Psychology; O) Social Research; P) Social Theory; Q) Anthropological Linguistics; R) Social Welfare. A student presenting a term paper or extended essay to do independent work under the guidance of an instructor may register for one or more of these sections. Prereq: 16 graduate hours of sociology and permission. Hours and credit to be arranged. 1–4 cr.

897. SPECIAL TOPICS IN SOCIOLOGY
A) Criminal Justice Field Work; B) Sociology of Crime and Justice; C) Sociology of Mental Health and Illness; D) Illness and Society; E) The Holocaust; F) Socio-Linguistics; G) Social Class and Family Patterns; H) Measurement in Sociology; I) Violence in the Family; J) Post-Industrial Society; K) Political Sociology; L) Bio-Sociology; M) Social Evolution; N) Social Differentiation; O) Modernization; P) Blacks in the Americas; Q) Religious Movements; R) American States and Regions. New or specialized courses presenting material not normally covered in regular course offerings. May be repeated, but not in duplicate areas. Course descriptions and prerequisites on file in department office during registration. 4 cr.

899. MASTER'S THESIS
Usually 6 cr. but up to 10 cr. when the problem warrants.

999. DOCTORAL RESEARCH
Spanish (Span)

Chairperson: Warren H. Held, Jr.

PROFESSORS: Richard J. Callan; R. Alberto Casás; Charles H. Leighton
ASSOCIATE PROFESSORS: F. William Forbes; Bernadette Komonchak; Barbara H. Wing
GRADUATE PROGRAM COORDINATOR: Charles H. Leighton

Master of Arts
To be admitted to graduate study for the master of arts degree in Spanish, a student must have completed 30 credits in Spanish language and literature beyond first year Spanish, including a survey of Spanish literature and two other literature courses.

To obtain the degree, the student must fulfill the course requirements, pass a comprehensive examination based on a master's degree reading list, and submit an acceptable thesis if such an option is chosen.

To satisfy the course requirements, the student must: a) successfully complete 10 graduate courses (of which eight should be from the Spanish offerings); or b) successfully complete at least eight courses in Spanish and submit a thesis (6 credits, thus completing the minimum of 30 credits required by the Graduate School). All advanced literature courses are conducted in Spanish.

In addition, M.A. students are required to take 801. Teaching assistants must also take 803. No student may register for a graduate course if he or she has already taken the corresponding undergraduate course here or its equivalent elsewhere.

A comprehensive examination based on a master's degree reading list will be given four times a year; in January, May, August, and September. The candidate will be permitted to take the examination only twice. Students failing their first attempt must wait at least three months before taking it again. The thesis option must embody the results of independent investigation and be written in a form acceptable to the Spanish section. It must be submitted to the thesis director six weeks before the expected time of degree conferral.

801. BIBLIOGRAPHY AND METHODS OF RESEARCH
Required of all graduate students in their first year of study. An introduction to standard bibliographical techniques and to form and style in the preparation and writing of research findings. Preparation of a research paper. 1 cr.

803. APPLIED LINGUISTICS
Required of all graduate assistants teaching in the departmental program, but open to all graduate students in Spanish. Discussion of current methodology and linguistic approaches to the teaching of Spanish. Instruction in the use of audio-visual aids including language laboratories. Readings, discussion, class observation. May be repeated for a total of 3 cr. 1 cr.

825. ADVANCED SPANISH CIVILIZATION AND CULTURE
Selective study of social, artistic, historical, and cultural aspects in the life and work of the people in present day Spain through readings in contemporary literature and journals. 3 cr. (Offered in alternate years.)

826. ADVANCED LATIN AMERICAN CIVILIZATION AND CULTURE
Indigenous peoples. Conquest period. Then a study of the European and Indian substrata that form the present-day Latin Americans. Modern and colonial architecture. Modern painting. 3 cr. (Offered alternate years.)

833. HISTORY OF THE SPANISH LANGUAGE
The evolution of the Spanish language from the period of origins to the present. 3 cr.

852. DRAMA AND POETRY OF THE SIGLO DE ORO
Social and historical background of Baroque period. Representative plays of Lope de Vega, Tirso de Molina, Calderón; lyric poetry of Lope, Góngora, and Quevedo; prose developments. 3 cr. (Not offered every year.)

854. CERVANTES
Cervantes's literary art. Selections from the major works. The Quijote, its originality and significance; its antecedents; its religious, philosophical, and sociological aspects; and its artistic structure. 3 cr. (Not offered every year.)

855. LITERATURE OF THE 19TH CENTURY
Larra, Espronceda, Bécquer, Pérez Galdós, and Blasco Ibáñez. Romanticism, realism, and naturalism. 3 cr. (Not offered every year.)

857. THEATER AND POETRY OF THE 20TH CENTURY
The Generation of 1898 and Modernismo: Lorca, Casoña, Buero Vallejo, Sastre, Salinas, Guillén, and Miguel Hernández. 3 cr. (Not offered every year.)

858. SPANISH PROSE OF THE 20TH CENTURY
Novels, short stories, and essays. Unamuno, Barjoa, Menéndez Pidal, Ortega y Gasset, Julián Marías, Aranguren, Pérez de Ayala, Gironella, and Cela; survey of contemporary prose. 3 cr. (Not offered every year.)

860. UNAMUNO AND ORTEGA Y GASSSET
Philosophical ideology and literary content of major contributions of Miguel de Unamuno and José Ortega y Gasset. 3 cr. (Not offered every year.)

871. LATIN AMERICAN DRAMA
From pre-Hispanic origins to the present; modern playwrights of Mexico and Puerto Rico. 3 cr. (Not offered every year.)

872. LATIN AMERICAN NOVEL
Development from Romanticism to the present; contemporary trends and techniques. 3 cr. (Not offered every year.)

873. LATIN AMERICAN SHORT STORY
Representative authors; stress on 20th century. Principles of interpretation. 3 cr. (Not offered every year.)

874. MAJOR LATIN AMERICAN AUTHORS
3 cr. (Not offered every year.)
890. GRAMMATICAL STRUCTURE OF SPANISH
An overview of the grammatical structure of Spanish through an in-depth analysis of both morphology and word syntax, with emphasis given to the meaningful contrasts that exist within the Spanish language and to grammatical contrasts between Spanish and English. 3 cr.

891. METHODS OF FOREIGN LANGUAGE TEACHING—SPANISH
Intermediate level course. Objectives, methods, and techniques in teaching Spanish, French, German, and Latin from elementary grades through college. Discussion, demonstration, preparation of instructional materials, microteaching of the language skills. Prereq: permission. 3 cr.

895. SPECIAL STUDIES IN SPANISH LANGUAGE AND LITERATURE
A) The History of the Spanish Language; B) Medieval Spanish Literature; C) Spanish Literature of the Renaissance; D) Spanish Literature of the Golden Age; E) Spanish Literature of the 18th and 19th Centuries; F) Spanish Literature of the 20th Century; G) Contemporary Spanish Literature; H) Latin American Literature of the 16th and 17th Centuries; I) Latin American Literature of the 18th and 19th Centuries; J) Latin American Literature of the 20th Century; K) Contemporary Latin American Literature; L) Structural and Applied Linguistics; M) Spanish Literary Criticism; N) Latin American Essay; O) Latin America; P) Catalan; Q) Spanish Poetry; R) Latin American Poetry; S) Galdós; T) Archetype Latin American Literature; U) Special Teaching Problems; V) Spanish Civilization and Culture; W) Latin American Civilization and Culture; X) Borges; Y) Spanish Theater; Z) Spanish for Graduates. Guided study with training in bibliography and organization of material. Topics selected by instructor and student in conference. Prereq: permission of major supervisor. 1–3 cr.

896. SPECIAL STUDIES IN SPANISH LANGUAGE AND LITERATURE
A) Hispanic Minorities of the United States; B) Portocesaria; C) Introduction to Hispanic Linguistics; D) Hispanic Dialectology. Guided study with training in bibliography and organization of material. Topics selected by instructor and student in conference. Prereq: permission of major supervisor. 1–3 cr.

899. MASTER'S THESIS
6 cr.

Vocational/Technical and Adult Education (VTAE)

Chairperson: Maynard C. Heckel
PROFESSORS: William H. Annis; Maynard C. Heckel
ASSOCIATE PROFESSORS: Gregory D. Gill; Peter J. Horne; David L. Howell; Lewis Roberts, Jr.
ASSISTANT PROFESSOR: Calvin F. Dill
GRADUATE PROGRAM COORDINATOR: Maynard C. Heckel

The Department of Vocational/Technical and Adult Education offers the master of occupational education degree. Graduate students can select one of two areas of concentration: a) vocational/technical education; or b) adult education.

Prospective students should consult with a faculty member before seeking admission, since an applicant’s scholastic achievement, experience, references, and professional goals are all relevant in the admission process. Applicants must also submit scores achieved on either the Graduate Record Examination, general test, or the Miller’s Analogies Test, in addition to the materials required by the Graduate School.

All candidates are required to take VTAE 812, Introduction to Research, and VTAE 898, Vocational/Technical and Adult Education Seminar (1–2 cr.). Candidates concentrating in the area of vocational/technical education must also complete VTAE 801, Advanced Methods and Materials of Instruction, and VTAE 802A, Concepts of Vocational/Technical Education; candidates concentrating in adult education are required to take VTAE 790, Programming in Extension and Continuing Education, and VTAE 802B, Concepts of Adult Education (2 cr.).

The candidate’s graduate committee will approve the individual’s graduate program, which normally includes a minimum of 18 credit hours within the department of the minimum of 30 credit hours required. The committee, working with the candidate, will make every effort to provide a total program that will achieve the goals of the degree. Degree candidates must select a thesis or non-thesis option. Candidates completing a thesis will be required to defend it orally. Students following the nonthesis option will be required to complete written and oral examinations plus a professional paper.

Students may obtain initial certification in vocational agriculture and trade and industrial education through this program.

700. WORKSHOPS IN VOCATIONAL/TECHNICAL AND ADULT EDUCATION
Modularized instruction in in-service education. Focus will vary with the needs of the student. May be repeated up to 8 credits. 1–2 cr.

730. DEVELOPMENT OF FOOD AND FIBER IN THIRD WORLD COUNTRIES
The world food situation and the role of agriculture and education in development of third world agrarian systems. Identification of constraints on food production, technology transfer, advantages and disadvantages of different agriculture systems, agricultural marketing, and career opportunities in international agriculture. Optional trip to United Nations over spring break. 3 cr.

752. YOUTH ORGANIZATIONS
A. Organizational Development: Emphasis on development and guidance of youth organizations. Parliamentary procedure, development of programs and activities, and identification of youth needs and interests. Required of all students seeking agricultural education teacher certification and as a prerequisite for B, C, and D. 2 cr.
B. FFA/4-H: Future Farmers of America/Super- vised Occupational Experience Programs for high school youth. Required of all students seeking agricultural education teacher certification. 2 cr.
C. VICA: Vocational Industrial Clubs of America. Required of those students seeking trade and industry teacher certification. 1 cr.

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783. CONDUCTING AND SUPERVISING ADULT EDUCATION PROGRAMS
Analysis of traditional and nontraditional adult education programs; development of strategies of program planning, instruction, evaluation, and supervision. 4 cr.

790. PROGRAMMING IN EXTENSION AND CONTINUING EDUCATION
Focus on the program development process with particular attention to the design and implementation of educational programs that respond to adult needs. Special attention given to the involvement of the adult learners in the programming process; educational programs in both the Cooperative Extension Service and continuing education will be stressed. Required for master's degree candidates concentrating in adult education. 4 cr.

791. PLANNING FOR TEACHING
Organization of materials of instruction to meet group and individual needs. Techniques of instruction, planning for teaching, function of consulting committees, working with youth groups, program evaluation. Course scheduled concurrently with Educ Supervised Teaching. Prereq: microteaching. 4 cr.

794. ISSUES IN VOCATIONAL CURRICULUM FOR SPECIAL LEARNERS
Examines contemporary issues in vocational/special education and provides vocational educators with skills needed to meet the special learning needs associated with disadvantaged and handicapped learners. Encompasses development and modification of curriculum to meet the needs of individuals with specific disabilities. Prereq: teaching vocational education to students with special needs or permission. 4 cr.

796. INVESTIGATIONS IN VOCATIONAL/TECHNICAL AND ADULT EDUCATION
A) Career Education; B) Secondary Education; C) Post-Secondary Education; D) Adult Education; E) Extension Education; F) Exemplary Programs; G) Cooperative Education Programs; H) Disadvantaged and Handicapped Education Programs. Student-selected problems in one of the areas listed. Elective after consultation with the instructor. Hours to be arranged. May be repeated. 2-4 cr.

800. COLLEGE TEACHING
An analysis of teaching strategies at the collegiate level. The planning, execution, and evaluation of instruction for meeting the needs of the young adult learner. Recommended for all who wish to teach in a collegiate setting. Discussion of lectures of selected, distinguished UNH lecturers. Prereq: permission. 2 cr.

801. ADVANCED METHODS AND MATERIALS OF INSTRUCTION
Organization and delivery of performance-based instruction. Provides opportunities for exploration in instructional planning, execution, evaluation, management, and guidance. Open to teachers of vocational-technical education and others by permission. Required of master's degree candidates concentrating in vocational/technical education. 4 cr.

802. CONCEPTS OF VOCATIONAL/TECHNICAL AND ADULT EDUCATION
A. Vocational/Technical Education: Development of vocational/technical education in the U.S.; socioeconomic influences responsible for its establishment; federal and state requirements for secondary and postsecondary schools. Coordination of programs with general education and vocational fields. Required of all master's degree candidates concentrating in vocational/technical education. 2 cr.
B. Adult Education: Focus on selected concepts relevant to the broad field of adult education. Special attention on the adult as a learner, volunteer management, evaluation and accountability, experiential learning, adult education organizations. Required of all master's degree candidates concentrating in adult education. 2 cr.

803. ADMINISTRATION AND SUPERVISION OF VOCATIONAL EDUCATION
Students identity and develop competencies required of vocational administrators, using a vocational administrator task analysis, which includes fair hiring and firing practices, staff development, long-range planning, federal administration for vocational programs, and evaluation of program effectiveness. Philosophy of, and federal regulations governing, vocational education. 4 cr.

804. PLANNING STRATEGIES IN VOCATIONAL/TECHNICAL EDUCATION
A systematic approach to the development of course materials for vocational/technical education. Topics included are: occupational analysis, establishing performance objectives, selection of content, development of supplemental material, and evaluation. Prereq: a course in teaching methods or permission. 4 cr.

805. THE DEVELOPMENT OF COOPERATIVE EDUCATION PROGRAMS
Organization and development of cooperative training programs. Designed for teachers, cooperative education coordinators, work-study coordinators, school administrators, industrialists, and others in charge of external training programs. Focus on planning, implementation, and evaluation of cooperative training programs as they relate to the role and function of the organization. 4 cr.

806. DEVELOPING VOCATIONAL PROGRAMS FOR SPECIAL NEEDS LEARNERS
Designed for teachers and administrators in vocational education who are working with or preparing to work with disadvantaged and/or handicapped individuals. Focus on issues associated with planning, developing, implementing, and evaluating vocational programs for special needs learners. 4 cr.

808. INTRODUCTION TO VOCATIONAL ASSESSMENT IN SECONDARY SCHOOL
Provides an overview of vocational evaluation and an in-depth look at informal vocational assessment. Designed for teachers. Topics include: the occupational cluster system, assessment techniques, behavioral analysis, and work sampling. 4 cr.

809. COMMUNITY ORGANIZATION AND PUBLIC RELATIONS
The composition, purposes, and objectives of the various social and economic organizations operating in local communities. The importance of their

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membership to the general welfare of the area and the development of a public relations program. 4 cr.

811. INTERNSHIP
Internship in a field of vocational/technical and adult education either in methodology of teaching or technical subject matter. Students may elect internship only after completing the qualifying examinations for the master's degree, with permission of their major adviser. May be repeated up to 8 cr. 0–8 cr.

812. INTRODUCTION TO RESEARCH
The course is designed to develop a knowledge and understanding that will contribute to the effective use of research in teaching and administering occupational education. The research process will be examined in terms of selection and formulation of research problems, design, techniques of data collection, analysis, and interrelation of data and reporting. 4 cr.

820. THE COMMUNITY-JUNIOR AND VOCATIONAL/TECHNICAL COLLEGES
Rise and development of community-junior colleges and two-year vocational/technical colleges in American education; their history, potential, philosophy, and functions. 4 cr.

895. INDEPENDENT STUDY
Individual study problems in various phases of vocational/technical and adult education. Prereq: permission. May be repeated. 2–6 cr.

898. VOCATIONAL/TECHNICAL AND ADULT EDUCATION SEMINAR
Discussion of current issues, problems, and research and development in vocational/technical and adult education. Students, faculty, and other personnel serve as discussion leaders. Required of departmental graduate students. 1–2 cr. (Fall semester only.)

899. MASTER'S THESIS
6–10 cr.

Zoology (Zool)

Chairperson: John E. Foret

PROFESSORS: Arthur C. Borror; Wilbur L. Bullock; Robert A. Croker; Larry G. Harris; Frank K. Hoornbeek; John J. Sasner, Jr.; Edward K. Tillinghast
ASSOCIATE PROFESSORS: John E. Foret; Edward N. Francq; James F. Haney; James T. Taylor; Charles W. Walker; Winsor H. Watson III
ASSISTANT PROFESSORS: W. Hunting Howell II; Stacia A. Sower
ADJUNCT ASSISTANT PROFESSORS: Stephen O. Dell; John B. Heiser
GRADUATE PROGRAM COORDINATOR: John J. Sasner, Jr.

The graduate program in zoology is intended for students who aspire to a professional career within or outside the area of college teaching and research. Degrees can be earned with emphasis in behavior, development, ecology (freshwater and marine), endocrinology, fisheries, genetics, invertebrate zoology, mammalogy, neurobiology, parasitology, and physiology.

To be admitted to graduate study in zoology, students ordinarily must have completed an undergraduate major in biology or zoology. A basic array of courses including general biology, development, general ecology, genetics, morphology, and physiology is normally required. Additionally, a background in chemistry through organic chemistry and a semester each of calculus and physics is necessary. Students who are deficient in any of these requirements may be admitted to graduate status but may be required to remedy their deficiencies by taking courses that do not give graduate credit. Applicants are requested to submit general and subject biology scores for the Graduate Record Examination.

Each newly accepted graduate student will be interviewed during the second week of classes of the first semester. This interview will be conducted at a specified time by a committee composed of the student's temporary academic adviser plus two additional faculty members. The purpose of this committee is to advise the student in constructing a program of study and to correct such academic deficiencies as may exist. The committee will have available transcripts, letters of recommendation, and the results of the diagnostic exam described below. The committee will then enter its evaluation and recommendations in the student's permanent record.

Students who hold a teaching assistantship will be given ample opportunity for practice teaching under the supervision of the instructor. All other graduate students are also required to obtain some appropriate teaching experience.

Master of Science
A candidate for the master of science degree in zoology, in addition to the requirements mentioned above, will ordinarily complete a special problem (Zool 895 or 896) of no more than 6 credits or a thesis of no more than 10 credits that is acceptable to the guidance committee. Prior to the receipt of the master's degree, all candidates must pass a comprehensive examination, which will include questions covering general knowledge in zoology in addition to specific questions relevant to the candidate's University of New Hampshire experience.

Doctor of Philosophy
All doctoral students must pass a written examination to certify their proficiency in one foreign language. Some fields of pursuit may require more languages, and this need will be determined by the student's guidance committee.

After the successful completion of the language requirements and of all required courses, students who wish to be admitted to doctoral candidacy must demonstrate a broad basic knowledge of their major and minor fields in a qualifying examination, administered by the guidance committee. In addition, students must convince their proposed major professor and doctoral committee, in whatever way the committee finds acceptable, of their superior capacity to carry out basic research in biology. Normally, the student may accomplish this by presenting to the committee a research proposal in which the soundness, originality, and feasibility of the investigative ideas are clearly revealed, and which, when approved—should serve as the basis of the doctoral dissertation.
704. COMPARATIVE ENDOCRINOLOGY
Endocrine organs; relationship to control of the internal environment; growth; development; and adaptation to external environment. Prereq: vertebrate anatomy; physiology; organic chemistry. 4 cr.

707. HUMAN GENETICS
Inheritance patterns; gene and chromosome mutation rates and effects; linkage and gene frequency. Prereq: prin of genetics or equivalent; / or permission. 4 cr. (Not offered every year.)

709. ENVIRONMENTAL PHYSIOLOGY OF ANIMALS
An examination of the responses of animals to natural changes or extremes of the physical environment. A synthesis of basic concepts from ecology and physiology for students with background in these areas. Emphasis on the adaptations of animals to the major environmental parameters such as nutrient levels, light, temperature, ionic environment, etc., as well as temporal (seasonal, daily) changes in these factors. Examples from several levels of organization including biofeedback mechanisms. Prereq: ecology and physiology; / or equivalent. 4 cr. (Not offered every year.)

711. NATURAL HISTORY OF COLD-BLOODED VERTEBRATES
Classes of poikilothermic vertebrates; their habits, habitats, and life histories in eastern North America. Prereq: general zoology; vert morph. Lab. 4 cr.

712. MAMMALOLOGY

713. ANIMAL BEHAVIOR
Individual and social behavior. The role of anatomy, physiology, ecology, and prior experience. Techniques and practical application. Prereq: one year of zoology. Lab. 4 cr.

717. GENERAL LIMNOLOGY
Special relationships of freshwater organisms to the chemical, physical, and biological aspects of the aquatic environment. Factors regulating the distribution of organisms and primary and secondary productivity of lake habitats. Prereq: gen ecol; / or equivalent. 4 cr.

719. FIELD LIMNOLOGY
Freshwater ecology examined through laboratory exercises with freshwater habitats. Methods to study freshwater lakes; interpretation of data. Seminars and occasional Saturday field trips. Prereq: present or prior enrollment in Bot 717, Zool 717, or equivalent; permission. 4 cr.

720. FIELD MARINE SCIENCE FOR TEACHERS
Primarily for teachers grades 6 through 12, but open to others. Overview of living marine organisms (algae, invertebrates, fishes, marine mammals, and marine birds) in their natural environments. Also such topics as coastal zone problems, marine fisheries, economics of marine organisms, and the educational resources of the marine environment. Field work. Offered at the Shoals Marine Laboratory (Isles of Shoals) in cooperation with Cornell University. Three lectures and two labs or field trips per day. Prereq: college-level intro biol. 1 cr. (Summers only.)

721. PARASITOLOGY
Introduction to the more important parasites causing disease in humans and animals. Living materials will be used as much as possible. Prereq: one year of zoology. Lab. 4 cr. (Not offered every year.)

723. CELL PHYSIOLOGY
Principles of chemistry and physics applied to understanding cell structure and function. Metabolic reactions and their control in relation to cell organization; genesis and function of specialized cells. Prereq: organic chemistry. Lab. 4 cr. (Not offered every year.)

728. DEVELOPMENTAL BIOLOGY OF THE INVERTEBRATES
Principles of animal development including a modern discussion of the cellular processing of developmental information and a panoramic view of reproduction and development in the invertebrates. Prereq: prin of zool or intro to invert zool. Lab. 4 cr.

730. VERTEBRATE HISTOLOGY
Microscopic anatomy of vertebrate tissues and organs at the light microscope level; emphasis-mammalian histology; some comparative study of lower vertebrates. Prereq: hum anat and phys, vert morph, or equivalent. Lab. 4 cr.

732. SOIL ZOOLOGY
Faunal communities of terrestrial soils, their ecology and natural history. Effects of animal activities on soil processes and composition. Collection, extraction, and study methods. Independent projects. Prereq: gen ecol or equivalent; permission. 4 cr. (Not offered every year.)

751. ADAPTATIONS OF MARINE ORGANISMS
Ecological physiology of selected algae and invertebrates from the Gulf of Maine. Offered at the Shoals Marine Lab (Isles of Shoals) in cooperation with Cornell University. Prereq: field marine science, plant or animal physiology, physiological ecology; understanding of chemical quantitative methods and analysis. 4 cr. (Summer Session only.)

753. MARINE VERTEBRATES
Lectures, laboratories, and field work on the systems, ecology, and physiology of fishes, marine reptiles, marine birds, and marine mammals of the Gulf of Maine. Offered at the Shoals Marine Lab (Isles of Shoals) in cooperation with Cornell University. Prereq: field marine science or vertebrate biology. 4 cr. (Summer Session only.)

772. FISHERIES BIOLOGY
Information and techniques used by fisheries biologists. Emphasis on fish life history, ecology, and economics as related to management techniques. Prereq: Zool 711 or equivalent; permission. Lab. 4 cr. (Alternate years.)

775. INVERTEBRATE EMBRYOLOGY
Comparative study of reproduction and early development of selected invertebrates, providing a classical approach to morphology of gonads, fertilization, cleavage, gastrulation, and formation of larvae. Prereq: field marine sci (UNH), Biol Sci 364 (Cornell), or invertebrate zoology. Offered at the Shoals Marine Lab (Isles of Shoals) in cooperation with Cornell University. 4 cr. (Summer Session only; not offered every year.)
INTRODUCTION TO NEUROBIOLOGY
Survey of fundamental concepts and recent discoveries in neurobiology. Topics include: structure and function of neurons, development, cellular basis of behavior (sensory and motor systems), neuropharmacology, and neural plasticity (learning). Prereq: prin zool or permission. 4 cr.

795, 796. SPECIAL PROBLEMS IN ZOOLOGY
A) Animal Behavior; B) Developmental Biology; C) Ecology; D) Electron Microscopy; E) Endocrinology; F) Evolution; G) Genetics; H) Histology; I) History of Biology; J) Invertebrate Biology; K) Parasitology; L) Physiology; M) Protozoology; N) Teaching Practices; O) Underwater Research; P) Vertebrate Biology; Q) Biological Techniques. Students may elect one or more sections for advanced study. Reading, laboratory work, organized seminars, and/or conferences. Prereq: permission. 1-4 cr.

803. MARINE ECOLOGY
Marine environment and its biota, emphasizing intertidal and estuarine habitats. Includes field, laboratory, and independent research project. Prereq: gen ecol or permission. Marine invert zool, oceanog, and statistics desirable. 4 cr. (Not offered every year.)

808. STREAM ECOLOGY
Ecological relationships of organisms in flowing water. Lectures on physical and chemical features of streams, floral and faunal communities, and factors controlling populations of benthic invertebrates. Laboratory exercises employ both field and laboratory experimental techniques. Occasional Saturday field trips. Weekly seminars on original research papers. 4 cr. (Not offered every year.)

811. FRESHWATER ZO PLANKTON ECOLOGY
Methods of sampling populations; factors regulating temporal and spatial distribution; trophic interactions of communities, role in nutrient cycle of lakes. Experimental techniques employed in field trips to freshwater habitats. Seminars examine current research. Prereq: gen ecol or limnology, Zoool 717, or equivalent or permission. 4 cr. (Not offered every year.)

815. POPULATION ECOLOGY
Dynamics of population growth; effects of age, structure, predation, and competition; measures of community interaction. Prereq: permission. Lab. 4 cr. (Not offered every year.)

821. ADVANCED INVERTEBRATE ZOOLOGY
Morphology, phylogeny, and natural history of the major invertebrate phyla. Prereq: intro to invert zool or equivalent. 4 cr. (Not offered every year.)

822. PROTOZOOLOGY
General biology of protozoa; morphology, physiology, natural history, and economic importance. Prereq: Zoool 721; 821; or permission. 4 cr. (Not offered every year.)

824. CONCEPTS AND TECHNIQUES IN REPRODUCTIVE BIOLOGY
Investigations of the reproductive biology of invertebrate and vertebrate organisms, including gonad and gamete structure and function; generation, maintenance, and modulation of gametogenesis by environmental factors; larval settlement and metamorphosis; and evolutionary significance and functional consequences of reproductive cycles in animals. Prereq: permission. 4 cr.

826. COMPARATIVE PHYSIOLOGY
Nutrition, metabolism, neural function, reproduction and homeostatic mechanisms of animals, especially invertebrates. Prereq: Zoool 723; permission. 4 cr. (Not offered every year.)

850. MORPHOGENESIS
Principles of differentiation at molecular, cellular, and organismic level; internal and external factors regulating gene activity and differentiation. (Also offered as Bot 850) Prereq: Permission. 4 cr. (Not offered every year.)

878. COMPARATIVE NEUROPHYSIOLOGY
Designed for students of the behavioral and physiological sciences who wish to understand the basic electrophysiological properties of neurons and how they interact. Both hormonal factors and vertebrate systems will be called upon to illustrate principles of synaptic transmission, integration, sensory information processing, and the control of movement. Prereq: Intro to neurobiology or permission. Lab. 4 cr.

895, 896. ADVANCED STUDIES IN ZOOLOGY
Course sections for advanced work, individual or group seminar. May include reading, laboratory work, organized seminars, and conferences. Prereq: permission of department chairperson and staff concerned. (Sections are the same as those listed under Zoool 795, 796.) 1-4 cr.

897, 898. ZOOLOGY SEMINAR
Reports on recent zoological literature. Subject fields are those listed under Zoool 795, 796; not all areas available every semester. Required of graduate students in zoology. 1-2 cr. Cr/F.

899. MASTER’S THESIS
Prereq: permission of department chairperson and prospective supervisor. 6–10 cr.

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Andrew, Michael D. (1966)  
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Annis, William H. (1962)  
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Antonak, Richard F. (1975)  
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Ballinger, L. Christian (1967)  
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Barlow, Robert F. (1962)  
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Birch, Francis S. (1972)  
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Blanchard, Fletcher A., Jr. (1950)  
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Bothner, Wallace A. (1967)  
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Bowman, James S. (1971)  
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Boy, Angelo V. (1965)  
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Hagstrom, Earl C. (1965) Associate Professor of Psychology; Ph.D., Brown University, 1957.

Haley, Russell (1975) Professor of Administration; Ph.D., Union Graduate School, 1974.

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Hall, Francis R. (1964) Professor of Hydrology; Ph.D., Stanford University, 1961.

Hamilton, Lawrence C. (1977) Associate Professor of Sociology; Ph.D., University of Colorado, 1978.

Haney, James F. (1972) Associate Professor of Zoology; Ph.D., University of Toronto, 1970.

Hansen, Jane A. (1979) Associate Professor of Education; Ph.D., University of Minnesota, 1979.

Hansen, Larry J. (1973) Associate Professor of Family and Consumer Studies; Ph.D., Florida State University, 1973.

Happgood, Robert (1955) Professor of English; Ph.D., University of California at Berkeley, 1955.
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Harris, Larry G. (1969)  
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Harter, Robert D. (1969)  
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Hartergink, Antoinette P. (1985)  
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Heilbronner, Hans (1954)  
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Held, Warren H., Jr. (1967)  
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Hers, Edward J. (1962)  
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Hettinger, Stanley D. (1965)  
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Hill, John L. (1964)  
Professor of Wood Science and Technology; D.F., Yale University, 1954.

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Hochgraf, Frederick G. (1958)  
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Hocker, Harold W., Jr. (1955)  
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Holter, James B. (1963)  
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Houston, Robert E., Jr. (1957)  
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Howell, W. Hunning, II (1980)  
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Hurd, Richard W. (1973)  
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Ikawa, Miyoshi (1963)  
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Irish, James D. (1979)  
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Jacoby, A. Robb (1961)  
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James, Marion E. (1955)
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Johnson, Paul C. (1979)
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Johnson, Richard P. (1985)
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Jones, William R. (1962)
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Kaen, Fred R. (1973)
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Kalinowski, Michael F. (1980)
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Karson, Marrin J. (1983)
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Kayser, John R. (1969)
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Kelley, Ann (1965)
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Kertzner, Robert (1965)
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Kleif, Bud B. (1967)
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Kiang, Yun-Tzu (1970)
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Kies, Christopher (1979)
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Kinner, Nancy E. (1983)
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Klotz, Louis H. (1965)
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Komonchak, Bernadette (1976)
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Kraft, L. Gordon (1978)
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Kuo, Shan S. (1964)
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LaCourse, John R. (1980)
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Larson, Barbara K. (1976)
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Larson, David L. (1965)
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Leak, William B. (1967)
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Lockwood, John A. (1948)
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Loy, J. Brent (1967)
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MacHardy, William E. (1972)
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Mann, G. Roy, Jr. (1980)
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Mathieson, Arthur C. (1965)
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Mayne, Howard R. (1985)
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McBride, Mekel (1979)
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McCann, Francis D., Jr. (1971)
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McKeough, D. Michael (1977)
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Mebert, Carolyn J. (1979)
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Melvin, Donald W. (1957)
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Menge, Carleton P. (1948)
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Mennel, Robert M. (1969)
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Merenda, Michael J. (1977)
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Merton, Andrew H. (1972)
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Miller, Walter T., III (1979)
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Mills, Richard L. (1967)
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Mitchell, James R. (1963)
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Moore, David W. (1972)
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Morrison, James D. (1965)
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Mott, Basil J. F. (1973)
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Mower, Lyman (1957)
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Mulhern, John E., Jr. (1954)
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Murdoch, Joseph B. (1952)
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Murray, Donald M. (1963)
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Murray, Frederick P. (1966)
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Nahin, Paul J. (1975)
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Nevin, John A. (1972)
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Newkirk, Thomas R. (1977)
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Nicolloff, Philip L. (1954)
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Nordgren, Eric A. (1964)
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O'Connell, Lawrence W. (1966)
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Oja, Sharon N. (1977)
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Olson, David P. (1968)
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Ossenbruggen, Paul J. (1975)
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Owens, Charles W. (1963)
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Palmer, Stuart H. (1955)
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Parsons, Alan H. (1979)
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Petillo, Juliette D. (1973)
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Pierce, Robert S. (1967)
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Pilar, Frank L. (1957)
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Pilgrim, Sidney A. L. (1979)
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Polasky, Janet L. (1981)
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Poll, Keith (1964)
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Poll, Solomon (1964)
Professor of Sociology; Ph.D., University of Pennsylvania, 1960.

Pollard, James E. (1970)
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Porter, Hugh M., III (1962)
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Power, Marilyn B. (1979)
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Quinn, Michael J. (1983)
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Radlow, James (1965)
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Rasmussen, Mary H. (1968)
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Reyna, Stephen P. (1973)
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Roberts, Lewis, Jr. (1972)
Interim Dean of University of New Hampshire at Manchester and Associate Professor of Occupational Education; Ed.D., Auburn University, 1972.

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Rogers, John E. (1967)
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Rogers, Owen M. (1959)
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Ross, Shepley L. (1955)
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Rohwell, Kenneth J. (1963)
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Routley, Douglas G. (1957)
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Russell, Robert D. (1975)
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Samuels, Fred (1966)
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Sandler, Melvin (1970)
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Savage, Godfrey H. (1965)
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Sawyer, Albert K. (1949)
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Schibanoff, Susan (1971)
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Schwab, Charles G. (1975)
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Schwarz, Marc L. (1967)
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Schweickart, Patrocinio P. (1979)
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Seiler, David E. (1972)
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Seitz, W. Rudolf (1976)
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Shar, Albert O. (1971)
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Shigo, Alex L. (1966)
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Shippee-Rice, Raelene (1979)
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Shore, Barry (1974)
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Shore, Samuel D. (1965)
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Short, Frederick T. (1985)
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Shortle, Walter C. (1976)
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Siddall, David V. (1965)
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Silverman, Robert J. (1962)
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Simic, Charles D. (1973)
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Simos, Evangelos O. (1977)
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Simpson, Robert E. (1963)
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Sir, W. Niel (1970)
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Sitkoff, Harald (1976)
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Smith, C. Tattersall (1982)  
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Smith, M. Daniel (1967)  
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Smith, Mark R. (1966)  
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Smith, Samuel C. (1961)  
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Snell, Elizabeth A. (1971)  
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Sohl, Jeffrey E. (1983)  
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Spears, Margaret W. (1981)  
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Sprague, Linda G. (1969)  
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Sproul, Otis J. (1982)  
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Stanick, Mary (1983)  
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Stewart, James A. (1968)  
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Stübler, Robert (1978)  
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Steine, William (1984)  
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Stone, Deborah E. (1962)  
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Straus, Murray A. (1968)  
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Strout, Richard G. (1954)  
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Sullivan, Janet R. (1985)  
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Sundberg, Donald C. (1978)  
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Taylor, James T. (1977)  
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Theuwke, Siegfried E. (1979)  
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Tillinghast, Edward K. (1967)  
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Tischler, Herbert (1965)  
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Tokay, F. Harry (1973)  
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Tomasi, Joan J. (1982)  
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Tomellini, Sterling A. (1985)  
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Trout, B. Thomas (1969)  
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Tse, Sie-Keung (1984)  
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Professor of Mathematics; Ph.D., University of Illinois, 1969.

Veal, Larry J. (1982)  
Assistant Professor of Music; M.M., University of Illinois, 1976.
Verrette, Paul F. (1962)
Associate Professor of Music; M.A., Boston University, 1971.

Vincent, Donald E. (1962)
Professor and University Librarian; Ph.D., University of Michigan, 1974.

Voll, John O. (1965)
Professor of History; Ph.D., Harvard University, 1969.

Assistant Professor of Physical Education; Ph.D., Pennsylvania State University, 1982.

Associate Professor of Zoology; Ph.D., Cornell University, 1976.

Wang, Rosemary Y. (1971)
Associate Professor of Nursing; Ph.D., Boston College, 1982.

Wang, Tung-Ming (1961)
Professor of Civil Engineering; Ph.D., Northwestern University, 1960.

Ward, Sally K. (1980)
Associate Professor of Sociology; Ph.D., Brown University, 1977.

Warner, Rebecca M. (1981)
Assistant Professor of Psychology; Ph.D., Harvard University, 1978.

Waterfield, D. Allan (1970)
Associate Professor of Physical Education; Ph.D., Ohio State University, 1976.

Watson, Winson H., III (1978)
Associate Professor of Zoology; Ph.D., University of Massachusetts, 1978.

Watters, David H. (1978)
Associate Professor of English; Ph.D., Brown University, 1978.

Wea, Robert E. (1964)
Associate Professor of Physical Education; Ph.D., University of Michigan, 1955.

Weathersby, Rita (1978)
Associate Professor of Administration; Ed.D., Harvard University, 1977.

Webb, Dwight (1967)
Associate Professor of Education; Ph.D., Stanford University, 1967.

Webber, William R. (1969)
Professor of Physics; Ph.D., University of Iowa, 1957.

Weber, James H. (1963)
Professor of Chemistry; Ph.D., Ohio State University, 1963.

Weiland, Walter E. (1964)
Associate Professor of Physical Education; Ph.D., Pennsylvania State University, 1964.

Weiner, James L. (1979)
Associate Professor of Computer Science; Ph.D., University of California at Los Angeles, 1979.

Weisman, Gary R. (1977)
Associate Professor of Chemistry; Ph.D., University of Wisconsin, 1976.

Wells, Otho S. (1966)
Associate Professor of Plant Science and Extension Horticulturist, Vegetables; Ph.D., Rutgers University, 1966.

Wells, Roger E. (1981)
Assistant Professor of Animal Science; D.V.M., Ohio State University, 1972.

Wetzel, William E., Jr. (1967)
Professor of Business Administration; M.B.A., University of Chicago, 1967.

Associate Professor of Forest Resources; Ph.D., University of Minnesota, 1968.

Wheeler, Douglas L. (1965)
Professor of History; Ph.D., Boston University, 1963.

White, Susan O. (1969)
Associate Professor of Political Science; Ph.D., University of Minnesota, 1970.

Assistant Professor of Economics; Ph.D., Pennsylvania State University, 1980.

Wicks, John D. (1956)
Professor of Music; Ph.D., Harvard University, 1959.

Wilcox, Donald J. (1970)
Professor of History; Ph.D., Harvard University, 1967.

Williams, Carol L. (1978)
Associate Professor of Nursing; D.N.Sc., Catholic University, 1979.

Williams, Daniel C. (1970)
Associate Professor of Psychology; Ph.D., University of California at Santa Barbara, 1970.

Williams, Kirk (1984)
Associate Professor of Sociology; Ph.D., University of Arizona, 1977.

Williams, Thomas A., Jr. (1958)
Professor of English; M.A., University of New Hampshire, 1958.

Willis, Robin D. (1965)
Professor of Administration and Organization; Ph.D., Massachusetts Institute of Technology, 1965.

Wilson, John A. (1960)
Associate Professor of Mechanical Engineering; Ph.D., Northeastern University, 1970.

Wing, Barbara H. (1970)
Associate Professor of Spanish; Ph.D., Ohio State University, 1980.

Wing, Henry J., Jr. (1970)
Associate Professor of Music; Ph.D., Boston University, 1966.

Winslow, Deborah (1978)
Assistant Professor of Anthropology; Ph.D., Stanford University, 1982.

Winslow, Mary Bowes (1978)
Associate Professor of Education; Ed.D., Harvard University, 1974.

Wirth, Clifford J. (1981)
Associate Professor of Political Science; Ph.D., Southern Illinois University at Carbondale, 1976.

Wong, Edward Hou Sen (1978)
Associate Professor of Chemistry; Ph.D., Harvard University, 1975.

Associate Professor of Psychology; Ph.D., Yale University, 1975.

Wright, John J. (1970)
Professor of Physics; Ph.D., University of New Hampshire, 1969.

Wrightman, Dwayne E. (1964)
Professor of Business and Economics; Ph.D., Michigan State University, 1964.

Yount, John A. (1962-64, 1965)
Professor of English; M.F.A., University of Iowa, 1962.
Zasowska, Aloise A. (1985)  
Professor of Nursing; Ed.D., Columbia University,  
Teachers College, 1967.  
Zia, Lee L. (1985)  
Assistant Professor of Mathematics; Ph.D., Brown University, 1985.  

Commities of the Graduate School  

Graduate Council  
Raymond L. Erickson, Ph.D.  
Dean of the Graduate School, Chairperson  
William H. Drew, Ph.D.  
Associate Dean of the Graduate School  
Harry J. Richards, Ph.D.  
Assistant Dean of the Graduate School, Secretary  
Richard P. Blakemore, Ph.D.  
Associate Professor of Microbiology  
John J. Carney, Ph.D.  
Associate Professor of Education  
R. Alberto Casais, Ph.D.  
Professor of Spanish  
Ellen S. Cohn, Ph.D.  
Associate Professor of Psychology  
Karl C. Diller, Ph.D.  
Professor of English  
Richard W. England, Ph.D.  
Associate Professor of Economics  
Albert D. Frost, Sc.D.  
Professor of Electrical Engineering  
Robert D. Harter, Ph.D.  
Professor of Soil Chemistry  
John A. Lockwood, Ph.D.  
Professor of Physics  
Paul A. Mayewski, Ph.D.  
Professor of Earth Sciences  

Three graduate students are appointed to this council each year.  

Research Council  
Paul A. Mayewski, Ph.D.  
Coordinator of Research Development  
William H. Drew, Ph.D.  
Associate Dean of the Graduate School  
Paul L. Bishop, Ph.D.  
Professor of Civil Engineering  
John F. Burger  
Associate Professor of Entomology  
Grant Cioffi, Ph.D.  
Assistant Professor of Education  
Bud B. Khleif, Ph.D.  
Professor of Sociology  
Kathryn B. Pope, M.B.A.  
Director of Research Administration  
Charles G. Schwab, Ph.D.  
Associate Professor of Animal Science  

Two faculty members from the College of Liberal Arts,  
one from the College of Engineering and Physical Sciences,  
and one from the Whittemore School of Business and Economics will be appointed in the fall.  
Two graduate students are appointed to the council each year.  

Student Fellowship Selection Committee  
William H. Drew, Ph.D.  
Associate Dean of the Graduate School  
John H. Barnett, D.B.A.  
Associate Professor of Business Administration  
Frank K. Hoornbeek, Ph.D.  
Professor of Zoology  
Yun-Tzu Kiang, Ph.D.  
Professor of Plant Science and Genetics  
Robert M. Mennel, Ph.D.  
Professor of History  
M. Robinson Swift, Ph.D.  
Associate Professor of Mechanical Engineering  

Faculty Fellowship Selection Committee  
William H. Drew, Ph.D.  
Associate Dean of the Graduate School  
Alexander R. Amell, Ph.D.  
Professor of Chemistry  
Fred R. Kaen, Ph.D.  
Professor of Finance  
John E. Limber, Ph.D.  
Associate Professor of Psychology  
William M. Muatz, Ph.D.  
Professor of Wildlife Ecology  
Michael D. McKeough, Ed.D.  
Associate Professor of Physical Education  

Tuition Scholarship Selection Committee  
Harry J. Richards, Ph.D.  
Assistant Dean of the Graduate School  
Michael J. Merenda, Ph.D.  
Associate Professor of Administration  
Donald S. Szarkowicz, Ph.D.  
Assistant Professor of Electrical Engineering  
Anthony R. Tagliaferro, Ph.D.  
Associate Professor of Animal and Nutritional Sciences  
Sally Ward, Ph.D.  
Associate Professor of Sociology  
Walter E. Weiland, Ph.D.  
Associate Professor of Physical Education  

Zsigay, Robert M. (1970)  
Professor of Microbiology and Genetics; Ph.D.,  
Georgetown University, 1969.
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Vocational/Technical and Adult Education 112
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Graduate School Calendar 1985–86

Semester I

**September 4, Wednesday**  8 a.m. Classes begin
**September 9, Monday**  Graduate student registration (day students)
**September 9–12, Mon.–Thurs.**  Graduate student registration (evening students, 5–7 p.m.)
**September 13, Friday**  Last day to register without $25 late registration fee
**September 16, Monday**  Last day for graduate students to withdraw or drop courses and qualify for $1/4 tuition refund
**September 20, Friday**  Last day to file Intent-to-Graduate for December graduation
Last day to add or drop courses without dean’s approval and $25 late add/drop fees
Last day to request audit without dean’s approval
Last day to drop courses or withdraw without academic liability; last day to carry more than 16 credits without surcharge

**October 3, Thursday**  Last day for graduate students to withdraw or drop courses and qualify for $1/2 tuition refund
**October 25, Friday**  Midsemester
**November 1, Friday**  Application forms for Part-time Tuition Scholarships for Semester II are available at the Graduate School
**November 11, Monday**  Veterans Day holiday—no classes
**November 27, Wednesday**  Classes hold Monday schedule
Last day for Ph.D. dissertation defense (December graduation)

**November 28–29, Thurs.–Fri.**  Thanksgiving holiday—no classes
**December 2, Monday**  8 a.m. Classes resume
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Spring Semester 1986
Last day for completing application for Part-time Tuition Scholarships for Spring Semester 1986

**December 6, Friday**  Last day for presenting final copies of doctoral dissertation or master’s thesis to the Graduate School for binding (December graduation)
Last day to take final comprehensive examination for the master’s degree

**December 13, Friday**  Last day of classes
Last day for resolving incompletes from Semester II, 1984–85 and/or Summer 1985

**December 14, Saturday**  Commencement
**December 16, Monday**  Reading Day
**December 17–21, Tues.–Sat.**  Final Exams
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tr>
<td>January 22, Wednesday</td>
<td>8 a.m. Classes begin</td>
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<tr>
<td>January 27, Monday</td>
<td>Graduate student registration (day students)</td>
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<tr>
<td>January 27–30, Mon.–Thurs.</td>
<td>Graduate student registration (evening students, 5–7 p.m.)</td>
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<td>January 31, Friday</td>
<td>Last day to register without $25 late registration fee</td>
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<tr>
<td>February 3, Monday</td>
<td>Last day for graduate students to withdraw or drop courses and qualify for 3/4 tuition refund</td>
</tr>
<tr>
<td>February 7, Friday</td>
<td>Last day to add or drop courses without dean’s approval and $25 late add/drop fees</td>
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<tr>
<td></td>
<td>Last day to request audit without dean’s approval</td>
</tr>
<tr>
<td></td>
<td>Last day to drop courses or withdraw without academic liability; last day to carry more than 16 credits without surcharge</td>
</tr>
<tr>
<td>February 14, Friday</td>
<td>Last day for completing application for admission to Graduate School for Fall Semester 1986, to ensure consideration for financial assistance for the 1986–87 academic year</td>
</tr>
<tr>
<td>February 20, Thursday</td>
<td>Last day to withdraw or drop courses and qualify for 1/2 tuition refund</td>
</tr>
<tr>
<td>February 21, Friday</td>
<td>Last day to file Intent-to-Graduate for May graduation</td>
</tr>
<tr>
<td>March 17–21, Mon.–Fri.</td>
<td>Spring recess</td>
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<tr>
<td>March 24, Monday</td>
<td>8 a.m. Classes resume</td>
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<tr>
<td>March 28, Friday</td>
<td>Midsemester</td>
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<tr>
<td>April 1, Tuesday</td>
<td>Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Summer Session 1986</td>
</tr>
<tr>
<td></td>
<td>Application forms for Part-time Tuition Scholarships for Semester I, 1986–87 are available at the Graduate School</td>
</tr>
<tr>
<td>April 30, Wednesday</td>
<td>Last day for final Ph.D. dissertation defense (May graduation)</td>
</tr>
<tr>
<td>May 9, Friday</td>
<td>Last day for presenting final copies of doctoral dissertation or master’s thesis to the Graduate School for binding (May graduation)</td>
</tr>
<tr>
<td></td>
<td>Last day to take final comprehensive examination for the master’s degree</td>
</tr>
<tr>
<td>May 13, Tuesday</td>
<td>Last day of classes</td>
</tr>
<tr>
<td></td>
<td>Last day for resolving incompletes from Semester I, 1985–86</td>
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<tr>
<td>May 14–15, Wed.–Thurs.</td>
<td>Reading days</td>
</tr>
<tr>
<td>May 16–22, Fri.–Thurs.</td>
<td>Semester II final exams</td>
</tr>
<tr>
<td>May 24, Saturday</td>
<td>Commencement</td>
</tr>
</tbody>
</table>

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Summer Session 1986

June 6, Friday  
Last day to file Intent-to-Graduate for September graduation  
Last day for completing application for Part-time Tuition Scholarships for Fall Semester 1986–87

July 1, Tuesday  
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Fall Semester 1986

July 30, Wednesday  
Last day for final Ph.D. dissertation defense (September graduation)

August 8, Friday  
Last day for presenting final copies of doctoral dissertation or master’s thesis to the Graduate School for binding (September graduation)

Graduate School Calendar 1986–87

Semester I

September 3, Wednesday  
8 a.m. Classes begin

September 8, Monday  
Graduate student registration (day students)

September 8–11, Mon.–Thurs.  
Graduate student registration (evening students, 5–7 p.m.)

September 12, Friday  
Last day to register without $25 late registration fee

September 15, Monday  
Last day for graduate students to withdraw or drop courses and qualify for ¾ tuition refund

September 19, Friday  
Last day to file Intent-to-Graduate for December graduation  
Last day to add or drop courses without dean’s approval and $25 late add/drop fee  
Last day to request audit without dean’s approval  
Last day to drop courses or withdraw without academic liability; last day to carry more than 16 credits without surcharge

October 2, Thursday  
Last day for graduate students to withdraw or drop courses and qualify for ½ tuition refund

October 24, Friday  
Midsemester

November 3, Monday  
Application forms for Part-time Tuition Scholarships for Semester II are available at the Graduate School

November 11, Tuesday  
Veterans Day holiday—no classes

November 26, Wednesday  
Classes hold Tuesday schedule  
Last day for Ph.D. dissertation defense (December graduation)

November 27–28, Thurs.–Fri.  
Thanksgiving holiday—no classes

December 1, Monday  
8 a.m. Classes resume  
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Spring Semester 1987  
Last day for completing application for Part-time Tuition Scholarships for Spring Semester 1987
December 5, Friday  Last day for presenting final copies of doctoral dissertation or master's thesis to the Graduate School for binding (December graduation)
Last day to take final comprehensive examination for the master's degree

December 12, Friday  Last day of classes
Last day for resolving incompletes from Semester II, 1985–86 and/or Summer 1986

December 13, Saturday  Commencement

December 15, Monday  Reading Day

December 16–20, Tues.–Sat.  Final Exams

Semester II

January 21, Wednesday  8 a.m. Classes begin

January 26, Monday  Graduate student registration (day students)

January 26–29, Mon.–Thurs.  Graduate student registration (evening students, 5–7 p.m.)

January 30, Friday  Last day to register without $25 late registration fee

February 2, Monday  Last day for graduate students to withdraw or drop courses and qualify for 3/4 tuition refund

February 6, Friday  Last day to add or drop courses without dean's approval and $25 late add/drop fees
Last day to request audit without dean's approval
Last day to drop courses or withdraw without academic liability; last day to carry more than 16 credits without surcharge

February 16, Monday  Last day for completing application for admission to Graduate School for Fall Semester 1987, to ensure consideration for financial assistance for the 1987–88 academic year

February 19, Thursday  Last day to withdraw or drop courses and qualify for 1/2 tuition refund

February 20, Friday  Last day to file Intent-to-Graduate for May graduation

March 13, Friday  Midsemester

March 16–20, Mon.–Fri.  Spring recess

March 23, Monday  8 a.m. Classes resume

April 1, Wednesday  Last day for completing application for admission to graduate study, request for change in degree program or application for readmission for Summer Session 1987
Application forms for Part-time Tuition Scholarships for Semester I, 1987–88 are available at the Graduate School

April 29, Wednesday  Last day for final Ph.D. dissertation defense (May graduation)
May 8, Friday
Last day for presenting final copies of doctoral dissertation or master’s thesis to the Graduate School for binding (May graduation)
Last day to take final comprehensive examination for the master’s degree

May 12, Tuesday
Last day of classes
Last day for resolving incompletes from Semester I, 1986–87

May 13–14, Wed.–Thurs.
Reading days

May 15–21, Fri.–Thurs.
Semester II final exams

May 23, Saturday
Commencement

Summer Session 1987

June 5, Friday
Last day to file Intent-to-Graduate for September graduation
Last day for completing application for Part-time Tuition Scholarships for Fall Semester 1987–88

July 1, Wednesday
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Fall Semester 1987

July 29, Wednesday
Last day for final Ph.D. dissertation defense (September graduation)

August 7, Friday
Last day for presenting final copies of doctoral dissertation or master’s thesis to the Graduate School for binding (September graduation)

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The University of New Hampshire has adopted a grievance procedure to provide for the resolution of complaints under this policy. A copy of the grievance procedure may be obtained at the Dean for Student Affairs Office, Huddleston Hall.

The University is in compliance with federal guaranteed student loan regulations and will supply information about the employment of its graduates who have majored in specialized degree programs that normally lead to specific employment fields. This information may be obtained upon request from the University’s Career Planning and Placement Service, which is available to all students. The University does not guarantee employment to its graduates.

The University provides full information pertaining to the Family Educational Rights and Privacy Act of 1974 (the “Buckley Amendment”) in the annual student guide. Information also is available from the offices of the dean for student affairs and the vice-president for academic affairs. The annual student guide also contains University regulations and policy regarding student conduct.

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Bulletin of the
University of New Hampshire
Office of Communications
Schofield House
University of New Hampshire
Durham, N.H. 03824