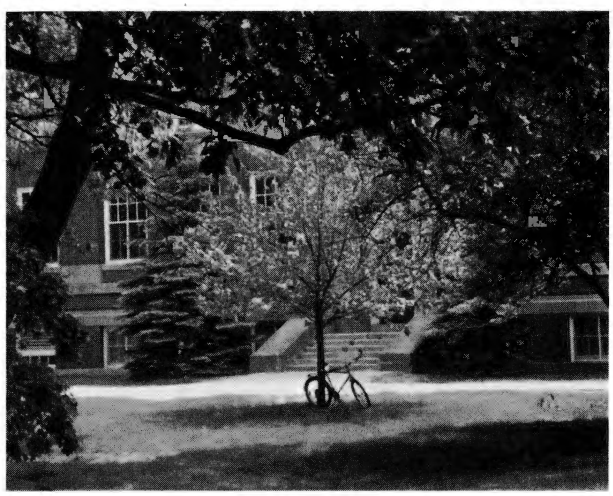
Bulletin of the

UNIVERSITY OF NEW HAMPSHIRE

Graduate Catalog
1989 – 1991

UNIVERSITY OF NEW HAMPSHIRE



Graduate Catalog
1989 – 1991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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
Chemical Engineering
Chemistry
Civil Engineering
Communication Disorders
Computer Science
Earth Sciences
  Geology
  Oceanography
Electrical Engineering
Entomology
Family and Consumer Studies
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Forestry
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Mathematics
Mechanical Engineering
Microbiology
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Nursing
Ocean Engineering
Physical Education
Physics
Plant Biology
Resource Administration and Management
Resource Economics
Soil Science
Wildlife
Zoology

Master of Arts in Teaching
Elementary Education
Secondary Education

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

Master of Science for Teachers
Chemistry
English
Mathematics
Physics

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
Chemistry
Computer Science
Earth Sciences
  Geology
  Oceanography
Economics
Engineering
English
Genetics
History
Mathematics
Mathematics Education
Microbiology
Physics
Plant Biology
Psychology
Reading and Writing Instruction
Sociology
Zoology

*no longer accepting applications

Graduate Study at the University of New Hampshire

About 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 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 200-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 amid the 74 classroom, research, and service buildings and 36 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, Whittemore School of Business and Economics, School of Health and Human Services, Thompson School of Applied Science, Division of Continuing Education, University of New Hampshire at Manchester, and the Graduate School. 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 about 600, and offers 94 undergraduate and 74 graduate programs. The student body includes more than 1,200 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 in 1866 as New Hampshire College of Agriculture and the Mechanic Arts to train young men and women for service to the state through agriculture and technology. In 1893, New Hampshire College 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 500. The Graduate School is led by the dean, who implements the policies of the graduate faculty. The Graduate Council, composed of elected faculty and student representatives, 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, carries 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 many programs, students can elect options that will permit them 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 coursework 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; the Biology Program, which makes the resources of the biological science departments available to students interested in a general master's program; the Resource Administration and Management Program, which involves faculty in the natural resources area; and the Institute for the Study of Earth, Oceans, and Space, which offers the opportunity for interdisciplinary study and research.

Opportunities for interdisciplinary study in the marine area are described under the Institute of Marine Science and Ocean Engineering. 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 serve 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 on the Academic Senate and serve on such University-wide committees as the Research Council, the Library Committee, and the Traffic Committee.

Cultural and Recreational Activities

The University offers students a variety of cultural, social, and recreational 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. Many departments and programs on campus sponsor lecture series on a wide range of topics. Among these are the School of Health and Human Services' Sidore Lecture Series and the Whittemore School's Degler Lecture Series. 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.

Recreational facilities are available at the Field House for all students who purchase recreation passes. A student ID entitles one 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 students intramural program.

The University competes in fourteen men's and twelve women's varsity athletic programs.

Graduate Student Residences

Babcock House 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 coed 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, students 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 about housing by the University's Department of Housing and Conferences, 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-bedroom 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. All interested individuals must fill out an application form available at the Forest Park Office. Generally, most applicants are offered an apartment within six 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 Department of Housing and Conferences (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 Office for Student Development 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.

UNH Dining

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 UNH Dining, Stillings Hall, University of New Hampshire, Durham, N.H. 03824.

University Health Services

University Health Services 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. The Office of Health Education and Promotion offers education in alcohol, drugs, sexuality, stress, fitness, and other aspects of healthful life styles.

During the regular academic year, University Health Services is staffed by full-time physicians and 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.

University Health Services 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. Health Services also offers a group accident and sickness insurance policy that is mandatory for international students and optional for all others.

Graduate students who are present on campus, but who are not formally enrolled in summer school and who have not paid the summer health fee may use Health Services during the summer session on a fee-for-service basis.

Counseling

The Counseling Center offers graduate students, without charge, professional assistance in meeting a variety of personal, educational, and vocational problems. Services include individual, couple, and group counseling/therapy, and clinical testing.

The center sponsors a variety of student-oriented workshops; e.g., personal skills groups on such topics as stress management, values clarification, life planning, conflict resolution, and time management.

All information about students' visits to the Counseling Center is held strictly private within the limits of confidentiality and cannot be released without the written permission of the student.

Career Planning and Placement Service

The Career Planning and Placement Service assists students in planning for professional careers. 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 counseling, placement techniques workshops, and aid in finding summer employment.

The service will also forward students' credential files to prospective employers/graduate schools 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.

Services for Students with Disabilities

ACCESS (Accessing Career Challenges in Education through Specialized Services) helps students with disabilities meet 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 ACCESS, 200 Memorial Union Building, University of New Hampshire, Durham, N.H. 03824-3594.

Child Care

The University operates on-campus day-care and preschool programs through the Child Study and Development Center and the Child Family Center. Call (603) 862-2835 for further information. In addition, information about Seacoast area child care and assistance in finding appropriate care are available through the Child Care Resource and Referral Service, (603) 862-2895.

Admission and Registration

Admission 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 admission and degree 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 through 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) completion of three years of teaching experience, or (3) holding 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. 03824-3586.

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 $25 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 that 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 by 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. Many programs will fill available openings before these deadlines. Therefore applicants should apply early.

Applicants for financial assistance (assistantships and scholarships) should complete their applications 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 applications completed by April 1. Foreign applicants currently residing in the United States should have their applications 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 term 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 before the student may enroll 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. Applicants who have received approved deferment of their admission cannot register as special students during the period of deferment.

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 3.20 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 14.)

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 programs (see the Undergraduate Catalog), 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 Whittemore School for information.

Special Students Individuals holding baccalaureate degrees may register for graduate courses on campus through the Division of Continuing Education, or for graduate courses off campus through the University of New Hampshire at Manchester, the Nashua Graduate Center, or 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 15.)

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 advisers or the chairperson of their guidance committees. Registration is usually held the first Monday after classes begin each semester for day students and Monday through Thursday evening 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. 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 9 or more credits, Master's Continuing Enrollment, or Doctoral Research 999 are classified as full-time students. Students holding assistantship appointments are also considered full time and must register for a minimum of 6 credits, Master's Continuing Enrollment or Doctoral Research each semester.

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

Half-Time Students Graduate students not on an assistantship and registered for 5 or 6 credits are classified as half-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 and also to notify the Graduate School.

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 one credit per week per session and twelve credits for the entire 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.

Student Load for Veterans' Benefits Graduate students eligible for V.A. benefits during the summer receive benefits according to the following schedule of average credit registrations: 1/2 credit/week or more = full time; 3/8 credit/week or more = 3/4 time; 1/4 credit/week or more = 1/2 time; less than 1/4 credit/week = tuition and fees only.

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 and the dean of the Graduate School. 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 Services 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 students with disabilities.

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 University Health Services; 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 in 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. 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 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.

Residency

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. Nonresident undergraduates continuing directly to the Graduate School will be classified as nonresidents.

All applicants claiming New Hampshire residency are required to have been legally domiciled in New Hampshire continuously for at least twelve 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 Student 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 twenty-five percent) if the program to which they are admitted is one that is not available at their home state university. Inquiries and requests for further information may be directed to the Dean of the Graduate School, UNH, Durham, N.H. 03824-3586, 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. 03824-3586.

Schedule of Fees

The following schedule of fees is in effect each semester of the 1989–90 academic year, and is subject to change for 1990–91. 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 ACCESS and the Commuter/Transfer Center; a health fee, which funds University Health Services; and a recreation fee, for the use of recreational facilities. 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.

Graduate Tuition and Fees

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

These charges will apply to admitted graduate students enrolling for courses at the University during the academic year. Admitted graduate students planning to enroll for UNH courses off campus or during the summer session should consult the relevant publications for information regarding tuition and fees.

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

Graduate Tuition and Fees 1989–90

Tuition: (per semester)	Full-time (9–16 credits)	Part-time (5–8 credits)	Part-time (1–4 credits)
N.H. Resident	$ 1295.00	$ 120.00 /cr. hr.	$ 120.00 /cr. hr.
Nonresident	4190.00	380.00 /cr. hr.	380.00 /cr. hr.
Doctoral Research	300.00	—	—
Master's Continuing Enrollment	150.00	—	—
Differential Tuition	87.50	5.00 /cr. hr.	5.00 /cr. hr.
Mandatory Fees*:			
Memorial Union	$ 50.00	$ 25.00	—
Student Services	13.00	6.50	—
Health Fee	96.00	48.00	—
Recreation Fee	23.00	11.50	—
Registration Fee:	—	$ 15.00	$ 15.00
Late Registration Fee:	$ 25.00	$ 25.00	$ 25.00

*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.

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 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 thirty 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 during the term in which their degree is awarded will be assessed an in-absentia charge one month prior to the conferral of their degrees. The in-absentia charge is $25 for master's students, $25 for C.A.G.S. students, and $100 for doctoral students.

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 The University strongly urges all students to be insured against illness or injury that may arise in the course of the academic year. A student accident and sickness insurance policy is available for all students. Graduate students may enroll in this insurance program on a voluntary basis (required of all international students) during graduate registration or through Health Services. The cut-off date for enrollment is the second Friday following graduate registration. Insurance coverage is also available for the spouse or children of a student provided the student is also enrolled in the plan. For information on student and/or dependent insurance, call University Health Services (603-862-1530).

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 University Health Services. (Students must petition for refund no later than two weeks after graduate registration. Forms are available in the Health Services Office. Refund requests should be sent directly to the Health Services Office.) The Memorial Union, student services, and recreation fees are nonrefundable.

Financial Assistance

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. The deadline for receipt of these applications is May 1.

The Tax Reform Act of 1986 (TRA '86) made all scholarships and fellowships taxable income to the recipients, except for that portion used by degree candidates for the payment of tuition and course-required fees, books, supplies, and equipment (as opposed to other expenses like room and board). Compensation for service, which includes assistantship stipends and work-study awards, is fully taxable. Tuition reduction waivers awarded to graduate students on assistantships are considered to be nontaxable scholarships.

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 Students may be granted academic-year or semester 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 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 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. These awards are in the form of a stipend for a period of two months in the summer. Application is made to the dean of the Graduate School.

Assistantships

Approximately 400 assistantships are awarded annually. Appointments are normally 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 twenty 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 6 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 1989–90 academic-year base stipend levels for assistantships are $7,000 ($7,650 in biochemistry, chemistry, computer science, engineering, mathematics, and physics). Doctoral students who have held an assistantship for two years may qualify for an advanced academic-year stipend of $7,300 ($7,850 in biochemistry, chemistry, computer science, engineering, mathematics, and physics). It is anticipated that the stipend level will increase for 1990–91.

Inquiries regarding assistantships should be addressed to the chairperson or graduate coordinator 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 are also eligible to receive tuition waivers.

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 are also eligible to receive tuition waivers.

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, depending upon the terms of the grant they are employed under, may also receive tuition waivers to cover the in-state portion of their tuition. Project assistants are also eligible to receive waivers to cover the out-of-state portion of their tuition.

Graduate Associates A 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 $12,000 per academic year according to the qualifications and duties of the student. A graduate associate may be eligible to receive a tuition waiver.

Summer Assistantships Full-time and part-time summer appointments may be available. Graduate students working full time on research or combined teaching and research for the entire summer earn 2/3 of their prior academic year stipend (which is based on half-time employment). Appointments for less than the maximum time are prorated. Students are not normally permitted to register for summer session courses if on a full-time appointment.

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. CURF support is intended primarily for full-time graduate students. However, applications from part-time graduate students are considered. 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 associate dean of the Graduate School, and two graduate student representatives. The CURF program is administered through the Research Administration Office.

Loan and Work-Study Programs

Perkins 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. **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.**

Stafford (GSL) Student Loan Programs Students may apply for as much as $7,500 per year from a bank or other financial institution participating in the Stafford Student Loan Program. Qualified borrowers pay no interest while attending college. Repayment of principal and interest begins six to nine months after the student ceases a full-time course of study. Check with your local bank for further details and current interest charges.

It is the student's responsibility 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 800 through 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- and 900-level Courses These courses are offered for graduate credit only and therefore are open only to admitted or special graduate students.

700-level Courses These are advanced undergraduate courses. Up to 12 credits earned in 700-level courses may be taken for graduate credit by a graduate degree student, provided such courses are approved by the student's adviser, graduate program coordinator, and the dean of the Graduate School, and provided they are given in a department other than the one in which the student is earning the degree. Such courses must be taken for a letter grade.

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 on the academic record 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 8 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.

A graduate student may petition to take graduate independent study courses (800/900 level) as well as undergraduate courses on a credit/fail basis. Such a petition must be approved by the end of the add period for the term the course is taken. Courses at the 700 level approved for graduate credit cannot be taken for credit/fail.

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 for excused unfinished work only. 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 (800- and 900-level courses only; midsemester for 400-, 500-, 600-, and 700-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 appropriate deadline. 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 fifth 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 fifth Friday of classes, a notation of "W" will be shown on the student's academic record. If the withdrawal or drop is after midsemester, a WP/WF is shown on the record. A WF is considered a failing grade.

Academic Standards

Grades below the B- level, including grades of C or C+ that 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 9 or more credits will be dismissed from the Graduate School. Students on a conditional status must meet the conditions as stated in their letter of admission in order to remain in the Graduate School.

Each individual program may set and announce standards for coursework and research achievement that are more rigorous than the Graduate School standard. Thus, students may be dismissed if they accumulate less than 9 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 9) may, upon recommendation of the department and approval of the Graduate School, be allowed, for a maximum of two graduate-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 6 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. 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 in 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. This number could be reduced if transfer credits are also applied.

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.

Twelve-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

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 800–999. Up to 12 credits earned in courses numbered 700–799 may be taken for graduate credit by master's degree students 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. A maximum of 12 credits taken by a student prior to admission can be applied to a degree program.

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 from the date of matriculation (admission/enrollment) in the program. 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.

Examining 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 student 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 Credit 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 and accepted by the Graduate School. 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 for completion of the Certificate of Advanced Graduate Study are found under the program descriptions of the education department. A maximum of 12 credits taken by a student prior to admission to the C.A.G.S. can be applied to a C.A.G.S. program.

All graduate work for the C.A.G.S. must be completed within six years from the date of matriculation (admission/enrollment) in the program.

Doctoral Degree Requirements

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 is 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 assists the student in outlining a program and preparing for the qualifying examination, and administers 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 chairperson of the student's program will communicate the examination results to the Graduate School dean.

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, three 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 is required, and the student assumes the cost. Students may choose to copyright their dissertation at the time of microfilming. If the dissertation material is further published, it should be designated as having been accepted as a doctoral dissertation by the University of New Hampshire.

Graduation

Students must 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 is available at the Graduate School or the Registrar's Office.

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.*

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.

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 and educational activities are conducted not only in individual departments but also in multidisciplinary research centers and institutes.

Centers and Laboratories

Biogeochemical Systems Center A research unit within the Institute for the Study of Earth, Oceans, and Space, the Biogeochemical Systems Center conducts a wide range of global research programs concerning biogeochemistry, chemical oceanography, isotope geochemistry, and sediment geochemistry. Graduate and undergraduate students are involved in all phases of this research.

Center for the Humanities The Center for the Humanities acts as a forum for discussion and intellectual cross-fertilization regarding humanistic issues and perspectives; it fosters and supports creative research in the humanities; it assists faculty in their educational and curricular activities in general, and in the development of interdisciplinary humanities courses and programs in particular; it serves the humanities faculty, students, programs, and community by assisting in the development and dissemination of educational and research materials; it fosters and develops relevant outreach activities in the humanities for the state and region; and it is a focus for the humanities within the University, the state, and the region.

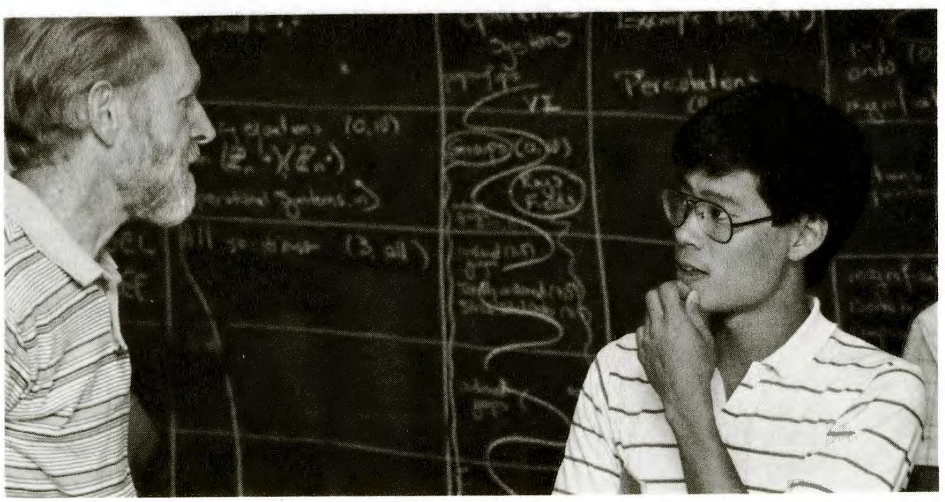
Center for Venture Research This multidisciplinary community of scholars and professionals is dedicated to the study and promotion of innovation, entrepreneurship, and economic development. The center pursues its objectives in three distinct ways: *research*—path-breaking studies of entrepreneurial ventures and their sources of equity financing; *service*—management of a confidential introduction service for entrepreneurs and high-net-worth private investors (Venture Capital Network, Inc.); and *education*—professional workshops for investors and entrepreneurs dealing with the pricing and structuring of venture capital investments. University faculty, graduate students, and professionals are involved in all aspects of the center and together address the equity financing needs of the entrepreneurial economy.

Complex Systems Research Center The CSRC investigates the effects of human disturbance on the Earth's biogeochemical processes. Utilizing remote sensing, field and laboratory investigations, computer modeling, and policy analysis, CSRC faculty and staff are currently examing the ocean's role in the global carbon cycle, forest decline and land-use change, nutrient cycling and decomposition in terrestrial ecosystems, processes contributing to changes in atmospheric chemistry and climate, and the impact of policy decisions on the global environment.

Environmental Research Group The ERG, affiliated with the Department of Civil Engineering, conducts applied and fundamental research in the areas of environmental engineering and environmental science. The group is made up of faculty with research interests in biological and physiochemical treatment processes, solid and hazardous waste management, environmental chemisty and microbiology, hydrogeology, and system modeling and optimization. Recent research sponsors include the Environmental Protection Agency, the National Science Foundation, the American Water Works Association Research Foundation, and the Office of Naval Research. One of the principal goals of the group is to seek sponsorship that supports both graduate and undergraduate education and research. Recent research projects include radon removal from drinking water, methods to enhance in situ biodegradation of gasoline-contaminated groundwater, and methods to stabilize incineration residues.

Family Research Laboratory Internationally recognized for its extensive and pioneering research on intrafamily violence and sexual abuse of children, the FRL 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. Graduate students are actively involved in the research activities of the laboratory.

Glacier Research Group The Glacier Research Group is a research unit within the Institute for the Study of Earth, Oceans, and Space devoted to the retrieval and interpretation of global change records such as climatic change, biogeochemical cycling, atmospheric chemistry, unique atmospheric phenomena, and the influence of human activities on our environment. The faculty (who are also members of the Department of Earth Sciences), research scientists, and graduate students in the group conduct a wide range of analytical measurements. Studies are conducted in the high latitudes (Antarctica, Greenland) as well as the lower latitudes (Himalayas, China).



Human Nutrition Center 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.

Institute for Policy and Social Science Research The Institute for Policy and Social Science Research provides financial and administrative support for social and policy-related research at the University. It works to raise the contribution that UNH faculty and students can make to public decision makers in universities, communities, New Hampshire, and the Northeast.

Work of the institute is conducted within a set of broad themes. These reflect concern for sustaining natural environments, achieving peace and social equity, providing public education, implementing microcomputer decision support systems, and sustaining economic development. The institute helps faculty to secure external research funds, aids in the dissemination of results, conducts short courses for senior public officials, offers research facilities to house interdepartmental groups, and provides students with opportunities for internships in public offices.

Institute on Disability The mission of the Institute on Disability is to improve knowledge, policy, and practice related to the economics and social participation of persons with disabilities. The institute provides a blend of program development and policy research that addresses the needs of local schools, community services, state and federal agencies. The institute's goal is to increase the ability of the state of New Hampshire to foster more and higher quality integration of persons with disabilities into New Hampshire communities.

Marine Systems Engineering Laboratory The MSEL, a component of the Institute for the Study of Earth, Oceans, and Space, is involved with the research and development of intelligent underwater systems. The primary research emphasis of the laboratory is the development of technologies related to autonomous underwater vehicles and robotics. The mission of MSEL is to build and maintain a base of technical excellence in ocean systems related to educational, research, and service activities within UNH. A major goal of the laboratory is to make use of the skills and enthusiasm of students by employing their talents in project roles to provide practical experience in engineering. The research at the laboratory centers around two experimental autonomous undersea submersibles (EAVE vehicles) which act as development testbeds for intelligent undersea systems research.

Ocean Process Analysis Laboratory Part of the Institute for the Study of Earth, Oceans, and Space (EOS), OPAL focuses on physical ocean science research. The three faculty members, who are also part of the Department of Earth Sciences, and thirteen other professional technical staff and students are involved in a number of ocean-going research programs. This work emphasizes the use of in-house developed instrumentation, to study the ocean in such places as California, the Strait of Gibraltar, and the local Gulf of Maine. Future plans include studies of the North Brazil Current in the equatorial Atlantic and the development of satellite data telemetry schemes.

Space Science Center This research unit within the Institute for the Study of Earth, Oceans, and Space, is funded by grants from the National Aeronautics and Space Administration and the National Science Foundation. The center is currently involved in 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.

Water Resource Research Center The Water Resource Research Center, supported by the United States Department of the Interior and the University, implements basic and applied research in freshwater and estuarine 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.

Writing Process Laboratory This laboratory provides unique opportunities for graduate students in education and English to acquire practical 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.

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, marine biology and aquaculture 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.

Dimond Library

The University library houses more than 925,000 volumes, more than 6,000 periodicals, and substantial microfilm and audiotape 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 Resources

Computing at UNH today has evolved from a centralized system to a distributed environment. Every full-time UNH student has computer access, both to mainframe computers and to microcomputers.

UNH has five conveniently located microcomputer centers for use by students through the DISCovery (Directions in Instructional and Scholarly Computing) Program. These centers are equipped with more than 170 AT&T 6300 (IBM-compatible), IBM PS/2, and Apple Macintosh personal computers and compatible printers. Each center also has a library of software for word processing, spreadsheet, graphics, modeling, and statistical analysis. The centers are staffed by student consultants who help users with questions or problems. Documentation is also available. Some students use their own software or class-specific software provided by their instructors.

The University has two large computers for academic use by students and faculty: a VAX 8820 and a VAX 8650, running VMS and ULTRIX operating systems. These computers operate 363 days a year, 24 hours a day. There are approximately 300 remote terminals and graphics devices in classrooms, the library, and other convenient places on campus.

Any student may have an account on the VAX computers; students may access these machines in any of four DISCovery Large Systems Centers, staffed by student consultants during peak hours.

A library of general-purpose software is available, including statistical packages, database management, and graphics. There is specific software for fields such as engineering, biochemistry, and computer science. Students may also use electronic MAIL and BITNET, a national and international academic computer network, for correspondence and file transfer.

The Research Computing Center houses three large Prime systems: a 6650, 9955-II, and a 750, running the PRIMOS operating system. There are also a MicroVAX II and a Prime 2655 for research testing. All systems are interconnected using Ethernet and PRIMENET. Some students involved in research projects use workstations in the CADAG (Computer-Aided Design and Advanced Graphics) laboratory to access Prime's MEDUSA software, a program that generates high-quality mechanical drawings, on the Prime 9955-II computer.

UNH is an affiliate of three National Science Foundation supercomputing sites—at Cornell University, the Pittsburgh Supercomputing Center, and the University of Illinois. Through this affiliation, students have an opportunity to learn supercomputing by working with faculty advisers.

The University Technology Center sells IBM Personal System/2 and Apple Macintosh computers, compatible printers, Hewlett-Packard products, software and computer supplies—all at substantial discounts for members of the University community.

Students can learn about computing through free short courses offered every semester, some of which may be viewed on videotape. Additional support and training are available through course handouts, documentation and guides, VAX on-line HELP, and on-disk tutorials.

Institute for the Study of Earth, Oceans, and Space (EOS)

Director: Berrien Moore III
Professors: Roger L. Arnoldy; Wendell S. Brown; Edward L. Chupp; Robert W. Corell; Lennard A. Fisk; Henri E. Gaudette; Robert C. Harriss; John A. Lockwood; Paul A. Mayewski; Berrien Moore III; William R. Webber
Research Professors: Joseph V. Hollweg; Martin A. Lee
Associate Professors: John D. Aber; Theodore C. Loder III; William Berry Lyons; Barrett N. Rock; Roy B. Torbert
Research Associate Professors: Terrence G. Forbes; David J. Forrest; Mark E. Hines; James D. Irish; Neal R. Pettigrew; James M. Ryan
Research Assistant Professors: Patrick M. Crill; George A. Simpson; Mary Jo Spencer; Judith A. Spiller; Robert W. Talbot; W. T. Vestrand

The Institute for the Study of Earth, Oceans, and Space is an interdisciplinary research institute devoted to the study of the Earth and its space environment. Particular emphasis is placed on studies that contribute to understanding the global, integrated behavior of this system. These studies involve phenomena that occur on large and small spatial and temporal scales. They include the development of advanced technology to probe physically inaccessible regions; they depend on both remote sensing and in situ observations; and they involve the development of theories and models, the use of laboratory experimentation, and questions of public policy.

Individual disciplines in the study of the Earth and space—such as physical, chemical, and biological ocean science; atmospheric science; and space science—are legitimate areas of specialization for education and research in their own right. Each is rooted in basic physics, mathematics, biology, and/or chemistry. Each has a large body of specialized knowledge developed over time that must be understood by students before they can become functional scientists in that field, and each presents a separate career opportunity.

The evolution of the study of the Earth and space over the next twenty-five years should be equally dramatic. The linkages among the disciplines of Earth and space studies—the science performed at the interfaces of the disciplines—will assume increasing importance. The field has matured to a point where a unified approach is appropriate; the physical, chemical, and biological processes at work on the Earth and in its environment in space compose a coupled system. The number of research problems requiring contributions from many different fields, as well as an understanding of the complex connections among different components, has grown substantially in recent years. For example, the changes in climate that can be expected from the worldwide consumption of fossil fuels, the influence of solar luminosity changes on the climate, the ongoing alterations in the Earth's albedo resulting from changing land use, the ability of the oceans to assimilate wastes, the sensitivity of stratospheric ozone to trace gases such as fluorocarbons, and the translation of scientific studies of these problems into public policy—these are all examples of fundamental issues that require a global, multidisciplinary approach.

Faculty members working in the Institute for the Study of Earth, Oceans, and Space are affiliated with academic departments through which graduate degree programs are offered. The degree programs currently offered are the physics degree with specialization in space science, the earth sciences degree with an option in oceanography or specialization in geochemical systems, and the forestry degree with specialization in forest ecosystem dynamics. Admission and degree requirements are set by the respective departments. In addition, EOS students will be required to participate in an EOS interdisciplinary seminar. Specialized courses on the various components of the Earth and space system are offered by the institute and can be elected both to fulfill degree requirements and to broaden the education of students completing this program emphasizing a global perspective.

Students who wish to access the degrees in earth sciences, forestry, and physics through EOS should have the desire to broaden their education beyond the specific requirements of these degrees by completing the specialized courses offered by EOS. The latter are interdisciplinary in nature and are designed to enhance understanding of the global Earth, its environment in space, and the nature of global research. Interested students should see page 36 for a description of these courses, and pages 37, 57, and 76 for the admission and degree requirements for the graduate programs in earth sciences, forestry, and physics.

Institute of Marine Science and Ocean Engineering (IMSOE)

Director: Darrell Jay Grimes
Professors: Francis S. Birch; Arthur C. Borror; Darrell Jay Grimes; Larry G. Harris; Galen E. Jones; David L. Larson; Arthur C. Mathieson; Thomas G. Pistole; Peter F. Sale; John J. Sasner, Jr.; Godfrey H. Savage; Kondagunta Sivaprasad; Herbert Tischler
Associate Professors: Kenneth C. Baldwin; Pedro A. De Alba; Allen D. Drake; W. Huntting Howell; Nancy E. Kinner; Bruce E. Lindsay; Theodore C. Loder III; Donald W. Melvin; Stacia A. Sower; M. Robinson Swift; Charles W. Walker; Winsor H. Watson III
Assistant Professors: Richard H. Cote; R. Randolph Olson

The Institute of Marine Science and Ocean Engineering carries out research, education, and service projects involving the freshwater, estuarine, coastal, and marine environments. It is closely tied to both graduate and undergraduate academic programs in a wide range of disciplines and gives special emphasis to interdisciplinary programs that enhance the strengths of academic units of the University. Researchers associated with IMSOE study diverse marine-related topics that are of importance to the state or region as well as some that are of national or international scope and significance. The institute also develops and maintains marine public service programs that provide information for the citizens of the state and region.

The faculty who are members of IMSOE are affiliated with a number of different academic departments, and marine-related graduate and undergraduate degree programs are offered through these departments. Graduate programs with interdisciplinary marine concentrations are offered in the departments of animal and nutritional sciences, biochemistry, chemical engineering, chemistry, civil engineering, earth sciences, electrical and computer engineering, mechanical engineering, microbiology, plant biology, political science, and zoology. The master of science program in ocean engineering is an interdisciplinary program involving faculty from several departments.

The Marine Programs Building houses the office of the Institute of Marine Science and Ocean Engineering as well as work space for ocean engineering, physical sciences, and other marine activities. The institute's facilities include the Jackson Estuarine Laboratory, which is located on Great Bay about five miles from campus and fourteen miles from the ocean via the Piscataqua River and which supports research in marine life sciences and physical sciences. The Coastal Marine Laboratory, a running-seawater facility, is located about fifteen miles from campus in New Castle and serves as a center for research involving living marine animals. A running-freshwater facility located on campus, the Anadromous Fish and Aquatic Invertebrate Research Laboratory, supports research on several freshwater species. The Shoals Marine Laboratory, located about seven miles off the New Hampshire coast on Appledore Island of the Isles of Shoals, is operated jointly by UNH and Cornell University and is principally concerned with marine and life science educational and research activities. The *R/V Jere Chase* is a forty-five-foot research vessel equipped for a wide variety of marine research activities in the estuarine and near-coast waters. IMSOE is also involved with the N. H. Lakes Lay Monitoring Program, which keeps track of changes in the quality of the state's lakes and maintains a long-term database on lakes.

Research by faculty and students is conducted on disciplinary and interdisciplinary bases and is supported by University, state, and private funds as well as by numerous federal granting agencies, such as the National Sea Grant Program. The University of New Hampshire and the University of Maine are partners in a joint Sea Grant College Program, one of twenty-eight programs around the country. Current research projects involving faculty and graduate students include an investigation of the interaction of blue mussels with eelgrass and the opportunities this provides for the blue mussel aquaculture industry, the development of a hinged navigational piling capable of surviving a collision with a ship or barge, a study of the feasibility of the marine disposal of incinerator ash that has been solidified and stabilized in a concrete matrix, an examination of the consequences of using steroids in commercial salmon feeds, and a comparison of methods for the detection of enteric viruses in shellfish.

Departmental Requirements and Course Descriptions

The following pages describe the graduate programs offered at the University. Program descriptions include faculty, degrees offered, special admission requirements, degree requirements, and course descriptions.

Course Description 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;/or 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.

Permission of instructor may be required for enrollment in a particular course. Courses are offered subject to adequate student demand. Consult departments for detailed descriptions of current course offerings.

Animal and Nutritional Sciences (ANSC)

Chairperson: William A. Condon
Professors: William A. Condon; Thomas P. Fairchild; James B. Holter; Samuel C. Smith; Richard G. Strout; Willard E. Urban, Jr.
Associate Professors: William E. Berndtson; Colette H. Janson-Sand; Alan H. Parsons; Charles G. Schwab; Anthony R. Tagliaferro; Roger E. Wells
Assistant Professors: Elizabeth P. Boulton; Joanne Curran-Celentano; Nancy R. Deuel; Patricia Dugan-Bedker; Thomas L. Foxall; Richard S. Kingston; Robert L. Taylor, Jr.; Paul C. Tsang
Graduate Program Coordinator: Charles G. Schwab

Degrees Offered

The Department of Animal and Nutritional Sciences offers the master of science and doctor of philosophy degrees. Doctoral and master's students may specialize in animal nutrition, human nutrition, reproductive physiology, mammalian physiology, or cell biology and immunology. Master's students may also specialize in animal breeding and quantitative genetics, animal diseases, or animal management.

Admission Requirements

An applicant 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.

M.S. Degree Requirements

A student will meet the Graduate School's requirements for the master's degree and must defend a thesis based on a research problem. The program may include no more than 6 credits of thesis research and no more than 4 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.

Ph.D. Degree Requirements

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 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.

801. Physiology of Reproduction
Comparative aspects of embryology, anatomy, endocrinology, and physiology of reproduction. Special fee. Lab. 4 cr.

802. 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 801 and permission. Lab. Special fee. 4 cr.

804. 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.

806. Physical Performance Enhancement
Improvement of physical performance of athletic humans and animals through the integrated application of principles of sports nutrition, exercise physiology, and biomechanics. Prereq: one semester of nutrition and one semester of exercise physiology or permission. 4 cr.

816. 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 cover avian pathology and immunology. Prereq: permission. 4 cr.

817. Mammalian Physiology I
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 intro. animal anatomy and physiology and one semester of biochem. or permission. 4 cr.

818. Mammalian Physiology II
Systems-level course with emphasis on the respiratory, gastrointestinal, excretory, reproductive, and endocrine systems. Prereq: one year of intro. animal anatomy and physiology and one semester of biochem. or permission. 4 cr.

820. Community Nutrition
Focus on managerial processes of planning, leading, and evaluating nutrition programs and the skills and tools needed to develop and present such programs. 4 cr. (Not offered every year.)

822. Immunogenetics
Cellular interactions and immune regulatory mechanisms. Genetics of the major histocompatibility complex, antibody diversity, and immune responses. Lab. 4 cr.

824. Reproductive Management and Artificial Insemination
Focus on goals and fundamentals of reproductive management of horses, dairy and livestock animals, and, through experience, development of competency in performing modern breeding techniques for equine or bovine reproduction. Prereq: physiology of reproduction and permission. Special fee. Lab. 4 cr.

850. Human Nutrition
Detailed analysis of the nutrient requirements throughout the life cycle. Nutrient needs are evaluated in the context of their physiological and biochemical functions. Prereq: basic nutrition and biochem. or permission. 4 cr. (Fall semester only.)

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 PBIO 851.) Lab. 4 cr.

855. Disorders in Energy Balance
Etiology, pathophysiology, and treatments of obesity, anorexia nervosa, and bulemia are reviewed. Role of hereditary, neurological, metabolic, and environmental mechanisms are discussed. Particular emphasis on obesity. Prereq: permission. 4 cr.

860. Geriatric Nutrition
Emphasis on the nutritional requirements and status of the elderly in view of psychological and physiologic changes in aging. Approaches for nutrition intervention and support are addressed. Prereq: prin. of human nutrition or permission of instructor. 3 cr. Cr/F.

873. Clinical Nutrition
Principles of normal nutrition and physiology applied to clinical problems; altered nutrient requirements in human disease. Prereq: basic nutrition and biochem. or permission. Coreq: ANSC 875. 4 cr. (Spring semester only.)

875. Practical Applications in Therapeutic Nutrition
Supervised practical experience in therapeutic dietetics in one of several cooperating New Hampshire hospitals. Emphasis on nutritional counseling, assessment, and instruction of patients with nutrition-related disorders. Coreq: ANSC 873. 3 cr. (Fall semester only.)

880. Critical Issues in Nutrition
Critical reviews and analysis of controversial topics in nutrition; emphasis on developing analytical reasoning skills. Prereq: permission. 4 cr. (Fall semester only.)

903. 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.)

904. 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.)

909. Contemporary Trends in Reproductive Physiology
Comprehensive survey of recent developments in the areas of comparative mammalian reproduction and animal biotechnology. Prereq: ANSC 801 or permission. May be repeated. 4 cr.

910. Minerals and Vitamins in Nutrition
Metabolism and function of mineral elements and vitamins in higher animals. Prereq: permission. 4 cr. (Not offered every year.)

913. Contemporary Topics in Immunobiology
Topical lectures, seminars, and assigned reading emphasizing recent advances in immunology. Prereq: one course in immunology; permission. May be repeated for a maximum of 6 credits. 3 cr. (Not offered every year.)

953. Advanced Cell Biology
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.)

995, 996. 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.

997, 998. Animal Science Seminar
Survey of recent literature and research in the animal sciences. (May be repeated.) 1 cr. Cr/F.

899. Master's Thesis
6 cr.

999. Doctoral Research

Biochemistry (BCHM)

Chairperson: Donald M. Green
Professors: Donald M. Green; Samuel C. Smith; James A. Stewart
Associate Professors: Clyde L. Denis; Thomas M. Laue; Stacia A. Sower
Assistant Professors: John J. Collins; Rick H. Cote; Anita S. Klein; Andrew P. Laudano
Graduate Program Coordinator: Donald M. Green

Degrees Offered

The Department of Biochemistry offers the master of science and the doctor of philosophy degrees. The department offers research opportunities in developmental biochemistry, eukaryotic gene regulation, metabolism, molecular genetics, plant biochemistry, physical biochemistry, oncogene function, regulatory molecules, structure and function of macromolecules, and transposable elements biology. Opportunities also exist for interdisciplinary research in marine biochemistry, biochemical nutrition, and cell biology in adjunct facilities on campus. In addition to the graduate courses in biochemistry, courses in advanced organic chemistry, radiochemistry, microbiology, or genetics are usually recommended.

Admission Requirements

An applicant 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.

M.S. Degree Requirements

A student will meet the Graduate School's requirements for the master's degree and 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.

Ph.D. Degree Requirements

Doctoral students 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 pro-

gram. 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, 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.

Teaching Requirement

Teaching assignments—in the laboratory, in lectures, or in an individual instruction format—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.

805. Techniques in Endocrinology
Application of modern laboratory techniques to the study of hormonal and molecular mechanisms in the endocrine system. Prereq: ZOOL 804 or ANSC 801 or BCHM 851, 852, 855;/or permission. (Also offered as ZOOL 805.) Special fee. Lab. 4 cr.

806. Genetics Laboratory
Advanced experiments in yeast genetics including research techniques in biochemical, transmission, and molecular genetics. Prereq: prin. of genetics or equivalent; a course in biochemistry is recommended. (Also offered as GEN 806.) Special fee. 3 cr.

850. Physical Biochemistry
Structure, interactions, and physical-chemical properties of biomolecules. Thermodynamic, hydrodynamic, and spectroscopic methods for study of proteins and nucleic acids. Laboratory work focuses on the theory and design of biochemical instrumentation. Students are responsible for designing and describing a useful new instrument. Prereq: physical chemistry; BCHM 852/or permission. Special fee. Lab. 4 cr.

851-852. Principles of Biochemistry
Fundamental biochemistry; chemistry, metabolism, and biological function of nucleic acids, proteins, carbohydrates, and lipids. Prereq: organic chem.;/or permission. 3 cr.

855. Biochemistry Laboratory
Application of modern techniques to the characterization of basic properties of the major biological molecules, including proteins, nucleic acids, lipids, and carbohydrates; the analysis of enzyme kinetics; and techniques used in molecular biology. Prereq: BCHM 851-852 or permission. 5 cr.

860. Enzyme Chemistry
Protein 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. Prereq: calculus; BCHM 852/or permission. 3 cr.

863. Biochemistry of Cancer
Molecular mechanisms of viral and chemical carcinogenesis; role of oncogenes in normal cell growth, development, and differentiation. Biochemical basis of cancer chemotherapy. Critical reviews of research papers and an advanced research paper required. Prereq: BCHM 852/or permission. 3 cr. Cr/F.

865. Plant Biochemistry
Structure, synthesis, metabolism, and regulation of the cellular constituents of plants. Utilization of plant biochemistry in biotechnology. Prereq: physiological chem. and nutrition; BCHM 851-852;/or permission. 3 cr.

871. Biochemical Genetics
Mechanisms of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Prereq: BCHM 852;/or permission. (Also offered as GEN 871.) 3 cr.

872. 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 852; BCHM 871 or MICR 804. (Also offered as GEN 872.) Special fee. 3 cr.

911. Biochemistry of Lipids
Chemistry, metabolism, and function of lipids. Prereq: BCHM 852 or permission. 3 cr. (Not offered every year.)

942. 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 852 or permission. (Also offered as GEN 942.) 3 cr.

991-992. Advanced Topics in Molecular Biology
Selected topics of current research on the molecular biology of gene regulation. Emphasis on eukaryotic systems such as yeast, mammals, and maize. (Also offered as GEN 991-992.) 1 cr. Cr/F.

993-994. Advanced Topics in Protein Structure and Function
Selected topics of current research on protein chemistry, macromolecular associations, and enzymology. 1 cr. Cr/F.

997, 998. Biochemistry Seminar
Prereq: permission. 1 cr.

899. Master's Thesis
6–10 cr.

999. Doctoral Research

Biology

Coordinator: James E. Pollard
Chairperson of Graduate Admissions Committee: Roger E. Wells

Degree Offered

The master of science degree in biology is achieved through a general, nonthesis program. Students in the program consult with the Graduate Admissions Committee for referral to an appropriate adviser for program planning. At present, participating faculty members are drawn from the following areas: molecular, cellular, and developmental biology; systematics; ecology; evolutionary biology; physiology; anatomy; nutrition; genetics and pathobiology. Specific program requirements and guidelines are available from the chairperson of the Graduate Admissions Committee.

Admission Requirements

Applicants should have a bachelor's degree in one of the biological sciences or a strong background in the biological and physical sciences. This degree is not intended as a prerequisite to Ph.D. programs and, therefore, might not satisfy requirements for admission to some of these programs.

Nonthesis M.S. Degree Requirements

Students will meet the Graduate School's requirements for the master's degree and must complete a four-credit research project and a final comprehensive examination on program coursework. The research project and coursework should focus on a specific aspect of biology of interest to the student; however, to ensure a broad base of preparation in biology, coursework should include courses from several biological science departments. Persons interested in this degree should contact the chairperson of the Graduate Admissions Committee for further information.

Business Administration (ADMN)

Chair of Graduate Programs: Stephen L. Fink
Professors: Stephen L. Fink; John Freear; Charles W. Gross; Jonathan Gutman; James O. Horrigan; Manley R. Irwin; Fred R. Kaen; Marvin J. Karson; Barry Shore; Linda G. Sprague; William E. Wetzel, Jr.; Robin D. Willits; Dwayne E. Wrightsman
Adjunct Professor: R. Stephen Jenks
Associate Professors: John H. Barnett; Gene Bocialetti; Ahmad Etebari; Francine S. Hall; Jinoos A. Hosseini; Allen M. Kaufman; Michael J. Merenda; Richard L. Mills; Melvin Sandler; Starr F. Schlobohm; Jeffrey E. Sohl; Allen R. Thompson; Rita Weathersby
Assistant Professors: Susan H. Herhold; R. Dan Reid; T. J. Wharton

Degree Offered

The Whittemore School offers a program leading to the M.B.A. in formats designed for day students and practicing managers. The M.B.A. program is directed toward a broad preparation in general administration. In the day program, functional concentrations are available at the student's option.

Admission Requirements

The Whittemore School welcomes applicants with an above-average academic record in any undergraduate specialty. The crucial requirement for admission into the M.B.A. program is a history that demonstrates that the applicant has the potential and desire for graduate study in business. The focus of the student's earlier education is of less importance than evidence of academic ability and potential for becoming a responsible manager and leader. Consequently a "portfolio" approach to admissions is adopted, in which an applicant's work and military experience along with other indications of maturity, motivation, and self-discipline are considered as well as the applicant's test scores and academic record. All applicants are required to take the Graduate Management Admission Test (GMAT). Applicants are expected to have successfully completed one year of college mathematics or have demonstrated proficiency in quantitative reasoning.

Day M.B.A. Degree Requirements

The Whittemore School curriculum for day students consists of an integrated sequence of eighteen to twenty courses normally requiring two years of full-time study. During the first year, ten 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. In the second year a student may continue the emphasis on general management or pursue a functional concentration. Students are encouraged to select appropriate graduate-level courses offered by other colleges of the University, as well as by the Whittemore School, and to undertake field studies or internships.

Executive M.B.A. Degree Requirements

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 those working full time at managerial level jobs. The program emphasizes general management and provides for broad-based exposure to the functional areas of finance and accounting, human resource management, marketing, and operations management. The program is offered in Durham at the New England Center. The twenty-two-month 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.

812. 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. 3 cr.

813. Interpersonal Skills for Managers
Focuses on student awareness of interpersonal style and its effectiveness in gaining personal and organizational rewards. Also considered are the process by which groups develop and the management of that development. 3 cr.

814. Managing Organizational Conflict
Conflict among individuals, small groups, and organizations. Analysis of cases, readings, simulations, and roleplays (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. 3 cr.

821. 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 manag. accounting;/or permission. 3 cr.

822. 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 relationship, distribution costs, transfer pricing, and capital budgeting analysis. 3 cr.

823. Topics in Finance
Prereq: financial management. 3 cr.

824, 825. Advanced Production Planning and Control I, II
Analysis and development of production planning and control systems. Topics include inventory management, material requirements planning, capacity management, and production activity control. 3 cr.

826. 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. 3 cr.

827. Topics in Accounting
Special topics. 3 cr.

830. Investments Analysis
Security analysis, efficient market hypothesis, portfolio theory, and alternative investments. 3 cr.

832. 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. 3 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. 3 cr.

840. 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. 3 cr.

842. Time Series Analysis
The role of time series analysis in operational forecasting is examined. Modern time series models are studied, with particular emphasis on Box-Jenkins methods. Computer programs are used and their output examined. 3 cr.

843. Regression Analysis
Regression analysis is studied as an applied statistical methodology, with a blend of underlying theory. Emphasis is on inference, diagnostic checking of assumptions, and remedial measures. 3 cr.

846. International Financial Management
Financial management problems facing multinational firms. Focus on effects of currency denominations on financial decisions. 3 cr.

847. Business Taxation
Taxation factors relevant to business decisions. Emphasis upon federal income taxation from the viewpoint of the firm. Prereq: financial and managerial accounting. 3 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. 3 cr.

849. 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. 3 cr.

850. Marketing Management
Examines marketing management and decision making in practical settings. Students are expected to draw upon various marketing and other business concepts and apply them to actual situations. Students are assigned one or two cases per week which they must prepare for class discussion. Emphasis on various aspects of marketing in various cases, including making decisions in strategic marketing, evaluating market opportunity, developing integrated marketing programs, and developing components of the marketing mix. 3 cr.

851. 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. 3 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. 3 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. 3 cr.

861. Sales Management
Principles and methods of successful personal selling and management of the sales function. Exposure to selling experience in field of student interest; case studies, sales presentations; oral and written analyses of sales management issues. 3 cr.

862. Marketing Workshop
Integrative study of a real marketing situation in a business, nonprofit institution, or government agency. Student teams identify problem, research or collect data, suggest alternative solutions, and submit a recommended course of action. 3 cr.

863. International Marketing
Environmental factors affecting international trade: culture and business customs, political and legal factors and constraints, economic and technological development, and the international monetary system. Integration of these with the marketing management functions of market research and segmentation; product, promotion, distribution, and pricing decisions. 3 cr.

870. 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. 3 cr.

875. 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. 3 cr.

880. Issues for Men and Women as Managers
Develops awareness of gender-related attitudes and behaviors as they affect work interactions. Topics include implications of gender expectations for leadership, communication, and career success; impact of stereotypical attitudes and behaviors; issue of sexual attraction and harassment at work; and considerations for balancing career and family. 3 cr.

885. 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. 3 cr.

898. Topics in Administration
Special topics; may be repeated. Prereq: consent of adviser and instructor. 1–3 cr.

900. Integrative Management Seminar
This course extends throughout the Executive M.B.A. 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. 0, 2 cr. Cr/F.

910. 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. (Executive M.B.A. Program only.) 3 cr.

911. Management Organization
Theories of organization and analysis of contemporary forms and structure. Concern is with development of rational management processes in a dynamic society. (Executive M.B.A. Program only.) 3 cr.

912. Organizational Behavior
Application of behavioral and social science concepts to contemporary organizational life. Covers theories and modes related to individual, interpersonal, and group behavior as well as to total organizational issues such as goals, structure, and design of management systems. In addition to reading material, the course methods include experiential learning and the use of case studies for application. 3 cr.

913. Consulting Practicum
Field consulting experience as a member of M.B.A. Associates. Development of client relationships, diagnoses and analyses of actual problems, written and oral reports to clients, and administrative participation in M.B.A. Associates. 3 cr.

920. 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.

921. Managerial Accounting
Introduction to various models employed by organizations in the financial planning and control processes. 3 cr.

930. Financial Management
Concepts and techniques for determining the need for, the acquisition of, and the management of, financial resources of the business. 3 cr.

940. 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.

941. Empirical and Modeling Methods in Business
Application of quantitative models and empirical methods to managerial decisions. 3 cr.

942. 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. 3 cr.

943. 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. 3 cr.

950. Managerial Statistics
Basic mathematical and statistical concepts applied to managerial decision making. Probability, statistics, decision trees, and mathematic models. 3 cr.

952. Multivariate Analysis
Applied multivariate analysis, with examples from business and economics research. Descriptive methods and classical inference methods are covered in the context of models and underlying assumptions. Computer programs are used and their output explained. 3 cr.

960. 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.

970. Applied Macroeconomics
The effect on management decisions of historical and forecasted movements in interest rates, national income, inflation, and unemployment. 3 cr.

971. Applied Microeconomics
An economics approach to the conceptualization, analysis, and management of revenues, costs, and profits. 3 cr.

980. Strategic Management: Environmental Issues
Study of various ways that nonmarket forces, including the legal, political, social, technical, and ethical dimensions, help to define the competitive process, and ways that business firms take these forces into account through the corporate strategic management process. (Executive M.B.A. Program only.) 3 cr.

981. Organization and Its Environment
Analysis of contemporary organizational forms in relation to changing external environments. 3 cr.

982. Strategic Management: Decision Making
A "capstone" course, focused on industries, companies, and other organizations in operation, and studied through the role of the strategic manager and case examples, with emphasis on integration of materials covered in prior courses. 3 cr.

992. 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. Variable credit, 1–6 cr.

Chemical Engineering (CHE)

Chairperson: Stephen S. T. Fan
Professors: Stephen S. T. Fan; Virendra K. Mathur; Gael D. Ulrich
Associate Professors: Ihab H. Farag; Donald C. Sundberg
Assistant Professors: Dale P. Barkey; Russell T. Carr; Palligarnai T. Vasudevan
Graduate Program Coordinator: Stephen S. T. Fan

Degree Offered

The Department of Chemical Engineering offers the master of science degree. Students interested in graduate studies beyond the master of science degree should refer to the section entitled Engineering Ph.D. Program.

Admission Requirements

An applicant is expected to have completed a baccalaureate degree in chemical engineering. 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.

M.S. Degree Requirements

A minimum of 30 credits, which must include CHE 913, 915, 916, 923, and 932, is required for the master of science in chemical engineering. The core courses requirement can be waived only in special cases with permission from the department faculty. A thesis is required, for which a minimum of 6 credits will be allowed, unless the candidate is specifically exempted by the faculty because of previous research experience.

Permission of the instructor and consent of the student's adviser are required for enrollment in all chemical engineering courses.

801. Introduction to Polymer Engineering
Principles of polymer chemistry, polymerization kinetics, polymer rheology, and material characteristics. Design and analysis of polymer reactors, extruders, molding machines, and other forming operations. Lab. 4 cr.

805. Natural and Synthetic Fossil Fuels
Study of U.S. and foreign reserves of coal, oil, and natural gas. Petroleum processing and refining. Coal, oil shale, and tar sand. Gasification and liquefaction of coal. Lab. 4 cr.

812. Introduction to Nuclear Engineering
Development of nuclear reactors; binding-energy; radioactivity; elements of nuclear reactor theory; engineering problems of heat transfer, fluid flow, materials selection, and shielding; environmental impacts. 4 cr.

844. Corrosion
Fundamentals of corrosion processes in industrial and environmental settings; thermodynamics, kinetics, and mass transport in local corrosion cells; protection by electrochemical, chemical, surface modification, or barrier methods; instrumental methods in corrosion science. Lab. 4 cr. (Not offered every year.)

851. 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. (Not offered every year.)

852. 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.

854. 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. (Not offered every year.)

861. Biochemical Engineering
Immobilized enzyme technology, microbial biomass production, transport phenomena in microbial systems, biological reactor design, process instrumentation and control, applications in separation and purification processes. Lab. 4 cr. (Not offered every year.)

872. 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. (Not offered every year.)

904. 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.)

913. Advanced Fluid Mechanics
Basic equations describing behavior of static and dynamic fluid systems. The equations of motions and application to laminar and turbulent flow. Momentum and energy equations for advanced problems associated with flow inside conduits. Flow of compressible fluids and boundary layer phenomena. 3 cr.

914. Fluidization Engineering
Fluidization regimes, fluid mechanics of particle suspensions, motion of single and multibubbles 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.)

915. Heat Transfer
Steady-state and transient heat conduction in solids; heat convection; analytic solutions, similarity relations, boundary layer methods; radiation. 3 cr.

916. 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.

923. 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.

932. Advanced Chemical Engineering Kinetics
Specialized 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.

990. 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.

996. Graduate Independent Study
Directed reading or investigation at the advanced level on topics in chemical engineering. 2–4 cr.

998. 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: Kenneth K. Andersen; N. Dennis Chasteen; Colin D. Hubbard; Paul R. Jones; James D. Morrison; Frank L. Pilar; W. Rudolf Seitz; James H. Weber; Edward H. Wong
Associate Professors: Christopher F. Bauer; Richard P. Johnson; Gary R. Weisman
Assistant Professors: Howard R. Mayne; Roy P. Planalp; Sterling A. Tomellini
Graduate Program Coordinator: Edward H. Wong

Degrees Offered

The Department of Chemistry offers programs leading to the doctor of philosophy and the master of science degrees in the areas of organic, inorganic, physical, and analytical chemistry. The department also offers the master of science for teachers.

Admission Requirements

Admission to the master of science and the doctor of philosophy degrees is based upon a strong undergraduate record 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.

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.

Applicants for the master of science for teachers should consult the General Regulations of the Graduate School for special admission requirements.

M.S. Degree Requirements

The master's degree requires completion of coursework appropriate to the student's field of study and the completion of a research problem presented in the form of a thesis. A minimum of 30 credit hours is required.

Master of Science for Teachers Degree Requirements

This degree requires 30 credit hours in courses approved by the graduate coordinator. Persons interested in this degree should confer with the department's graduate program coordinator.

Ph.D. Degree Requirements

The doctoral degree requires completion of coursework appropriate to the student's field of study and the completion of a research problem presented in the form of a thesis. Ph.D. candidates in organic chemistry will be expected to demonstrate proficiency in reading chemical literature in German. The analytical, inorganic, and physical divisions require expertise in the use of computers. 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.

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 graduate coordinator for further information.

Teaching Requirement

All graduate students who are doctor of philosophy or master of science candidates will obtain some teaching experience during their tenure.

Analytical Chemistry

930. 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.)

931. Advanced Electrochemical Methods
Theory and application of important electrochemical techniques such as potentiometry, polarography, and voltammetry. 2 cr. (Not offered every year.)

932. 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.)

933. Chemical Separations
The use of various separation techniques prior to analysis; separations as methods of analysis. 3 cr. (Not offered every year.)

934. 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.)

935. Electronics for Chemical Instrumentation
Introductory analog and digital electronics for chemists. Emphasis placed on how electronic components and circuits affect acquisition, manipulation, and quality of chemical information. 2 cr. (Not offered every year.)

Inorganic Chemistry

903. Advanced Inorganic Chemistry I
Survey of important concepts of modern inorganic chemistry. Intended as general background material for all graduate students and as basic fundamentals for further courses in inorganic chemistry. 4 cr.

904. Advanced Inorganic Chemistry II
Advanced topics for students after CHEM 903: transition metal reaction mechanisms; organometallic chemistry. Overview of current trends in inorganic research. 3 cr.

947. Advanced Inorganic Chemistry III
Special topics in metal complexes and chemistry of organometallic compounds. Prereq: CHEM 903 or permission. 3 cr.

Organic Chemistry

901. Theoretical Organic Chemistry I
Discussion of theoretical and experimental methods used in study of reaction mechanisms and molecular stereochemistry. 4 cr.

902. Theoretical Organic Chemistry II
A continuation of CHEM 901. 3 cr.

911. Synthetic Organic Chemistry I
Advanced synthetic methods for preparing organic molecules. Prereq: permission. 3 cr.

912. Synthetic Organic Chemistry II
A continuation of CHEM 911. Prereq: permission. 3 cr.

917, 918. 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

905. Advanced Physical Chemistry I
Introduction to topics in quantum mechanics and group theory, which form the background of all areas of modern chemistry. 4 cr.

906. 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.

921. 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.

922. 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.

926. 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.)

927, 928. 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. Scattering theory. Molecular reaction dynamics. May be offered as a tutorial. 3 cr. (Not offered every year.)

929. 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.

907. 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.

995, 996. 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.

997, 998. 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 (CIE)

Chairperson: David L. Gress
Professors: Otis J. Sproul; Tung-Ming Wang
Associate Professors: Thomas P. Ballestero; Jean Benoit; Pedro A. De Alba; Charles H. Goodspeed; David L. Gress; Robert M. Henry; Nancy E. Kinner; Paul J. Ossenbruggen
Assistant Professors: Richard Alan Behr; Michael R. Collins; James P. Malley, Jr.
Research Assistant Professor: T. Taylor Eighmy
Graduate Program Coordinator: Pedro A. De Alba

Degree Offered

The Department of Civil Engineering offers the master's degree in civil engineering with the following areas of specialization: structural/materials, geotechnical, water resources, systems analysis, and environmental engineering. The environmental and water resources areas offer a joint program in hazardous waste management. Interested applicants are encouraged to write the graduate program coordinator for specific information on current research in the department.

An engineering Ph.D. program with specialization in civil engineering is also available. For general information, refer to the section entitled Engineering Ph.D. Program.

Admission Requirements

An applicant must have completed a baccalaureate degree in engineering, mathematics, or science at an accredited college or university. If coursework or laboratory experience is deficient, an admitted 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 or-

der to achieve a well-integrated program of study.

M.S. Degree Requirements

A student in the master's program may elect either a thesis (minimum of 25 course credits and 6 thesis credits) or nonthesis (minimum of 31 course credits and a 0-credit project) option. For the thesis option, a formal oral presentation/thesis defense is required. A student 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 nonthesis candidate must pass a departmental comprehensive examination on fundamental engineering concepts prepared and evaluated by the candidate's advisory committee.

For graduation, a B average must be achieved. All students are required to register for Civil Engineering Seminar (CIE 900) for one semester.

821. 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 or permission. 3 cr.

822. 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.

823. 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.

834. 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.

840. 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 septage treatment. Prereq: intro. environ. pollution control. 3 cr.

841. Open Channel Flow
Energy and momentum principles in open channel flow; flow resistance; channel controls and transitions; unsteady open channel flow; convective and dispersive transport of pollutants; and basic modeling techniques. Prereq: fluid mechanics or permission. 3 cr.

842. 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.

843. 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.

844. 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.

845. 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 operations, hydropower development, multipurpose projects. Prereq: permission. 3 cr.

846. 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.

847. 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.

848. 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.

849. 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.

851. 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.

852. Traffic Engineering
Fundamental relationships of speed-density-flow are introduced. Topics include correlation and linear regression analyses, the design of roadways for uninterrupted and interrupted flow, analysis of signalized and unsignalized intersections, and classification of roadways by capacity and level of service considerations. Prereq: probability and statistics for applications or equivalent is recommended. 3 cr.

855. 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.

856. 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.

857. 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 ME 857 and OE 857.) 3 cr.

860. Foundation Engineering
Subsurface investigation and characterization using current methods of laboratory and in situ testing. Application of consolidation theory to settlement problems. Bearing capacity theory and design of shallow foundations including footings and rafts. Design and analysis of deep foundations including piles, piers, and caissons. Prereq: soil mechanics or permission. 3 cr.

861. Earth Structures
Earth pressure theory and design of temporary and permanent retaining structures including retaining walls, sheet-pile walls, braced and tieback walls. Design and analysis of slurry trench cutoffs and walls. Dewatering with design of shallow and deep systems. Slope stability theory and applications. Embankment design. Prereq: soil mechanics; foundation engineering;/or permission. 3 cr.

874. Reinforced Concrete Design I
Introduction to the design of reinforced concrete structural members by the strength method and deflection performance. Includes beams, columns and foundations, and construction details of reinforcing. Prereq: structural analysis. 4 cr.

882. 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 or permission. 3 cr.

883. Matrix Structural Analysis
Analysis of determinate and indeterminate structures; nonprismatic members subject to static and moving loads. Solution by matrix and computer-applied methods. Prereq: structural analysis or permission. 3 cr.

884. Civil Engineering Analysis with Numerical Techniques
Unifying concepts of civil engineering analysis, theory, and numerical techniques. Discussion includes the assumptions required by numerical techniques and their relationship to the theory and the analytical results. Prereq: permission. 3 cr.

885. Introduction to Structural Vibrations
Dynamic analysis of single- and multi-degree-of-freedom systems. Applications include simple beam and frame structures. Earthquake analysis and design. Co- or prereq: indeterminate structures. 3 cr.

886. Introduction to Finite Element Analysis
Topics include basic matrix theory, Galerkin method, direct stiffness method, calculus of variations, development of finite element theory, and modeling techniques. Applications in solid mechanics, heat transfer, fluids, dynamics, and electromagnetic devices, via both commercially available codes and student-written codes. Prereq: programming with FORTRAN; heat transfer;/or permission. (Also offered as ME 886 in alternate years.) 3 cr.

891. Prestressed Concrete
Design of prestressed and post-tensioned concrete sections in flexure and shear. Introduction to prestressing systems and ultimate strength methods. Prereq: CIE 893 or permission. 3 cr.

893. 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.

895, 896. Independent Study
A limited number of qualified graduate students will be permitted to pursue independent studies under faculty guidance. (May be repeated.) 1–4 cr.

900. 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.

922. 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: CIE 821 or permission. 2–4 cr.

930. Environmental Risk Analysis
Risk analysis involves the calculation of individual excess risk and the establishment of acceptable concentrations based upon epidemiological and animal studies. This course deals with practical application and theory. Appropriate topics from probability and statistics are reviewed. Prereq: probability and statistics for applications or equivalent. 4 cr.

940. Hydrologic Monitoring
Field course designed to familiarize the student with measurement of hydrologic variables in surface and ground water situations. Topics covered include weirs, stream gaging, dilution gaging, sampling of bed and suspended sediments, ground water/surface water interactions, well monitoring, borehole dilution measurements, ground water velocity and dispersion, unsaturated zone, well construction, and water quality measurements. Prereq: permission only. 3 cr. (Summer session only, in even-numbered years.)

942. River Mechanics
Geomorphic principles, erosion and sediment transport problems, sediment transport mechanics in pipes and open channels, sediment measurement techniques, sediment sources and yields, control methods, effects of structures on riverine systems, design of hydraulic structures. Prereq: fluid mechanics or permission. 3 cr.

943. 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.

945. Advanced Ground Water Topics
Review of Darcy's Law for confined and unconfined aquifers, linearization techniques, drawdown computations under varying boundary conditions, solutions to the inverse problem, drainage theory, recharge theory, two-phase flow, succession of steady states modeling, and borehole geophysics. Prereq: groundwater hydrology. 3 cr.

949. Chemistry of Natural Waters
Application of chemical principles to limnology 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: CIE 849 or equivalent. 4 cr.

955. 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 are examined. Prereq: CIE 856 or permission. Lab. 4 cr.

956. 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.

957. Advanced Water Treatment
The theory, application, and evaluation of physicochemical methods in the treatment of water. The unit processes of gas transform, coagulation, flocculation, sedimentation, filtration, activated carbon adsorption, and disinfection are analyzed at a fundamental level stressing recent advances and applications in the current literature. Prereq: CIE 849. 4 cr.

958. 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: CIE 846; CIE 957. Lab. 4 cr.

960. Advanced Soil Mechanics
Stresses and stress spaces. Stress-strain and strength behavior of sands and clays. Introduction to constitutive models for soils. Prereq: foundation engineering; earth structures;/or permission. 3 cr.

961. In Situ Geotechnical Testing
In situ geotechnical testing methods for site characterization; theory and practice. The geotechnical methods include the piezocone, the

pressuremeter, the dilatometer, the field vane, and the standard penetration test. Sampling techniques. Geophysical exploration. Prereq: CIE 960 or equivalent. 3 cr.

962. Soil Testing for Engineering Purposes
Modern techniques for measuring mechanical properties of soils in the laboratory. Instrumentation. Static shear strength and consolidation. Dynamic properties. Prereq: CIE 960 or permission. 3 cr.

963. Geological Engineering
Functional classification of rocks and rock masses. Stereographic projection. Engineering properties of rocks. Rock mechanics. The influence of geology in the design of underground excavations, tunneling, foundations, and rock slope engineering. Prereq: soil mechanics; prin. of geology;/or permission. 3 cr.

964. Theoretical Soil Mechanics
Constitutive laws for soils. Finite element methods for geotechnical engineering: theory and applications. Prereq: CIE 960; fundamentals of finite elements;/or permission. 3 cr.

965. Soil Stabilization and Site Improvement
Techniques for improving support and behavior characteristics of soils. Includes compaction, reinforcement, geofabrics, grouting, subsurface drainage, and admixtures. Prereq: CIE 860; CIE 861;/or permission. 3 cr.

966. Earth Dam Design
Flow through earth structures; Darcy's law, flow nets. Analytical techniques. Site selection, foundation problems, embankment stability analysis under static and earthquake conditions. Construction problems. Prereq: CIE 860; 861;/or permission. 3 cr.

967. 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: CIE 865; CIE 863;/or permission. 3 cr.

968. Offshore Geotechnical Problems
Techniques for sampling and testing of marine soils; design of offshore foundations. Stability problems under wave and earthquake loading. Prereq: CIE 863; CIE 865;/or permission. 3 cr.

969. Advanced Topics in Geotechnical Engineering
Seminar for advanced graduate students: presentations by students, faculty, and outside speakers on topics of current research interest. Prereq: CIE 960; 962; 964;/or permission. 3 cr.

981. Advanced Structural Analysis I
Advanced structural theory and analysis with computer applications, including multistory structures, beam columns, frames with variable moment of inertia, arches, rings, continuous curved beams, and curved frames. 4 cr.

982. 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.

983. 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.

984. 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: CIE 885 or permission. 4 cr.

985. 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.

990. Topics in Structures
Studies of topics of special interest and need of the student in structural design, analysis, and optimization. 2–4 cr.

995, 996. 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: Frederick C. Lewis
Associate Professors: Stephen N. Calculator; Frederick C. Lewis
Adjunct Associate Professors: Linda Hanrahan; Frederick P. Murray
Assistant Professors: Penelope Webster
Adjunct Assistant Professor: Richard Guare
Graduate Program Coordinator: Frederick C. Lewis

Degree Offered

The Department of Communication Disorders offers the master of science degree. 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 Requirements

Applicants for admission should possess a bachelor's degree in communication disorders or its equivalent. Applicants must submit Graduate Record Examination general test or Miller Analogies Test scores.

M.S. Degree Requirements

Required Courses The following courses are required of all students: 900, Articulation Disorders; 902, Stuttering; 903, Organic Pathologies in Children; 904, Neuropathologies of Speech and Language; 906, Voice Disorders; 912, Diagnosis and Remediation of Language Disorders; EDUC 981, Methods and Techniques of Educational Research.

Students who have not completed COMM 880, Diagnosis of Speech and Language Disorders, or its equivalent prior to enrolling in the master's program must complete this course as part of their program requirements.

Electives Electives 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.

Clinical Practicum Up to 6 credits may be completed in practicum registration. The specific number of credits needed by a student will depend on undergraduate program and experience. Students will be helped to gain the practicum requirements for certification by the American Speech, Language, and Hearing Association.

Written Examination All students except those selecting the thesis option 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. Upon completion of the research project, a student must defend the thesis in an oral examination and must gain approval of the thesis committee. Six credits will be awarded for satisfactory completion of a thesis.

800. American Sign Language II
Advanced phonology, syntax, and semantics of American Sign Language. Emphasis on grammatical processes that modulate meanings of signs in discourse and development of receptive language skills. Prereq: American Sign Language I; permission. 2 cr.

802. 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 800; permission. 2 cr.

880. Diagnosis of Speech and Language Disorders
Principles and practice for diagnosis of speech and language disorders; examination procedures and measurement techniques. 4 cr.

895. Special Topics in Communication Disorders
Advanced study in specific areas; involves an independent project. Prereq: permission. (May be repeated.) 1–3 cr.

900. Articulation Disorders
Phonological theories as they relate to analysis and remediation of articulation disorders. 3 cr.

902. Stuttering
Theoretical and therapeutic considerations of the stuttering syndrome; emphasis upon clinical management. Prereq: speech pathology II or permission. 3 cr.

903. Organic Pathologies in Children
Speech/language disorders associated with neuromotor and oro-facial pathologies in children; etiologies; methods of evaluation and treatment. 3 cr.

904. 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.

906. 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.

910. Clinical Practicum
Practicum provides graduate students with the 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.

911. Off-Campus Clinical Practicum
Application of advanced theoretical knowledge in an off-campus clinical setting. Prereq: permission. (May be repeated up to 6 cr.) 1–6 cr.

912. Diagnosis and Remediation of Language Disorders
Current diagnostic procedures and remediation techniques to evaluate and treat language disorders. 3 cr.

914. 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.

916. Advanced Clinical Audiology
Advanced clinical testing for identification of organic and nonorganic hearing disorders; instrumentation and calibration procedures; ISO and ANSI standards. 3 cr.

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

899. Master's Thesis
Prereq: permission. 6 cr.

Computer Science (CS)

Chairperson: Ted Martin Sparr
Professor: Shan S. Kuo; Ted Martin Sparr
Associate Professors: R. Daniel Bergeron; Eugene C. Freuder; Robert D. Russell; James L. Weiner
Assistant Professors: Pilar de la Torre; Raymond Greenlaw; Philip J. Hatcher
Adjunct Assistant Professors: Mohammad Ayab Khan; Sylvia Weber Russell
Graduate Program Coordinator: R. Daniel Bergeron

Degrees Offered

The Department of Computer Science offers programs leading to the master of science and the doctor of philosophy degrees. A major emphasis in these programs is the blending of theoretical and applied aspects of computer science. Students pursuing a specialization in computer science theory are required to develop a strong background in systems and are encouraged whenever possible to identify applications for theory. Similarly, students specializing in applied areas of computer science are required to base their work on strong theoretical foundations.

Admission Requirements

Applicants for the master's program are expected to have studied high-level language programming, assembler-language programming, data structures, analysis of algorithms, operating system fundamentals, programming language concepts, and discrete mathematics. Further experience in computer science, mathematics, and/or electrical engineering will also be expected. All applicants must submit general and subject test scores from the Graduate Record Examination.

Applicants for the Ph.D. program must have a strong academic record and a bachelor's or master's degree in computer science (or a closely related area with a strong concentration in computer science). All applicants must submit general and subject test scores from the Graduate Record Examination.

M.S. 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 CS 901-902 and CS 900 (a 1-credit graduate seminar). The thesis option requires six additional courses numbered 800 or above (three must be above 902), plus 6 credits of thesis work. The nonthesis option requires eight additional courses numbered 800 or above (four must be above 902), plus comprehensive examinations covering the two broad areas: systems and theory.

A maximum of three courses numbered 800 to 899 may be applied to the master of science degree in computer science.

Ph.D. Degree Requirements

Following the student's entrance into the program, a guidance committee will be appointed by the dean of the Graduate School to review the student's preparation for pursuing a particular program and to assist in outlining a program of study. The program of study will include courses in both the theoretical and applied aspects of computer science as determined by the guidance committee. Normally a student will be expected to complete at least the equivalent of 16 semester courses (of at least 3 credits each) beyond the bachelor's degree, or 8 courses beyond the master's degree.

In addition, each doctoral student is required to acquire competence in the use of a research tool determined by the guidance committee. The research tool should contribute to the student's dissertation research and is expected to consist of courses from disciplines outside computer science, such as mathematics, engineering, psychology, or linguistics, as determined by the guidance committee.

Each Ph.D. student must also acquire experience in teaching equivalent to at least one-half time for one year.

Every doctoral student must pass a written qualifying exam consisting of three parts: basic theory, basic systems, and an advanced exam in either theory or systems, depending on the student's proposed area of specialization.

A student is admitted to candidacy for the Ph.D. after successfully completing the qualifying examination and the research tool requirement. A doctoral committee will be appointed by the dean of the Graduate School for the purpose of approving and monitoring the candidate's dissertation work and administering the final dissertation defense. The doctoral candidate must make a formal presentation of the proposed research work, including both written and oral components, prior to undertaking the major research effort. Upon completion of the research, the candidate must present a written dissertation and a formal oral defense.

812. 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.

818. Software Engineering
Design approaches, implementation methodologies, and management techniques required to develop large, reliable software systems including applications-oriented systems. Team programming projects. Prereq: CS 822 or permission. 3 cr.

822. 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 assembly language programming and machine organization. 4 cr.

827. Computer Communications Software Design
Telecommunications software. Error detection algorithms. Asynchronous and synchronous communications software. Network architectures. Protocol definition and implementation. Links through a local area network. Timing considerations. Implementation of selected communications software. Prereq: operating system fundamentals. 4 cr.

830. 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.

846. 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.

853. 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. to data structures with C or scientific programming with FORTRAN or intro. to computer science II. (Also offered as MATH 853.) 4 cr.

854. Numerical Methods and Computers II
Mathematical software. Computer solutions of differential equations, eigenvalues and eigenvectors. Prereq: diff. equations with linear alg.; intro. to data structures with C or scientific programming with FORTRAN or intro. to computer science II. (Also offered as MATH 854.) 4 cr.

865. Semantic Issues in Natural Language Processing
Introduction to computational analysis of natural language, with a focus on semantic issues. Syntax and formal grammars, parsing, semantic representations, inference, memory. Ambiguity, metaphor, noun groups. Prerequisites: elementary knowledge of a programming language such as LISP or PROLOG, or permission. 4 cr.

870. 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: intro. to computer science or data structures and algorithms. 4 cr.

875. Database Techniques
Database 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: operating system fundamentals and either intro. to computer science or data structures and algorithms. 4 cr.

880. Topics in Computer Science
Offered on an irregular basis with varying content. 4 cr.

900. 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.

901. Fundamental of Computer Science I
Fundamental elements of computer science with particular emphasis on the interaction between theory and practice. Topics include data structures and data abstractions, analysis of algorithms, graph theory, and logic programming. 3 cr.

902. Fundamentals of Computer Science II
Fundamental elements of computer science with particular emphasis on the interaction between theory and practice. Topics include formal languages, automata theory, models of computation, logic, and program verification. 3 cr.

912. Advanced Compiler Design
In-depth study of automatically generated syntactic error recovery, intermediate representation, machine independent and machine dependent optimization, code generation, register allocation. Tools for generating code generators and Graham-Glanville style instruction selectors. Example of production code generators. Prereq: CS 812 or equivalent. 3 cr.

920. 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: CS 822 or equivalent. 3 cr.

927. Computer Networks
Distributed computer systems; techniques for connecting and controlling them. Tightly coupled systems to 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: EE 812 or equivalent; CS 822. 3 cr.

930. 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. 3 cr.

934. Logic Programming
Introduction to the foundation, implementations, and application of logic programming. Emphasis on the study of example applications. Application areas include compilers, databases and expert systems. 3 cr.

942. Parallel Computers and Computations
Models of parallel computation. Parallel computation thesis. Overview of parallel architectures. Mapping parallel algorithms onto networks. Parallel programming languages. Fifth generation computer systems. Prereq: CS 901-902. 3 cr.

958. 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 EE 958.) 3 cr.

965. 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.

970. Advanced Computer Graphics
Advanced image synthesis techniques and photorealism. Ray tracing. Complex shading and lighting models. Antialiasing. Texture mapping. Surface generation and display. 3 cr.

975. Database Systems
Access control techniques; access strategies; database software; database-related languages; data translation techniques; recovery and restart; restructuring; concurrent access methods; very large databases; performance and evaluation; protection and security. Prereq: CS 822 or 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.

980. Advanced Topics in Computer Science
3 cr.

981. Advanced Topics in Database Systems
3 cr.

983. Advanced Topics in Artificial Intelligence
3 cr.

984. Advanced Topics in Computer Science Theory
3 cr.

985. Advanced Topics in Operating Systems
3 cr.

987. Advanced Topics in Computational Linguistics
3 cr.

988. Advanced Topics in Computer Graphics
3 cr.

998. Reading Course
1–6 cr.

899. Master's Thesis
6 cr.

999. Doctoral Research
0 cr.

Earth, Oceans, and Space, Institute for the Study of (EOS)

The Institute for the Study of Earth, Oceans, and Space offers students the opportunity for interdisciplinary study and research. Certain graduate degree programs in earth sciences, forestry, and physics may be accessed through the institute: at both the master's and Ph.D. levels, the option in oceanography and the specialization in geochemical systems in earth sciences, and the specialization in space physics in physics; at the master's level only, the specialization in forest ecosystem dynamics in forestry. Admission and degree requirements are set by the respective departments. In addition, EOS students are required to participate in an EOS interdisciplinary seminar and are encouraged to elect specialized courses on the various components of the earth and space system. See page 20 for details concerning EOS, and the graduate program descriptions in earth sciences, forest resources, and physics for admission and degree requirements.

806. Introductory Dynamic Oceanography
Basic physical laws governing ocean and atmospheric circulation under the influence of Earth rotation, density stratification, and friction. Topics include surface waves, wind-driven and thermohaline ocean circulation, ocean/atmosphere interaction, instabilities, fronts, and climate. Simplified mathematical models will demonstrate the important principles. Prereq: college physics and differential equations or permission. 3 cr.

807. Global Ecosystem Policy
Scientific and institutional issues pertinent to global change; scientific basis for the global Earth and biogeochemical cycles that maintain Earth's thermostasis; long-term effects of major human perturbations (greenhouse warming of the atmosphere, ozone depletion, deforestation, desertification, and biotic and soil impoverishment) and human-environment feedback mechanisms on the viability of the Earth versus the survival of the human species; effectiveness of existing and alternative national, regional, and international institutions in responding to global change. Prereq: permission. 3 cr.

813. Biogeochemical Dynamics
Examines the influence of biological processes on geochemical transformations and elemental cycles from the molecular to the global scale involving both microorganisms and higher plants and animals; factors that regulate cycles; interactions among biosphere, hydrosphere, lithosphere, and atmosphere; transformations of C, N, S and trace elements. Prereq: one semester each biology and chemistry. 3 cr.

815. Atmospheric and Precipitation Chemistry
An interdisciplinary course concerned with understanding the physical and chemical processes that affect the composition of the atmosphere and precipitation and that are of fundamental importance to the atmosphere-biosphere-cryosphere-hydrosphere-lithosphere-anthrosphere systematics of planet Earth. Topics include tropospheric chemistry; stratospheric chemistry; chemistry of rain, snow, and fog; the ozone problem; and the acid rain problem. Prereq: one year college chemistry or permission. 3 cr.

817. Global Biogeochemical Modeling
Modeling the global system and the interactive processes between its components (atmosphere, hydrosphere, cryosphere, pedosphere, lithosphere, biosphere, and anthrosphere); sensitivity analyses of models to identify incompatibilities and interactive instabilities and comparison with observation from field studies and remote sensing; applying techniques involving large database management to estimate global productivity, simulate biogeochemical cycling, and detect vegetative stress in terrestrial ecosystems. Prereq: MATH 845-846 and permission. 3 cr.

854. Ocean Waves and Tides
Introduction to waves: small-amplitude, linear wave theory, standing and propagating waves, transformation in shallow water, energy and forces on structures, generation by wind and specification of a random sea, long waves with rotation, and internal waves. Introduction to tides: description of tides in ocean tidal generation forces, equilibrium tide, and tidal analysis. Lab/project: field and lab measurements with computer analysis. Prereq: gen. physics; differential equations;/or permission. (Also offered as OE 854.) Lab. 4 cr.

901. EOS Seminar
Introduction to the fundamental components of the Earth system, such as the biosphere, cryosphere, hydrosphere, and its environment in space. Basic concepts are presented in a lecture format by selected EOS faculty according to their research specialization. To familiarize the student with the literature in earth, ocean, and space science and engineering, students are expected to contribute to a discussion of current topics of interest in the literature. 3 cr.

955. Geophysical and Astrophysical Fluid Dynamics
The principles of fluid dynamics and magnetohydrodynamics, applied to the Earth's atmosphere and oceans and to space plasmas. Emphasis on common problems and techniques. Topics include mass, momentum, and energy conservation; static equilibriums; quasigeostrophic flow; waves (acoustic-gravity, planetary, magnetoacoustic); surface waves in the ocean and in space; instabilities (convective, baroclinic Rayleigh-Taylor, Kevin Helmholz); boundary layer problems (Ekman layers, Stewartson layers, tearing modes; resonance absorption); supersonic flows (the solar wind, shock waves). Prereq: MATH 845 and 846, or PHYS 931. 3 cr. (Not offered every year.)

995. Special Topics in Earth, Ocean, and Space Science
1–4 cr.

Earth Sciences (ESCI)

Chairperson: Herbert Tischler
Professors: Franz E. Anderson; Francis S. Birch; Wallace A. Bothner; Wendell S. Brown; S. Lawrence Dingman; Henri E. Gaudette; Francis R. Hall; Robert C. Harriss; Paul A. Mayewski; Herbert Tischler
Adjunct Professors: Eugene L. Boudette; Anthony Jack Gow; Berrien Moore III; Lincoln R. Page
Associate Professors: Jo Laird; Theodore C. Loder III; William Berry Lyons
Research Associate Professors: Mark E. Hines; James D. Irish; Neal R. Pettigrew
Adjunct Associate Professor: Mary E. Dowse
Assistant Professor: David A. Gust
Research Assistant Professors: Patrick M. Crill; Julie M. Palais; Mary Jo Spencer; Robert W. Talbot
Adjunct Assistant Professors: William B. Bowden; Judith A. Spiller
Graduate Program Coordinator: Francis S. Birch

Degrees Offered

The Department of Earth Sciences offers the master of science and doctor of philosophy degrees in earth sciences with options in geology and oceanography and a specialization in geochemical systems. The department also offers the master of science degree in hydrology.

Emphasis in the geology option may be placed upon petrology, mineralogy, structural geology, tectonics, geophysics, sedimentation, glacial geology, geomorphology, glaciology, hydrogeology, stratigraphy, paleontology, low- or high-temperature geochemistry, and isotope geochemistry.

Concentration in the oceanography option may be placed upon chemical, geological, or physical oceanography. Although the broad scope of oceanography will be presented, the program emphasizes estuarine, coastal, and continental margin processes and environments.

The hydrology major is intended for students with an interest in hydrology, water quality, quantitative hydrology, and water resource management.

The geochemical systems specialization is intended for students with an interest in all aspects of geochemistry: bedrock, sediment, water, ice, and air with particular emphasis on interpreting and modeling the interaction of these media. Students may access this specialization through the Institute for the Study of Earth, Oceans, and Space.

Admission Requirements

An applicant is expected to have completed one year each of college chemistry, physics, and calculus; to have an undergraduate major or equivalent in geology, chemistry, physics, mathematics, engineering, or the biological sciences; and to present 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 of study (geology, hydrology, oceanography, or geochemistry) a student wishes to follow as well as the student's undergraduate major determines the level of necessary preparation. The preparation of each student is determined before the beginning of the first semester in residence in order to plan the course of study. Each entering student is assigned an academic adviser who assists the student in planning a program of study. Normally, students are required to have completed a master's degree before entering the Ph.D. program.

M.S. Degree Requirements

Students in the M.S. programs are required to complete the core curriculum for their respective area. A minimum of 30 credits, which may include the credits accumulated in the core curriculum, must be completed satisfactorily. Eight credits must be taken at the 900 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.

Geology The core curriculum for the option in geology normally includes 832, Regional Geology and Advanced Structure; 834, Applied Geophysics; 841, Geochemistry; 997, 998, Seminar in Earth Sciences, 1 cr. each semester of the first year.

Hydrology The core curriculum for the major in hydrology usually includes 805, Principles of Hydrology; 810, Groundwater Hydrology; and 997, 998, Seminar in Earth Sciences, 1 cr. each semester of the first year.

Oceanography The core curriculum for the option in oceanography normally includes 852, Chemical Oceanography, 3 or 4 cr.; 858, Introductory Physical Oceanography; 859, Geological Oceanography; 997, 998, Seminar in Earth Sciences, 1 cr. each semester of the first year.

Geochemical Systems The core curriculum for the specialization in geochemical systems usually includes 841, Geochemistry; and 997, 998, Seminar in Earth Sciences, 1 cr. each semester of the first year.

In each of the above, additional electives are to be selected from 800- and 900-level courses in the department and/or from courses numbered 700 and above in related disciplines outside of the department.

Ph.D. Degree Requirements

Course requirements for the Ph.D. program are flexible and are determined by the student's individual guidance committee. In addition, students are required to (1) have a reading knowledge of an appropriate foreign language; (2) pass a qualifying examination, given generally after two years of study; (3) have a teaching experience equivalent to at least half time for one year; (4) complete significant original research presented in a dissertation; and (5) pass an oral defense of that work.

Emphasis in the Ph.D. program may be placed on geology, oceanography, or geochemical systems.

803. Fluvial Hydrology
Mechanics of flows in the hydrologic cycle. Natural open-channel flows: forces, energy principles, velocity profiles, flow resistance, erosion and sediment transport, 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.

805. Principles of Hydrology
Physical principles important in the hydrologic cycle, 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 aspects 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. 4 cr.

807. Aqueous Geochemistry
Processes that determine the geochemical characteristics of water bodies. Emphasis on the geochemical continuum of terrestrial water and its geochemical evolution. Topics include the influence of cyclic salts, the nature of weathering reactions, the CO_2-$CaCO_3$ system, the formation and dissolution of salts and authigenic mineral formation. Prereq: one year of chem. or geochem.;/or permission. 3 cr.

810. 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: ESCI 805 or permission. Lab. 4 cr.

825. Igneous Petrology
The origin, formation, and geologic history of igneous 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: optical mineralogy and petrography. Field trips. Lab. 4 cr.

826. Metamorphic Petrology
The origin, formation, and geologic history of metamorphic rocks; undertaken in same manner as ESCI 825 above. Prereq: optical mineralogy and petrography. Field trips. Lab. 4 cr.

832. Regional Geology and Advanced Structure
Readings, discussion, and field/lab exercises in the tectonic analysis of mountain systems. Emphasis on the northern Appalachian Orogen. Application of modern structural analysis. Prereq: structural geology or permission. Field excursion, lab fee. 4 cr.

834. 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.

841. Geochemistry
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. Prereq: one year of mineralogy or permission. 4 cr.

843. Thermodynamics in Geology
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. Lab involves mass spectrometric and chemical techniques of isotopic analysis. Course includes the completion of a laboratory project. 4 cr.

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

850. Biological Oceanography
Biological processes of the oceans including primary and secondary production, trophodynamics, plankton diversity, zooplankton feeding ecology, microbial ecology, and global ocean dynamics. Emphasis on experimental approaches. Term project involves either development of an ecosystem model or performance of a field experiment. Field trips on *R.V. Jere Chase* and to the Jackson Estuarine Laboratory. Prereq: one year of biol. or permission of instructor. (Also offered as ZOOL 850.) 4 cr.

852. 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 R/V *Jere A. Chase*. Prereq: permission. Lab (optional). 3 or 4 cr.

853. Geolimnology
Geological and geochemical aspects of lake systems, including formation of lake basins, water budgets, sediment derivation and dispersal, biogeochemical interactions in the water column and sediments, sedimentary record of lakes, chemical sedimentation in brackish and saline lakes, as well as lake sediments in the geologic record. 3 cr.

854. Modern Sediments
Examines recent sediments from their source area to the depositional environment. Emphasis on the shallow water clastic sediments and their characteristic properties. The weekly laboratory, conducted off campus at the Jackson Estuarine Laboratory, is concerned with aspects of textural and compositional analysis. New analytical techniques are compared with classical sediment analysis. Lab. 4 cr.

856. Estuarine Sedimentation
Examines all aspects of estuarine sedimentation from erosion and transportation to deposition. Emphasis on fine-grained estuarine sediments and factors affecting particulate matter transport. Animal/sediment and plant/sediment interactions are considered in detail. Includes an in-depth field research project in the student's area of interest conducted by graduate students with undergraduate participation at the Jackson Estuarine Laboratory. Subject matter is relevant to students in related disciplines where animal/plant/sediment relationships are important. Lab. 4 cr.

858. Introductory Physical Oceanography
A descriptive treatment of atmosphere-ocean interaction; general wind-driven and thermohaline ocean circulation; waves and tides; continental shelf and near-shore processes; instrumentation and methods used in ocean research. Simplified conceptual models demonstrate the important principles. Prereq: college physics; intro. oceanography;/or permission. 4 cr.

859. Geological Oceanography
Major geological features and processes of the ocean floor; geological and geophysical methods; plate tectonics. Prereq: permission. 4 cr.

862. 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.

863. 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 is 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.

871. 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.

895. 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; Y) Chemical Oceanography; Z) Glaciology, Advanced.

Advanced work on an individual or group basis under members of the graduate staff. Prereq: permission of dept. chairperson and staff concerned. 1–4 cr. (May be taken more than once.)

896. Topics in Earth Sciences
A) Thermodynamics in Geology; B) Earth Systems; C) Earth Resource Policy. 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.

903. 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 805; computer methods; basic statistics. 3 cr.

904. 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.

906. Statistical Hydrology
Application of statistical principles to hydrologic problems. Covers laws of probability; parameter estimation; discrete and continuous distributions of importance in hydrology, inference, regression and multivariate analysis, and elementary time series analysis. Prereq: ESCI 805; basic statistics;/or permission. 4 cr. (Offered alternate years.)

908. Water Resource Management
Hydrologic, economic, environmental, social, and legal aspects of water resource management; local, national, and global water resource problems. Prereq: ESCI 805; basic statistics;/or permission. 3 cr. (Offered alternate years.)

920. 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.)

921. 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.)

934. 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 834; elementary computer programming; differential equations recommended. 3 cr. (Not offered every year.)

942. 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.)

952. Advanced Chemical Oceanography
Readings on physical, chemical, and biological processes that affect the distribution of chemical components in estuaries and the open ocean. Lab includes projects investigating selected processes. Prereq: ESCI 852 or permission. 3 or 4 cr.

958. 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 858; ME 807;/or permission. 4 cr. (Not offered every year.)

959. Data Analysis Methods in Ocean and Earth Sciences
Methods of analysis of oceanographic, geophysical, geological, and environmental data. 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.

962. 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 or 4 cr. (Offered alternate years.)

995. Topics in Earth Sciences
Advanced work on an individual or group basis. Sections of this course are the same as those listed under ESCI 895. Prereq: permission of department chairperson and staff concerned. (May be taken more than once.) 1–4 cr.

996. Topics in Earth Sciences
Advanced work on an individual or group basis. Sections of this course are the same as those listed under ESCI 896. Prereq: permission of department chairperson and staff concerned. (May be taken more than once.) 1–4 cr.

997, 998. 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)

Chair of Graduate Programs: Evangelos O. Simos
Professors: Richard W. Hurd; Manley R. Irwin; Robert C. Puth; Kenneth J. Rothwell; Evangelos O. Simos; Dwayne E. Wrightsman
Associate Professors: Richard W. England; Marc W. Herold; Adrienne M. McElwain; Richard L. Mills; Allen R. Thompson; James R. Wible
Adjunct Associate Professor: Evangelos Charos
Assistant Professors: Bruce T. Elmslie; Neil B. Niman; Karen Smith

Degrees Offered

The economics program offers the master of arts and the doctor of philosophy degrees.

The master's program allows concentration in public policy, international and development economics, or heterodox economic theories. A student does not have to select a concentration.

The doctoral program offers research workshops in macroeconomics, political economy, econometrics, finance, international development, resource economics, and labor economics. Dissertation topics are usually developed from research performed in the workshop context.

Admission Requirements

In addition to requirements established by the Graduate School, the results from the Graduate Record Examination general test must be presented.

The master's program seeks students whose undergraduate experience provides evidence of superior ability and indicates the promise of serious scholarship. Undergraduate preparation will usually include exposure to economic reasoning and methodology, including mathematics and statistics. For those whose backgrounds are deficient, remedial work is available.

The doctoral program expects a master's degree in economics. Previous graduate study of economics is required.

M.A. Degree Requirements

Every student must meet the general requirements of the Graduate School and the following requirements of the major:

1) at least 30 total semester hours, which may include 8 hours of thesis;
2) of the total hours:
   a) A minimum of 12 hours *must* be in 900-level courses. Two of these courses must be ECON 973 and ECON 977.
   b) In addition, 2 hours *must* be in the Graduate Economics Seminar.
   c) a maximum of 4 credit hours *may* be taken in related disciplines in approved 700-level and above courses.
   d) the remaining credit hours are to be taken in 800-level and above courses.
3) Written evidence of proficiency in economic theory (either by passing the qualifying examination in economic theory or by completing a thesis).

Additional requirements are associated with the concentrations in public policy, international development, and heterodox economic theories. At least three electives from a prescribed list are required by each concentration. Further information about concentrations can be obtained from the program director. A concentration is not required.

Ph.D. Degree Requirements

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), four semesters (1 credit hour each semester) of the Graduate Economics Seminar, and demonstrated knowledge of one foreign language. At present, workshops exist in finance, political economy, labor economics, econometrics, international development, resource economics, and macroeconomics. Research workshops are intended to launch the student into the dissertation. The last formal public presentation in a workshop should be the dissertation proposal. Acceptance of the dissertation proposal is required in order to be advanced to candidacy.

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

807. Economic Growth and Environmental Quality
Analysis of the interrelationships among economic growth, technological change, population increase, natural resource use, and environmental quality. Application of alternative theoretical approaches drawn from the social and natural sciences. Focus on specific environmental problems, e.g., health effects of air pollution, environmental impact of technology transfer to less-developed nations. Prereq: intermed. microecon. and macroecon. analysis or permission. 4 cr.

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

815. Marxian Economic Analysis
Analyses of capitalism by Marx and contemporary Marxists. Discussion of social class, values and prices, technical change, capital accumulation, and socioeconomic crises. Prereq: intermed. micro. and intermed. macro.;/or permission. 4 cr.

820. 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: intermed. micro. and macro.;/or permission. 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.

827. Advanced Econometrics
Relatively advanced econometric techniques such as simultaneous equation models, distributed lag models, nonlinear estimation, and limited dependent variables. Prereq: intro. to quantitative econ. or ECON 926 or permission. 4 cr.

835. 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 (including term-structure theory), and macroeconomic models of the financial sector. Prereq: money and banking or permission. 4 cr.

836. Seminar in Monetary Theory and Policy
Contemporary developments in monetary theory and the evaluation of policy measures. Prereq: money and banking or permission. 4 cr.

845. International Trade
Contemporary issues in international economic theory and policy. Analysis of trade theory, dynamics of world trade and exchange, and international commercial policy. Prereq: international econ. or permission. 4 cr.

846. International Finance
International monetary mechanism; balance of payments, international investment; exchange rates, adjustment systems, international liquidity, foreign aid, multinational corporations. Prereq: prin. of econ. 4 cr.

847. Multinational Enterprises
The internationalization of economies. Growth and implications of the multinational corporation at the level of systems. Theories of imperialism, international unity/rivalry; theories of direct investment; the exercise of influence and conflict, technology transfer, bargaining with host country; effects on U.S. economy. Prereq: permission. 4 cr.

852. Technology, Information, and Public Policy
The U.S. as a post-industrial economy. Impact of microelectronics on manufacturing, distribution, employment, and competition; domestic and international policy implications of information transfer. 4 cr.

855. Collective Bargaining
Historical development of the U.S. labor movement and the industrial relations system. Contemporary collective bargaining issues; the role of public policy in industrial relations. 4 cr.

856. Labor Economics
Recent developments in labor market analysis and public policies related to contemporary labor issues. Labor supply, the structure and stratification of labor markets, economic discrimination, unemployment and poverty, inflation, and wage-price controls. Prereq: labor econ. or permission. 4 cr.

859. Economics of Work
Organization of work under capitalism. Competing management philosophies, response of workers to management practices. Satisfaction of workers with their jobs, trends in worker productivity, alternative work arrangements, and worker participation in management. Prereq: labor unions and the working class; labor econ.;/or permission. 4 cr.

868. 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.

869. 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.

898. Economic Problems
Special topics; may be repeated. Prereq: permission of adviser and instructor. 2 or 4 cr.

926. 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.

957-958. 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.

973. 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.

974. Economic Dynamics
Dynamic analysis of macro- and microeconomic models. Dynamic stability, disequilibrium dynamics, growth theory, and stochastic processes. Prereq: ECON 973; 977;/or equivalent. 4 cr.

977. 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.

978. 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 973; ECON 977;/or permission. 4 cr.

988. Graduate Economics Seminar
Required of all first-year graduate students. 1 cr.

995. Independent Study
1–6 cr.

996. 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: Bruce L. Mallory
Professors: Michael D. Andrew; Richard F. Antonak; Angelo V. Boy; Donald H. Graves; Roland B. Kimball; John H. Lawson; Carleton P. Menge
Associate Professors: Charles H. Ashley; John J. Carney; John G. Chaltas; Grant L. Cioffi; Ellen P. Corcoran; Ann L. Diller; Susan D. Franzosa; Jane A. Hansen; David J. Hebert; Judith A. Kull; Bruce L. Mallory; Sharon N. Oja; Richard L. Schwab; M. Daniel Smith; Deborah E. Stone; Dwight Webb
Adjunct Associate Professor: Richard H. Goodman
Assistant Professors: Nancy E. Ellis; Janet Elizabeth Falvey; Virginia E. Garland; Jane E. Nisbet; William L. Wansart
Graduate Program Coordinator: John J. Carney

Degrees Offered

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

The master of arts is offered in counseling. The master of arts in teaching is offered in elementary and secondary education. The master of education is offered in administration and supervision, counseling, early childhood education (including an option in special needs), elementary education, reading, secondary education, and special education. Special education certification is also available to those who complete the M.A.T. or M.Ed. programs in either elementary or secondary education.

The certificate of advanced graduate study is offered in counseling and in educational administration and supervision. The doctor of philosophy is offered in reading and writing instruction.

The master of science for teachers is offered through the departments of chemistry, English, mathematics, and physics; the master of science in music education is offered through the Department of Music. (See those departments for information.)

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.

Admission Requirements

In addition to the materials required by the Graduate School, each application must include recent Graduate Record Examination general test scores and a thoughtful, well-written statement of purpose for undertaking graduate study in a particular program.

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.

Action on applications to Department of Education programs varies by individual program. Admission to programs in early childhood education, educational administration and supervision, and reading is on a rolling basis. Applications for special education are acted on during the fall and spring semesters. Applications to programs in counseling and teacher education are normally acted on three times per year following Graduate School application deadlines although a summer meeting may not occur if openings for fall are full. 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.

Administration and Supervision

Program Information: Charles Ashley, Virginia Garland, Roland Kimball, John Lawson

The Department of Education offers the degree of master of education and the certificate of advanced graduate study in educational administration and supervision.

Master of Education The program is designed for the experienced teacher who wishes 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.

The requirements for the degree include the following:

Core Requirements (28 credits): 972, Educational Program Evaluation; 965, Educational Supervision; 953, Seminar in Curriculum Study; 961, Public School Administration; 963, Seminar in Educational Administration; 967, Legal Aspects of School Administration; and 969, Practicum in Educational Administration.

Electives (8 credits): selected in consultation with the program adviser.

Concluding Experience: A degree candidate must successfully complete one of the following: a comprehensive oral examination based on a set of theses statements prepared by the candidate or a major research study related to school administration, curricula, or educational supervision.

Certificate of Advanced Graduate Study 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. This program requires 40 credits.

The certificate program requires the following:

Core Requirements (16–20 credits): Courses are required in five areas of competency: institutional analysis, organizational behavior, policy analysis, managerial leadership, and instructional leadership.

Electives (8–12 credits): Electives are selected in consultation with the program adviser.

Concluding Experience (12 credits): A student must complete a significant field project and field internship in an appropriate administrative setting.

Counseling

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

The Department of Education offers the degrees of master of arts and master of education and the certificate of advanced graduate study in counseling.

The master of arts and the master of education programs prepare counselors to function in a variety of professional settings.

Master of Arts The master of arts in counseling program has the following requirements:

Core Requirements (48 credits): 920, Counseling Theory and Practice; 921, Psychology of Career and Personal Development; 922, Assessment in Counseling; 923, Group Counseling; 924, Psychological Disorders and Adaptation; 925, Counseling Internship I; 926, Counseling Internship II; 927, Theories of Personality; 928, Family Counseling; 929, Advanced Counseling Internship; 930, Research in Counseling; 931, Clinical Diagnosis and Treatment Planning in Counseling.

Electives (8 credits): Selected in consultation with the student's adviser. Additional coursework in statistics and research methodology is frequently required in order to complete the thesis.

Concluding Experience (6 credits): A degree candidate must complete a research thesis.

Master of Education The master of education in counseling requires the following:

Core Requirements (28 credits): 920, 921, 922, 923, 924, 925, and 926 (see course titles above under master of arts core requirements).

Electives (8 credits): Selected in consultation with the student's adviser.

Concluding Experience: A degree candidate must successfully complete a comprehensive essay examination.

Certificate of Advanced Graduate Study This program is being phased out during the next two years and is no longer accepting applications.

The certificate requirements for those students in the program are as follows:

Core Requirements (20 credits): 927, Theories of Personality; 928, Family Counseling; 929, Advanced Counseling Internship; 930, Research in Counseling; and 931, Diagnosis and Treatment Planning in Counseling.

Electives (12 credits): selected in consultation with the program adviser.

Concluding Experience: A candidate for the certificate must successfully complete one of the following: a written examination or a comprehensive oral examination based on a set of theses statements prepared by the candidate.

Early Childhood Education

Program Information: Deborah Stone, Bruce L. Mallory, Georgia Kerns

The Department of Education offers the master of education degree in early childhood education and an option in special needs.

The early childhood program primarily serves experienced child care workers who wish to improve their professional competence and broaden their career options. The program emphasizes field-based experience in local school districts, private nursery and kindergarten programs, day care centers, development centers, and special service facilities. This is coordinated with extensive coursework in related academic disciplines.

The program requirements are as follows:

Core Requirements (22 credits): 941, Child Development for the Early Childhood Professional; 943, Environment for Early Childhood; 946, Assessment in Early Childhood; 948, Contemporary Influences in Early Childhood Education; 900B, 901B, Internship and Seminar/Early Childhood (3 credits each).

Electives (14 credits): selected in consultation with the program adviser.

Special Needs Option Students who wish to specialize in the education and development of children with disabilities 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 children with special needs.

The option has the following requirements:

Core Requirements (34 credits): identical to core requirements of early childhood program with addition of 860, Introduction to Young Children with Special Needs; 947, Diagnosis and Educational Planning for Young Special Needs Children; and 949, Supporting Parents of Young Special Needs Children.

Electives (8 credits): selected in consultation with the program adviser.

Concluding Experience: A degree candidate must successfully complete one of the fol-

lowing: a comprehensive written and oral examination or a research thesis.

Reading

Program Information: John Carney, Grant Cioffi, Jane Hansen

The Department of Education offers the master of education degree in reading. This program provides professional training for individuals seeking certification as reading specialists: as teachers of reading, clinicians, and consultants.

The program's requirements are as follows:

Core Requirements (28 credits): selected from the following: 907, Foundations of Reading Instruction; 908-909, Clinical Diagnosis and Remediation of Reading Difficulties and Disabilities; 910, Comprehensive Reading Methods in the Secondary School; 913, Field Practicum; 914, Seminar in Reading. Choose one of the following: 834, Children's Literature; 876, Reading for Children with Special Needs; 906, Language Arts through Reading and Writing; 915, Reading and the Adult Learner.

Electives (8 credits): selected in consultation with the program adviser. 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: a written examination or a research thesis.

Reading and Writing Instruction

Program Information: John Carney, Grant Cioffi, Donald Graves, Jane Hansen

The Department of Education offers the Ph.D degree 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.

Degree Requirements 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 coursework and a third year of doctoral research.

Concluding Experience: Each degree candidate must successfully complete and defend a doctoral dissertation in accordance with Graduate School policy.

Special Education

Program Information: Richard Antonak, Bruce Mallory, Jan Nisbet, William Wansart

The special education program prepares special education teachers certified at the master's degree level to provide specialized educational services for children and young adults with disabilities. Graduates will be certified in general special education and may obtain additional endorsements in the areas of mental retardation or emotional handicaps.

Degree Requirements

Prerequisites: All candidates who are not certified teachers are required to complete a course in mathematics teaching methods and a course in reading teaching methods. All candidates who have not already done so are required to complete an introductory course in exceptionality (e.g., 850, Introduction to Exceptionality) and an introductory course in special education (e.g., 851, Educating Exceptional Learners) with credits not to be counted toward the M.Ed. degree.

Core Requirements (11 credits): 939, Assessment of Children with Learning Difficulties; 940, Teaching Children with Learning Difficulties; 900C, Internship and Seminar/General Special Education.

Special Courses (11 credits): Selected in consultation with the program adviser in general special education, mental retardation, or emotional handicaps, including a second internship in the appropriate area.

Advanced Courses (6 credits): 938, Advanced Seminar in Special Education; 981, Methods and Techniques of Educational Research.

Electives (8 credits): Selected in consultation with adviser. Students with no previous teaching certificate must complete at least 8 credits in elementary or secondary education in addition to reading and mathematics prerequisites.

Concluding Experience: All degree candidates must pass a written comprehensive exam, in addition to one of the following: a major curriculum project with a defense, or a research thesis. The thesis typically involves an additional 6–10 credits of coursework.

Teacher Education

Program Information: Michael Andrew, Richard Schwab, Randall Schroeder

The Department of Education offers the master of arts in teaching degree in elementary and secondary education for those seeking certification and the master of education degree in elementary and secondary education both for those seeking teacher certification and for certified teachers.

Applicants for teacher education programs should have the following: an undergraduate grade-point average of at least 2.75; combined scores on the verbal and quantitative sections of the Graduate Record Examination of 900 or above; and three strongly supportive letters of recommendation. Those seeking admission to programs leading to teacher certification should also have a positive recommendation from EDUC 500, Exploring Teaching, or its equivalent.

Beginning in fall semester, 1990, any course taken in the Department of Education that will be used for a teacher certification requirement must be completed with a grade of B- or better.

Master of Arts in Teaching and Master of Education Programs for Those Seeking Teacher Certification These programs are designed for two types of students: (1) those who entered the Five-year Teacher Preparation Program at UNH and (2) those who completed an undergraduate degree either at UNH or elsewhere with little or no coursework in education. The programs lead to certification for teaching at the elementary and secondary levels.

Certification requirements that must be met prior to or as part of the master's degree program include completion of four credits or an equivalent in each of the following: 500, Exploring Teaching; 800,

Educational Structure and Change; 801, Human Development and Learning: Educational Psychology; 803, Alternative Teaching Models; 805, Alternative Perspectives on the Nature of Education; 900A, 901A, Internship and Seminar/Teaching (6 credits each).

Elementary teacher certification requirements include two additional courses: 806, Introduction to Reading Instruction in the Elementary Schools, or 907, Foundations of Reading Instruction; and one mathematics course appropriate to preparation for teaching in an elementary school.

All students recommended for teacher certification receive academic preparation in working with exceptional children, which is integrated throughout certification coursework. Those pursuing teacher certification in art, biology, chemistry, earth sciences, general science, home economics, physical education, physics, or social studies must also complete EDUC 807, Teaching Reading through the Content Areas (2 credits).

The seven-week Live, Learn, and Teach summer program's 10 credits (4 credits of 935, Seminar and Practicum in Secondary School Teaching; or 936, Seminar and Practicum in Elementary School Teaching; 2 credits of 800A, Educational Structure and Change; 2 credits of 803H, Experiential Curriculum; and 2 credits of 805M, Readings in Philosophies of Outdoor Education) may be applied toward the master's degree. The Live, Learn, and Teach program satisfies the Exploring Teaching requirement.

Preparation for *certification in general special education* is available to those who complete the M.A.T. or M.Ed. programs in either elementary or secondary education. This certification allows recipients to serve as special education resource room teachers. In order to qualify for certification in general special education, students must complete 22 credits (18 of which may be used toward the M.Ed. degree, or 6 toward the M.A.T. degree); 850, Introduction to Exceptionality; 851, Educating Exceptional Learners; 939, Assessment of Children with Learning Difficulties; 940, Teaching Children with Learning Difficulties; 900, 901, Internship and Seminar (6 credits).

Master of Arts in Teaching for Those Seeking Certification (Elementary and Secondary) The master of arts in teaching program is most appropriate for students who wish to do a portion of their graduate study outside the Department of Education in their major teaching field or associated fields.

The program has the following requirements:

Core Requirements (12–40 credits): selected from the following: 800, Educational Structure and Change; 801, Human Development and Learning: Educational Psychology; 803, Alternative Teaching Models (or required methods course); 805, Alternative Perspectives on the Nature of Education; 900A, 901A, Internship and Seminar/Teaching; (in addition, for elementary certification: 806, Introduction to Reading Instruction in the Elementary Schools, or 907, Foundations of Reading Instruction; and one appropriate mathematics course). Twelve credits outside the Department of Education related to the student's teaching field are selected to form a concentration.

Electives (up to 6 credits): selected in consultation with the program adviser.

Concluding Experience: A degree candidate must successfully complete one of the following: a project related to the internship, a comprehensive oral examination based on a set of theses statements prepared by the student, or a research thesis (6–10 credits).

Master of Education for Those Seeking Certification (Elementary and Secondary) This master of education degree is most appropriate for those students who wish to concentrate their graduate study in the Department of Education.

The program has the following requirements:

Core Requirements (12–40 credits): Core requirements are identical to those for the master of arts in teaching degree for those seeking certification. Twelve credits within the Department of Education are selected to form a concentration. Elementary education candidates may apply 806 or 907 toward this concentration.

Electives (up to 6 credits): selected in consultation with the program adviser.

Concluding Experience: Concluding experiences are the same as those for the master of arts in teaching degree.

Master of Education for Certified Teachers (Elementary and Secondary) The elementary and secondary education programs for certified teachers are most appropriate for those holding teaching certificates who intend to become or continue to be classroom teachers.

The program has the following requirements:

Core Requirements (12 credits): selected from the following: 885, Educational Tests and Measurements; 953, Seminar in Curriculum Study; 983, Advanced Psychology of Human Learning; 984, Advanced Human Development; 986, Philosophy of Education; and SOC 938, Sociology of Education: Social Organization of Schools and Community.

Electives (18 credits): selected in consultation with the program adviser.

Concluding Experience: A student must successfully complete one of the following: a comprehensive oral examination based on a set of theses statements prepared by the student, or a research thesis (6–10 credits). A student using the research thesis option will normally use elective credits for 981, Methods and Techniques of Educational Research; and 899, Master's Thesis.

800. 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; nature 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.

801. 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) Deliberate Psychological 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 minicourses offered 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 (801A). 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.

803. 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 School Science; G) Language Arts for Elementary Teachers; H) Experiential Curriculum; I) Children with Special Needs: Teaching Strategies; K) Writing Across the Curriculum; L) LOGO and Learning; M) Teaching Elementary School Social Studies. 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. Candidates for teacher certification should be aware that each certification area has a specified methods course required for that area, e.g., all elementary education candidates need to complete 803F and 803M; English certification candidates must complete ENGL 892, Teaching Secondary School English. Contact the Dept. of Education for a complete list of the required methods course for each certification area. 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.

805. Alternative Perspectives on the Nature of Education
A) Contemporary Educational 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; contemporary 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 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.

806. Introduction to Reading Instruction in the Elementary Schools
Reading 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.

807. Teaching Reading through the Content Areas
Approaches and methods for teaching reading through content materials; coursework includes practical applications through development of instructional strategies and materials. Required for candidates seeking certification in art, biology, chemistry, earth science, general science, home economics, physical education, physics, or social studies. 2 cr.

820. Introduction to Computer Applications for Education
Major issues related to classroom computer applications: historical development; computer functioning; methods of instruction, problem solving, educational software development and evaluation, psychological and sociological impact of the computer on children and learning. Introduction to classroom applications of the programming language LOGO and the authoring language PILOT. A practical approach is stressed. Lab. 4 cr.

833. 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.

834. 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.

841. 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.

842. 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.

850. Introduction to Exceptionality
Social, psychological, and physical characteristics of exceptional individuals including intellectual, sensory, motor, health, and communication impairments. Implications for educational and human services delivery. 4 cr.

851. Educating Exceptional Learners
Foundations of special education and introduction to the techniques of special teaching. Primary application to learners with mild and moderate handicaps. 4 cr.

852. 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.

853. 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.

854. Survey of Developmental Disabilities
The causal factors, physical and psychological characteristics, and educational and therapeutic implications of mental retardation, cerebral palsy, epilepsy, autism, and related handicapping conditions. Observations of programs and services for the developmentally disabled are required. 4 cr.

860. Introduction to Young Children with Special Needs
The needs of children (birth to eight years) with developmental problems or who are at risk for disabilities. Strengths and special needs of such children; causes, identification, and treatment; current legislation; parent and family concerns; program models. 4 cr.

864. 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.

876. 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.

881. Probability and Statistics
Introductory-level coverage of applied probability and statistical methods. Problems are selected from many disciplines, with a focus on the behavioral and social sciences, to illustrate the logic and typical application of the techniques. Understanding concepts is emphasized through analyses of prepared data. 4 cr.

885. 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.

891. Methods of Teaching Secondary Physical Science
Application of theory and research findings in science education to classroom teaching with emphasis on inquiry learning, developmental levels of children, societal issues, integration of technology, critical evaluation of texts and materials for science teaching, and planning for instruction. Lab. 4 cr.

897. 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.

900, 901. Internship and Seminar
A) Internship and Seminar/Teaching: a two-semester, full-time, supervised internship consisting of less-than-full-time teaching responsibility in selected educational settings and programs. Weekly seminars and occasional workshops held concurrently with internship. B) Internship and Seminar/Early Childhood; C) Internship and Seminar/General Special Education; D) Internship and Seminar/Emotional Handicaps; E) Internship and Seminar/Mental Retardation; F) Internship and Seminar/Secondary Special Education. Admission by application. 3 or 6 cr.

906. Language Arts through Reading and Writing
Teaching practices in reading, writing, listening, and oral language. Language development and application to school learning environments. 4 cr.

907. 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.

908-909. 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 907; 910;/or permission. 4 cr.

910. 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.

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

914. Seminar in Reading
Investigation of current research findings in reading and the related language arts. Seminars 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.

915. 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 involves a case study in which students examine an extant program or develop a new course of study that addresses a particular need in adult reading education. Prereq: permission. 4 cr.

918-919. 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.

920. Counseling Theory and Practice
Basic approaches to counseling are examined —their theoretical foundations, process components, goals, and outcomes. 4 cr.

921. 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.

922. 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.

923. 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 920; permission. 4 cr.

924. Psychological Disorders and Adaptation
The development of effective and ineffective human functioning is examined. 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.

925. 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.

926. 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.

927. Theories of Personality
Structure of personality and the dimensions along which individuals may vary; implications for the counseling process. 4 cr.

928. Family Counseling
Introduction to the theories, processes, goals, outcomes, and problems of family counseling. Prereq: EDUC 920. 4 cr.

929. Advanced Counseling Internship
Supervised application of advanced counseling theory and practice in counseling relationships. Samplings of the advanced counseling practices of students are analyzed and evaluated. Prereq: permission. 4 cr.

930. 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.

931. Clinical Diagnosis and Treatment Planning in Counseling
A comparative review of major diagnostic classifications in the Diagnostic and Statistical Manual of Mental Disorders, third edition (DSM-III). Lectures, readings, and simulated cases will illustrate differential diagnoses, with examination of the current status of treatment approaches for specific disorders. Prereq: EDUC 922 or permission. 4 cr.

932. Administration and Professional Issues in Counseling
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.

935. 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 instruction 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 Live, Learn, and Teach program. 4 cr. (Summer Session only.)

936. 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. 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 high school students are available for candidates who wish to determine better what level of teaching they prefer. Prereq: admission to the Live, Learn, and Teach program. 4 cr. (Summer Session only.)

938. Advanced Seminar in Special Education
Biweekly seminars on specialized and advanced topics related to the assessment of exceptional learners, the prescription and implementation of educational interventions, and evaluation of special education service delivery systems. Prereq: permission. 2 cr.

939-940. Assessment and Teaching of Children with Learning Difficulties
A two-semester course to develop teacher competency to analyze learners and learning environments; specify learner characteristics; and design, implement, and evaluate appropriate educational interventions in the areas of language, mathematics, reading, behavior, and social skills. Focus on children with mild and moderate learning difficulties in regular class and resource rooms. Prereq: EDUC 850; 851;/or permission. 4 cr.

941. 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 home visits to interview parents and other relatives and to observe the child 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.

943. 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.

945. 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.

946. Assessment in Early Childhood
Students study, administer, and design a range of assessment materials; develop strategies for selection and utilization of clusters of assessment materials; and collect and organize relevant data. Prereq: EDUC 941 or equivalent; EDUC 943. 4 cr.

947. 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 860; 941;/or equivalent. 4 cr.

948. 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.

949. Supporting Parents of Special Needs Children
Social, economic, and psychological consequences of raising a child with a handicapping condition. Issues include diagnosis and prognosis for the child, parent-child attachment, and interactions with other care givers. Counseling and support techniques. 4 cr.

951. 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.

952. Models of Intervention for Children with Behavior Disorders
A comparative analysis of models of teaching behavior-disordered students, focusing on an understanding of the theoretical foundation of each model and procedures for implementation with behavior-disordered students. Prereq: EDUC 853 or permission. 4 cr.

953. 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.

955. Teaching Students with Mental Retardation
Application of theory and research in the field of mental retardation to classroom teaching: functional curriculum design, behavioral and instructional strategies, program development, integration of related services, and pre- and post-school transition planning. Prereq: EDUC 854 or permission. 4 cr.

956. Program Development and Administration in Special Education
Analysis and application of techniques for program development and administration, including grantsmanship, program planning, staff supervision, program evaluation, fiscal management, and statutory issues. 4 cr.

958. 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.

959. Curriculum and Instruction in Secondary Special Education
An analysis of forces and factors affecting secondary special education curriculum, the theoretical constructs of curriculum models, and the practical aspects of development and modification of curriculum for meeting the needs of learners with special needs. 4 cr.

961. 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.

962. 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 961. 4 cr.

963. 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 considera-

tions, minorities, and rural and urban problems. Prereq: EDUC 961 or permission. 4 cr.

964. Personnel and Communication in Educational Organizations
Problems arising from the communications process. Implications of group problem-solving processes. Interpersonal relations and group dynamics among students, faculty, staff, administration, and the community. Application of theories. 4 cr.

965. Educational Supervision
Theoretical foundations and practical applications of supervisory and instructional practices and procedures; consideration of instruments and techniques. Each student conducts a field supervision project. Prereq: teaching experience or permission. 4 cr.

966. 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 953; EDUC 965; permission. 4 cr.

967. 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, state agencies, supervisory unions, school districts, school boards, teacher employment, negotiations, student rights, tort liability, school finance. 4 cr.

968. 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 963. 4 cr.

969. Practicum in Educational Administration
Supervised practical experience in planning and implementing student-initiated field projects. Prereq: All core requirements. 4 cr.

970. 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 are required to apply some of the theories in an institutional setting. 4 cr.

971. School Facilities Management
Techniques and procedures involved in the long-range planning of school facilities: for example, school populations 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 963 or permission. 4 cr.

972. Educational Program Evaluation
Selected models for educational program evaluation; rationale underlying these models examined and compared; practical applications developed. Each student plans a complete evaluation design for an appropriate educational program. Prereq: EDUC 953; EDUC 961;/or permission. 4 cr.

973. Analysis of Education Policy
Policy systems and disciplinary perspectives shaping the development and enactment of education policy at the federal, state, and local levels. Prereq: EDUC 970 or permission; EDUC 969. 4 cr.

974, 975. 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. Supervision 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.

980. 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.

981. 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.

983. 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 801 or equivalent. 4 cr.

984. 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 801; intro. to psych.;/or equivalent. 4 cr.

986. 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.

990. 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. Prereq: permission. 4 cr.

995. 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.

998. Special Topics in Education
Study of a particular theoretical, methodological, or policy issue. May be offered off campus as professional development. 1–4 cr.

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

999. Doctoral Research

Electrical and Computer Engineering (EE)

Chairperson: John L. Pokoski
Professors: Ronald R. Clark; Albert D. Frost; Glen C. Gerhard; W. Thomas Miller III; Joseph B. Murdoch; John L. Pokoski; Kondagunta Sivaprasad
Adjunct Professor: Sidney W. Darlington; Robert E. Levin
Associate Professors: Kent C. Chamberlin; Allen D. Drake; Filson H. Glanz; L. Gordon Kraft; John R. LaCourse; Donald W. Melvin; Paul J. Nahin; Andrzej Rucinski
Assistant Professors: Michael J. Carter; Richard A. Messner; Weicheng Shen
Adjunct Assistant Professor: Stuart M. Selikowitz
Graduate Program Coordinator: Kondagunta Sivaprasad

Degree Offered

The Department of Electrical Engineering offers a program of study leading to the master of science degree. Those who wish to pursue doctoral work should refer to the engineering Ph.D. program.

The department offers studies leading to specialization in the following major areas: biomedical engineering, communication systems and information theory,

computer engineering and digital systems, image processing and pattern analysis, control and systems engineering, fiber optics, electromagnetics, geophysical sensing and propagation, illumination engineering, and ocean engineering and instrumentation.

Admission Requirements

An applicant 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.

M.S. Degree Requirements

Each student meets with a faculty adviser to set up a program of study. No specific course requirements are mandated. Normally, a minimum of 12 credits of 900-level courses is required, not including thesis or project.

The department considers the development of professional communication skills through technical presentations a basic component of a graduate education. Every master's student is required to participate in seminars or course lectures as needed to satisfy the technical presentation requirement.

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 (EE 899) or (2) a minimum of 27 credits of coursework plus a 3-credit, one-semester project (EE 995). 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 EE 995.

Permission of instructor is required for enrollment in all electrical and computer engineering courses taken for graduate credit.

804. 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 I. 4 cr.

805. 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 fabrication technology. Prereq: gen. physics; adv. electronics, electromag. fields and waves;/or equivalent. 4 cr.

811. Digital Systems
Digital design principles and procedures, including top-down design techniques, prototyping and documentation methods, and realistic considerations such as grounding, noise reduction, loading, and timing; digital design and development tools; computer-aided design using microprocessor development systems and engineering workstations including practical experience with state-of-the-art design automation systems. Prereq: computer organization. Lab. 4 cr.

812. Advanced Digital System Design
Further development and application of concepts introduced in EE 811. A semester project involving the design and development of a microprocessor-based system or an ASIC (Application-Specific Integrated Circuit) device is required. Classroom emphasis is on creative design techniques, troubleshooting strategies, and current microcomputer, off-the-shelf, PLA, and semi-custom VLSI technology. Students make oral presentations and write formal engineering reports. Prereq: EE 811. Lab. 4 cr.

814. Real-Time Computer Applications
Organization and programming of real-time computer-based systems. Special purpose peripherals, digital filters, program and data organization, priority interrupt processing of tasks, real-time monitor systems. Applications to communication, automated-measurement, and process-control systems. A semester design project is required. Prereq: computer organization; programming experience. Lab. 4 cr.

817. Introduction to Digital Image Processing
Digital image representation; elements of digital processing systems; sampling and quantization, image transformation including the Fourier, the Walsh, and the Hough transforms; image enhancement techniques including image smoothing, sharpening, histogram equalization, and pseudo-color processing; image restoration fundamentals. Prereq: elec. networks; random processes in elec. eng.; intro. computer programming or equivalent. Lab. 4 cr.

841. 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 ME 841.) 4 cr.

845. 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 control; ultrasonics; architectural acoustics. Prereq: general physics II; differential equations. Lab. 4 cr.

857. 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. Lab. 4 cr.

858. 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: electromag. fields and waves I; EE 857 or equivalent. Lab. 4 cr.

860. Introduction to Fiber Optics
Basic physical and geometric optics, solution of 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: physics; differential equations with linear algebra; electricity and magnetism or electromagnetic fields and waves. Lab. 4 cr.

861. Optical Engineering
First-order imaging optics, thin and thick lenses, aberrations, mirrors, stops, apertures, gratings, prisms, resolution, interferometry, diffraction, ray tracing, design of optical instruments, image evaluation, modulation transfer function, optical system design by computer. Prereq: physics; differential equations; introduction to computer programming or equivalent experience. Lab. 4 cr.

862. Illumination Engineering
Radiation, spectra, wave and particle nature of light, physics of light production, light sources and circuits, luminaires, science of seeing, color theory, measurements, control of light, light and health, lighting calculations. Prereq: differential equations with linear algebra and physics. Lab. 4 cr.

863. Lighting Design and Application
Lighting design process, modeling, interior and exterior lighting calculation and design, flux transfer, form and configuration factors, lighting quantity and aesthetics, daylighting calculations, lighting economics, lighting power and energy analysis, selected applications of light in interior and exterior spaces. Prereq: EE 862. Design lab. 4 cr.

871. Linear Systems and Control
Fundamentals of linear system analysis and design in both continuous and discrete time. Design of feedback control systems. Topics include modeling; time and frequency analysis; Laplace and Z transforms; state variables; root locus; digital and analog servomechanisms; proportional, integral, and derivative controllers. Demonstrations and computer simulations included. (Also offered as ME 871.) 3 cr.

872. Control Systems
Extension of EE 871 to include more advanced control system design concepts such as Nyquist analysis; lead-lag compensation; multi-input/multi-output systems; state feedback; parameter sensitivity; controllability; observability; decoupling; introduction to nonlinear and modern control. Includes interactive computer-aided design and real-time digital control. Prereq: EE 871. (Also offered as ME 872.) Lab. 4 cr.

875. 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.

881. 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. (Also offered as OE 881.) 4 cr.

884. 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 biotelemetry, ultrasonic diagnosis, and computer applications. Lab. 4 cr.

885. 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 OE 885.) 4 cr.

886. Introduction to Radio Astronomy
Electromagnetic radiation, propagation. Positional astronomy and the radio sky, discrete radio sources, source-structure distribution, the sun as a radio source, flare and burst activity, planetary emissions, quasars, pulsars, techniques of observation and data reduction, radiometry, polarimeters, correlation interferometers, aperture synthesis. 4 cr.

887. Analysis and Design of Human Physiological Control Systems
Analysis and design of human physiological control systems and regulators through mathematical models. Identification and linearization of system components. Membrane biophysics. Design of feedback systems to control physiological states through the automatic administration of drugs. System interactions, stability, noise, and the relation of system malfunction to disease. Prereq: EE 871. 4 cr.

896. Special Topics in Electrical Engineering
New or specialized courses and/or independent study. 1–4 cr.

901. Electromagnetic Field Theory
Maxwell's equations; plane wave propagation; reflection and refraction; guided wave propagation; wave guides; simple resonators; elements of microwave circuits, linear and aperture antennas, arrays of dipoles; receiving antennas. Prereq: electromag. fields and waves I or equivalent. 3 cr.

902. Electromagnetic Wave Theory
Selected advanced topics in electromagnetic wave theory taken from such areas as antennas, propagation in various media, diffraction and scattering, microwave generation and waveguide propagation. Prereq: EE 901. 3 cr.

911. Fundamentals of Signal Processing
Matrices and determinants, introductory graph theory. Laplace transforms and pole-zero concepts, complex variable theory, convolution, concept of state, formulation and solution of state equations. 3 cr.

912. Filter Design and Synthesis
Network theoretical techniques basic to the design of electrical filters of various sorts and transfer synthesis techniques. Approximation theory, sensitivity, RC-amplifier filters, passive simulation, adaptive and tracking filters, analog sampled data, high frequency, digital. 3 cr.

915. Advanced Active Circuits
Investigation of devices and techniques used in advanced circuit design using discrete solid-state devices and integrated circuits. Oscillators, phase-locked systems, low noise techniques, etc. 3 cr.

920. Illumination Design
Advanced illumination design; task visibility levels, bidirectional reflectance factors, contrast rendition factor, equivalent-sphere illumination, visual performance criteria, visual comfort probability, daylighting systems, inverse-square-law approximating techniques, luminaire effectiveness, and lighting energy budgets. Students write computer programs and lighting design projects. Prereq: EE 862 or equivalent experience. 3 cr.

933-934. 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.

936. Biomedical Engineering
Applications of engineering in such areas as surgery, critical-care units, neurophysiology, rehabilitation, modeling, and interaction of waves and biological tissues. Prereq: EE 884 and human anatomy and physiology or equivalent. 3 cr.

939. Statistical Theory of Communications
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.

940. Information Theory
A continuation of EE 939. Introduction of information-theory concepts. Topics include message sources, entropy, channel capacity, fundamentals of encoding, Shannon's theorems. Prereq: EE 939. 3 cr.

941. Digital Signal Processing
Introduction to digital signal processing theory and practice, including coverage of discrete-time signals and systems, the z-transform, the discrete Fourier transform. Brief coverage of digital filters and terminology, random number generators and signal models, the FFT, the pitfalls of using the FFT, and applications of digital signal processing including convolution, correlation, power spectral estimation. Prereq: programming experience, communications, basic probability. 3 cr.

942. 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 ME 942.) 4 cr.

944. 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: EE or ME 951. (Also offered as ME 944). 4 cr.

951. 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: EE or ME 872. (Also offered as ME 951.) 3 cr.

952. Advanced Control Systems II
Special topics in control theory: continuous and discrete systems; optimal control systems, including calculus of variations, maximum principle, dynamic programming, Wiener and Kalman filtering techniques, stochastic systems, adaptive control systems. Prereq: EE or ME 951. (Also offered as ME 952.) 3 cr.

955. 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, Wiener and Kalman filters, combined estimation and control, prediction, parameter identification, and nonlinear filtering. Prereq: ME or EE 951; MATH 835 or equivalent. (Also offered as ME 955.) 3 cr.

958. 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-bounded and push-down automata; cellular and reproducing automata. Prereq: programming experience. (Also offered as CS 958.) 3 cr.

960. 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.

961. Advanced VLSI
Principles of VLSI systems design at the physical level. CMOS circuit and logic design, structured design and testing, symbolic layout systems, CMOS system case studies. Prereq: EE 811 or equivalent. 3 cr.

962. Fault-Tolerant Computers
Test generation, design for stability, fault simulation, fault-tolerant systems, system diagnosis. An individual computer project is required. Prereq: computer organization. 3 cr.

965. Introduction to Pattern Recognition
Machine classification of data, feature space representation, multi-spectral feature extraction, Bayes decision theory, linear discriminant functions, parameter estimation, supervised and unsupervised learning, clustering, scene analysis, associative memory techniques, and syntactic methods of recognition. Prereq: Fourier analysis; multi-dimensional calculus; probability and statistics or equivalents. 3 cr.

970. Introduction to Optical Signal Processing
Theory and application of optical signal processing; foundations of scalar diffraction theory, the angular spectrum of plane waves, Fourier transforming properties of lenses, spatial filtering and optical information processing, the Vander-Lugt filter, holography principles and application, optical computers. Emphasis on coherent processing. Prereq: EE 941 or EE 857. 3 cr.

980. Opto-Electronics
Interaction between light waves and electronics; theory and specific applications for analysis and design of the following: optical communication systems, opto-electronic sensing instruments, and various optical effectors, such as laser scalpels and coherent light guns. Prereq: advanced electronics, EE 804 or EE 860 or PHYS 804;/or permission. 3 cr.

995. 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.

998. 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

Degree Offered

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. Students in systems design 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.

Problems addressed in the other four areas of specialization follow the four classical departmental boundaries. Interested applicants should contact the area coordinator for information on current research activities in the area of interest.

Chemical Engineering: Stephen S. T. Fan, area coordinator.
Civil Engineering: Pedro A. de Alba, area coordinator.
Electrical Engineering: Kondagunta Sivaprasad, area coordinator.
Mechanical Engineering: John McHugh, area coordinator.
Systems Design: Charles K. Taft, area coordinator.

Admission 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.

Ph.D. Degree Requirements

Following entrance into the program, a guidance committee is 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 also conducts an annual in-depth review of each student's progress and, following substantial completion of a student's coursework, administers 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.

Every doctoral student in electrical engineering is required to participate in seminar and/or course presentations, as determined by the department, to satisfy a teaching requirement.

Upon the successful completion of the qualifying examination and other proficiency requirements, the student is advanced to candidacy and, upon the recommendation of the student's area coordinator, a doctoral committee is appointed by the dean of the Graduate School. The doctoral committee conducts an annual review of the student's progress, supervises and approves the doctoral disserta-

tion, and administers 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 are normally expected to take coursework equivalent to two full-time academic years beyond the baccalaureate and to 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 (ENGL)

Chairperson: Michael V. DePorte
Professors: Thomas A. Carnicelli; Michael V. DePorte; Karl C. Diller; Walter F. Eggers; Burt H. Feintuch; Elizabeth H. Hageman; Robert Hapgood; Jean E. Kennard; Andrew H. Merton; Philip L. Nicoloff; Susan Schibanoff; Charles D. Simic; Mark R. Smith; Thomas A. Williams, Jr.; John A. Yount
Associate Professors: Janet E. Aikins; Mary Morris Clark; Robert J. Connors; Michael K. Ferber; Lester A. Fisher; Melody G. Graulich; Rochelle Lieber; Mekeel McBride; Thomas R. Newkirk; Hugh M. Potter III; Patrocinio P. Schweickart; Sarah Way Sherman; David H. Watters
Assistant Professors: Brigitte Gabcke Bailey; Jane T. Harrigan; Susan M. Hertz; Romana C. Huk; James Krasner; Lisa W. MacFarlane; Ramachandran Sethuraman; Charles P. Shepherdson; Sandhya Shetty; Patricia A. Sullivan; Rachel Trubowitz
Graduate Program Coordinator: Sarah Way Sherman

Degrees Offered

The Department of English offers three advanced degrees: master of arts with options in literature, English language and linguistics, and writing; master of science for teachers; and doctor of philosophy.

Admission Requirements

All applicants must submit writing samples in accordance with departmental guidelines. All applicants are also 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. Applicants for the Ph.D. are normally expected to have a reading knowledge of at least one foreign language. 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.

Applicants for the degree of master of science for teachers should consult the General Regulations of the Graduate School for special admission requirements.

Master of Arts Degree Requirements

Literature Option An M.A. candidate must complete 32 credit hours at the 800 or 900 level including at least two seminar courses and 4 credits of English 998. At least four courses must be in English or American literature (as distinct from courses in critical analysis, linguistics, writing, teaching methods, or other literatures). Each M.A. candidate must pass the master's seminar in the study of literature (ENGL 925) 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 4 credits of ENGL 998 and produce a substantial scholarly paper.

Writing Option 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 at the 800 or 900 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, 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.

English Language and Linguistics Option 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 at the 800 or 900 level, including one seminar course, and 4 credits of ENGL 998 in which they are to produce a substantial scholarly paper. 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 Degree Requirements

The master of science for teachers is designed for high school teachers. No foreign language is required. The student must complete 32 credit hours at the 800 or 900 level. At least 24 of these credits must be in the Department of English. Courses taken outside the department must be approved by the student's adviser.

Ph.D. Degree Requirements

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 normally complete ten English courses beyond the M.A. degree. Four of these courses must be gradu-

ate seminars in this department. The other courses should be at the 800 or 900 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 920); and a half-course (2-credit) ungraded module on bibliography and professional methods (ENGL 924). In special circumstances, 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 areas related 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.

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. Includes 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. (May be repeated.)

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.

805. 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.

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 vary, depending on the instructor. 4 cr.

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.)

809. Form and Theory of Poetry
A writer's view of the problems, traditions, and structures of poetry. 4 cr.

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. 2–6 cr.

813, 814. Literary Criticism
Major critics from Plato to the present; the chief critical approaches to literature. 4 cr. (Not offered every year.)

815. TESL: Theory and Methods
A study of how linguistic, psychological, sociological, and neurological theory influence or even determine the choice of methods of language teaching. Research on second language acquisition and bilingualism, language aptitude, and the cultural context of language acquisition. Includes an introduction to standard and exotic methods of language teaching. 4 cr.

816. Curriculum Design, Materials, and Testing in English as a Second Language
A study of the problems in designing an effective teaching program for various types of ESL students. An introduction to competence and aptitude testing and to the choosing and adapting of materials for ESL classes. 4 cr.

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.)

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.)

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.)

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.

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.

845. Contemporary American Literature
A gathering of forms, figures, and movements since 1945. Individual works and cultural background. 4 cr.

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.)

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.)

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.

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.

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.

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.)

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.)

853. Old English
Introduction to Old English language and literature through the readings of selected poetry and prose. 4 cr.

854. Beowulf
A reading of the poem and an introduction to the scholarship. Prereq: ENGL 853. 4 cr.

856. Chaucer
A study of The Canterbury Tales in its original language. 4 cr.

858. Shakespeare
A few plays studied intensively. Live and filmed performances included as available. 4 cr.

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.)

863. Continental Backgrounds of the English Renaissance
Major philosophers, artists, and writers of the continental Renaissance (in translation): Petrarch, Ficino, 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.)

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.)

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.)

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. 867: Milton, Dryden, Rochester, Restoration plays, Defoe, Swift, and Pope. 868: Fielding, Johnson, Boswell, Voltaire, Sterne, Rousseau, Beckford, Diderot, Godwin, and Blake. 4 cr.

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.)

871. Victorian Prose and Poetry
Major writers; social and cultural history. Selections vary from year to year. 4 cr. (Not offered every year.)

873, 874. British Literature of the 20th Century
Poets and novelists of the modernist and postmodernist periods. 873: W. B. Yeats, James Joyce, Virginia Woolf, E. M. Forster, D. H. Lawrence, and other modernists. 874: a selection of postmodernist or contemporary writers, such as William Golding, Doris Lessing, John Fowles, Philip Larkin, Seamus Heaney, Margaret Drabble, and others. 4 cr.

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.)

878. Brain and Language
An introduction to neurolinguistics, a study of how language is related to the structure of the brain. The biological foundations of linguistic universals and language acquisition. Examination of evidence from aphasia and from normal language use. 4 cr.

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 are introduced as needed. 4 cr.

880. English Drama to 1640
Development of the drama through the Renaissance, emphasizing the Elizabethan and Jacobean dramatists. 4 cr.

881. English Drama from 1660 to 1780
Representative plays, both serious and comic, by such writers as Wycherley, Congreve, Etherege, Goldsmith, Sheridan, Davenant, Dryden, Otway, Rowe, and Lillo. 4 cr.

882. 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.)

883. 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.

884. 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.

885. Major Women Writers
Intensive study of one or more women writers. Selections vary from year to year. 4 cr.

890. 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.

891. 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.

892. 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.

893. 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.)

894. 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.

897. 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. 2–6 cr.

901. 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.

911. Writing for Teachers
Opportunity for teachers of composition to work intensively on their writing, to read as writers, and to discover the principles appropriate to the writing genre they are teaching. 4 cr.

912. 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, Quintillian), the eighteenth century (Blair and Campbell), and the modern era (Burke, Booth, Perelman, Ong, Weaver). 4 cr.

913. Composition Theory
Recent advances in our understanding of the composing process; the social and cultural context of literacy learning. 4 cr.

919. Teaching the Writing Process
Focus both on the writing of the participants and on the teaching of writing in grades K–12. Special attention is given to strategies for prewriting, revision, evaluation, and conducting writing conferences. 2–6 cr.

920. Issues in Teaching English and the Language Arts
Special topics in the teaching of English and the language arts. Inquire at the department to see what topics in the teaching of reading, writing, literature, or language arts 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.

924. 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.

925. 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.

992. Twentieth-Century Linguistics
The field of linguistic analysis; reading original works of some key figures in twentieth-century linguistics, e.g., de Saussure, Sapir, Bloomfield, Jakobson, and Chomsky. Analysis of various phonological, morphological, and syntactic phenomena in English and other languages; and testing implications of differing approaches to linguistics. Philosophical as well as technical issues; exploration of connections of linguistics to related fields. 4 cr.

994. Practicum in Teaching English to Speakers of Other Languages
Students will have an opportunity to observe and discuss ESL classes and to design and carry out their own lessons, with follow-up evaluation. 2–6 cr. Cr/F.

Seminars

914. Seminar—Rhetorical and Composition Theory
4 cr.

917. Seminar—Teaching Writing
4 cr.

936. Seminar—Literature of Early America
4 cr.

937. Seminar—Studies in 19th-Century American Literature
4 cr.

938. Seminar—Studies in 20th-Century American Literature
4 cr.

953. Seminar—Studies in Old English
4 cr.

956. Seminar—Studies in Medieval Literature
4 cr.

958. Seminar—Studies in Shakespeare
4 cr.

959. Seminar—Studies in Milton
4 cr.

960. Seminar—Studies in English Drama
4 cr.

964. Seminar—Studies in 16th-Century Literature
4 cr.

965. Seminar—Studies in Early 17th-Century Literature
4 cr.

968. Seminar—Studies in 18th-Century Literature
4 cr.

970. Seminar—Studies in the Romantic Period
4 cr.

971. Seminar—Studies in the Victorian Period
4 cr.

974. Seminar—Studies in 20th-Century British Literature
4 cr.

990. Seminar—Linguistics
4 cr.

993. Seminar—Current Issues in Second Language Acquisition
4 cr.

995. Independent Study
To be elected only with permission of the director of graduate studies and of the supervising faculty member. 2, 4, or 8 cr.

996. Reading and Research
2, 4, or 8 cr. Cr/F.

998. Master's Paper
4 cr. "IA," Cr/F.

999. Doctoral Research

Entomology (ENTO)

Chairperson: Paul C. Johnson
Professor: James S. Bowman
Associate Professors: John F. Burger; Donald S. Chandler; G. Thomas Fisher; Paul C. Johnson; R. Marcel Reeves
Adjunct Assistant Professor: Siegfried E. Thewke
Graduate Program Coordinator: Paul C. Johnson

Degree Offered

The Department of Entomology offers a master of science 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 pest management, forest entomology, medical entomology, aquatic entomology, insect ecology, and systematics.

Admission Requirements

An applicant is expected to have at least a basic course in entomology as well as adequate preparation in the allied sciences of chemistry, botany, and zoology. During the first semester of residency, students' backgrounds in entomology are reviewed in conference with at least three faculty members. Students lacking the necessary background courses may be required to complete certain of these courses without credit before they are admitted to full candidacy for a degree. Applicants are required to submit general and subject biology scores from the Graduate Record Examination.

M.S. Degree Requirements

Students are expected to meet Graduate School requirements for the master's degree. A thesis is required of all students for the master's degree. An oral examination on the thesis is required as well as an oral exam covering general entomological expertise.

804. 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.

805. 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. ento.;/or permission. Lab. 4 cr.

806. Terrestrial Arthropods
Biology, ecology, and systematics of the principal terrestrial arthropods, with emphasis on forest and grassland communities. The role of arthropods in decomposition and nutrient cycling, and the effects of forestry and agricultural practices on the fauna are considered—collection, extraction, identification, and experimental procedures. Prereq: permission.

(Also offered as FORS 806.) Lab. 4 cr. (Not offered every year.)

809. Aquatic Insect Ecology
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. Lab emphasizes qualitative and semiquantitative sampling techniques, collection and identification of principal aquatic groups. Prereq: intro. ento.; principles of zoology;/or permission. Lab. 4 cr. (Not offered every year.)

810. Insect Morphology
Study of homology of insect structure with that of other arthropods using evolutionary morphology approach. Integration of external and internal anatomy in delineating relationships within the *Insecta* and *Arthropoda*. Special fee. Prereq: permission. 4 cr. (Not offered every year.)

821. Principles of Biological Control
Natural and applied aspects of biological control of insect and plant pests. Prereq: permission. 4 cr. (Not offered every year.)

822. Toxicology
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.

824. Industrial and Domestic Pest Management
For students wishing to study household and industrial entomology. Prereq: permission. Lab. 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. Required field research project. Prereq: permission. 4 cr. (Not offered every year.)

826. Integrated Pest Management
Integration of pest management techniques involving biological, culture, and chemical control with principles of insect ecology into management approach for insect pests. Prereq: permission. 4 cr.

901. 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.

997, 998. 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 (FS)

Chairperson: Larry J. Hansen
Associate Professors: Elizabeth M. Dolan; Larry J. Hansen; Michael F. Kalinowski; Victor R. Messier
Assistant Professors: Kristine M. Baber; Barbara R. Frankel; Joseph J. Tobin
Graduate Program Coordinator: Kristine M. Baber

Degree Offered

The Department of Family Studies offers a master of science degree in family and consumer studies and an option in marriage and family therapy. The goal of the program is to provide students with an understanding of theory and methods relevant to child, family, and consumer studies and to prepare them to work with families in therapeutic, educational, and other community and corporate settings. The marriage and family therapy option prepares students to work with families in clinical settings. The program requires full-time study for a minimum of one year or a preapproved alternative plan of study.

Admission Requirements

Students in good academic standing with undergraduate degrees in any related field are encouraged to apply. If a student's undergraduate program does not include an introductory statistics course or the equivalent, successful completion of such a course is required before beginning graduate work. Students seeking admission must submit recent scores from the Graduate Record Examination general test. Additional admissions information and/or personal interviews may be required of applicants for the marriage and family therapy option.

M.S. Degree Requirements

Each student will complete coursework appropriate to his/her area of specialization. Program requirements for the master of science degree for those specializing in child, family, or consumer studies include (1) completion of a 12-credit core curriculum that includes 991, Professional Issues for Family Specialists; 993, Theoretical Approaches to Family and Consumer Studies; 994, Research Seminar; (2) 22 additional semester hours of coursework including 4 semester hours of Practicum (807) and an advanced statistics course; and (3) successful completion and defense of a research thesis (6–10 credits in 899).

Marriage and Family Therapy Option
This option specifically prepares students to work in mental health, family service, medical, and human service settings. The emphasis is on structural, strategic, and systemic approaches to marriage and family therapy. Program requirements for the master of science degree for students admitted to the marriage and family therapy option include (1) the 12-credit core curriculum; (2) 24 additional semester hours of coursework including 841, Marital and Family Therapy; 846, Human Sexuality; 942, Advanced Systems of Marital and Family Therapy; 945, Family Therapy Practice I; 946, Critical Problems in Family Life; 947, Family Therapy Practice II; and (3) successful completion of at least 10 credits of 898 (500 hours of clinical practice) and an integrative paper. Clinical training is provided under the direction of an approved supervisor of the American Association for Marriage and Family Therapy in the department's Marriage and Family Therapy Clinic.

807. 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: permission. 1–6 cr. Cr/F.

808. Child and Family Center Internship
Supervised positions within the UNH Child and Family Center nursery school programs. A) videotape assistant; B) assessment assistant; C) toddler assistant; D) 3–5 year old assistant; E) computer technology assistant; F) international perspectives assistant. Can be repeated up to a total of 9 cr. Prereq: permission. 1–6 Cr. Cr/F.

809. Child Study and Development Center Internship
Supervised positions within the UNH Child Study and Development Center child care programs. A) videotape assistant; B) assessment assistant; C) infant assistant; D) toddler assistant; E) 3–5 year old assistant; F) computer technology assistant; G) international perspectives assistant; H) health issues assistant. Can be repeated up to a total of 9 cr. Prereq: permission. 1–6 cr. Cr/F.

833. 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.)

834. Curriculum for Young Children
Designing and implementing developmentally appropriate activities for young children; assessing the effectiveness of activities; evaluating materials and equipment. Prereq: FS 833; permission. 4 cr. (Spring semester only.)

841. Marital and Family Therapy
Introduction to the theory and practice of marital and family therapy; major approaches to be examined include strategic, transgenerational, structural, experiential/humanistic, and behavioral. Prereq: family relations or equivalent; permission. 4 cr.

843. Parents, Children, and Professionals
Exploration of professional roles related to child and family advocacy. Consideration of philosophical, ethical, and pragmatic issues in the helping professions; evaluation and design of advocacy programs. Prereq: permission. 4 cr. (Fall semester only.)

846. Human Sexuality
Investigation of physiological, psychological, and sociological aspects of human sexuality. Particular attention to various social practices, policies, and programs that affect sexual attitudes and behaviors. 4 cr.

853. Family Economics
The effect of economic change on families and family income and resource allocation. Prereq: one course in economics or permission. 4 cr.

854. Consumers in Society
Problems and issues facing selected groups of consumers; e.g., the elderly, the poor, children and adolescents, women, etc. Prereq: permission. 4 cr.

891. Methods of Teaching
Curriculum materials, methods, and resources in teaching family and consumer studies. Prereq: permission. 4 cr.

894. Families and the Law
Exploration of laws that affect families as members interact with each other and with society in general. Prereq: management and decision making; family relations; and permission. 4 cr.

897. Special Topics
Highly focused examination of a particular theoretical, methodological, or policy issue. Prereq: permission. 4 cr.

898. Marriage and Family Therapy Practicum
Clinical experience under direct faculty supervision. Trainees will develop competency in treating individuals in the context of their families and larger systems. Prereq: permission. May be repeated. 1–4 cr.

942. Advanced Systems of Marital and Family Therapy
Critical analysis and integration of selected systems of marital and family therapy. Prereq: FS 841; permission. 4 cr.

943. American Families in Poverty
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.)

944. Children in the Family
Advanced seminar focusing on the family environment as a context for child development; relationships between parents and children, current theories and research. Prereq: permission. 4 cr.

945. Family Therapy Practice I
Designed to develop clinical skills in structural family therapy, sensitivity to gender differences, and assessment and treatment skills necessary to manage specialized problems (e.g., divorce, remarriage, substance abuse, suicidal behavior) encountered in practice. Prereq: permission. 2 cr.

946. 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 demonstrate mastery of theoretical concepts by developing self-help strategies to be used by families experiencing stress. Prereq: permission. 4 cr.

947. Family Therapy Practice II
Designed to develop clinical skills in strategic systematic family therapies, sensitivity to cultural diversity, and assessment and treatment skills necessary to manage specialized problems (i.e., women, child, and elder abuse; sexual abuse/incest; sexual dysfunction) encountered in practice. Prereq: permission. 2 cr.

991. Professional Issues for Family Specialists
Exploration of major ethical, legal, and professional issues facing child, family, and consumer specialists. Focus on ethical decision making, values clarification, and development of professional identity. Prereq: permission. 4 cr.

993. 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.

994. 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: FS 993 and permission. 4 cr.

995. Seminar and Special Problems
A) Consumer Research; B) Family Relations; C) Education; D) Family Resource Management; and E) Human Development. The student contributes 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 are not scheduled every semester. One or more semesters, maximum of 4 credits in one area. Prereq: permission. 2–4 cr.

997. 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.

899. Master's Thesis
6 cr.

Forest Resources (FORS)

Chairperson: William W. Mautz
Professors: James P. Barrett; John E. Carroll; Robert A. Croker; Nicolas Engalichev; Robert D. Harter; John L. Hill; William W. Mautz; David P. Olson
Adjunct Professor: Robert S. Pierce
Associate Professors: John D. Aber; Robert T. Eckert; Theodore E. Howard; R. Marcel Reeves; Barrett N. Rock; C. Tattersall Smith; Richard R. Weyrick
Adjunct Associate Professors: C. Anthony Federer; James W. Hornbeck; William B. Leak; Sidney A. L. Pilgrim; Lawrence O. Safford
Assistant Professors: William B. Bowden; Christine V. Evans; John A. Litvaitis; David L. Verbyla
Adjunct Assistant Professor: Peter W. Garrett
Graduate Program Coordinator: Robert D. Harter

Degree Offered

The Department of Forest Resources offers master of science degrees in three areas.

Forestry: forest resource management, forest marketing, wood industry management, forest mensuration, forest tree improvement, wood science and technology, and forest ecosystem dynamics.

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

Applicants 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 test 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.

M.S. 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 993, Seminar, 1 cr.; FORS 903, Approach to Research, 2 cr.; a quantitative methods course; FOR 995L, SOIL 995F, or WILD 995G, 1 cr.; (2) FORS 998, 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 forestry 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. Forestry students specializing in forest ecosystem dynamics may conduct research through the Institute for the study of Earth, Oceans, and Space.

Forest Resources (FORS)

903. 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. Prereq: permission. 2 cr.

993. Natural and Environmental Resources Seminar
Presentation and discussion of recent research, literature, and policy problems in the natural and social sciences influencing resource use. 1 cr. Cr/F.

998. 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.

Forestry (FOR)

806. Terrestrial Arthropods
Biology, ecology, and systematics of the principal terrestrial arthropods, with emphasis on forest and grassland communities. Role of arthropods in decomposition and nutrient cycling; effects of forestry and agricultural practices on fauna. Collection, extraction, identification, and experimental procedures. Two lectures, one lab fieldwork, and discussions. Prereq: permission. (Also offered as ENTO 806.) 4 cr. (Not offered every year.)

811. 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.

812. 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.)

813. 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: intro. courses in calculus, statistics, and ecology. 3 or 4 cr. (Not offered every year.)

820. 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. Special fee. Lab. 3 cr. (Not offered every year.)

822. 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. Special fee. 3 cr. (Not offered every year.)

830. Terrestrial Ecosystems
Processes controlling the energy, water, and nutrient dynamics of terrestrial ecosystems; concepts of study at the ecosystem level, controls on primary production, transportation, decomposition, herbivory; links to Earth system science, acid deposition, agriculture. Prereq: forest ecology; intro. bot./biol. course;/or permission of instructor. 4 cr.

834. Forest Protection Seminar
Discussion and special problems based on principles and techniques of forest protection. Prereq: permission. 3 cr. (Not offered every year.)

845. Forest Management
Forest land ownership; management objectives; forest inventory regulation and economic analysis; forest administration; professional responsibilities and opportunities. Special fee. Lab. 4 cr.

853. Decision Sciences in Natural Resource Management
Application of operations research techniques and capital investment analysis to natural resource situations. Linear, goal, and dynamic programming; simulation and decision theory. Prereq: calculus; intermed. microecon. Lab. 4 cr.

854. 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. Prereq: wood sci. and tech. or permission. Special fee. Lab. 4 cr.

855. Regional Silviculture and Forest Management
Extended field trip to another forest region. Prereq: FOR 845 or permission. (Limited enrollment.) 2 cr. Cr/F.

857. 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. Special fee. Lab. 3 cr.

858. Aerial 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: FOR 857 or equivalent; binocular vision an advantage. Special fee. Lab. 2 cr.

859. Digital Geoimage Analysis
Computer enhancement and classification of remotely sensed images; integration of remotely sensed data into computer-based geographic information systems. Prereq: FOR 857 or equivalent. Lab. 3 cr.

860. Geographic Information Systems
Fundamentals of computer-assisted systems for the capture, storage, retrieval, analysis, and display of spatial data. Emphasis on spatial analysis, cartographic modeling, and database management as applied to natural resources and land-use planning. 3 cr.

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.)

901. Forest Management Seminar
Seminar discussions of current literature, plans, principles, and new developments in the general field of forest management. Special fee. Prereq: permission. 2 cr. (Not offered every year.)

905. 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.)

906. 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.)

910. 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.)

916. 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.)

918. Advanced Forest Biology
Topical orientation with presentations by faculty and students. Emphasis 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.)

930. Modeling of Forest Ecosystems
Computer modeling of energy, water, and nutrient dynamics of forest ecosystems; review of existing ecosystem models, modification of an existing model. Original programming of new model required as course project. Prereq: FOR 830 or permission. 3 cr.

995. Investigations in:
A) Forest Ecology; B) Remote Sensing; C) Wood Products; D) Mensuration; E) Forest Economics; F) Forest Management; G) Operations; H) Recreation; I) Policy; J) Forest Genetics; K) Watershed Management; L) Natural Resource Education. Prereq: permission. 1–4 cr.

Soil Science (SOIL)

802. 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 chem. or permission. 3 cr.

804. Soil Genesis and Classification
Processes involved in formation of soils and soil properties as reflectors of genetic processes. Classification systems of soils related to soil genesis and soil landscapes. Lab sessions illustrate concepts by examining soils in the field. Prereq: soils and the environment or equivalent. Special fee. Lab. 4 cr.

805. Forest Soils
Basic ecological and management perspectives; soil-site quality evaluation; forest land classification and interpretation; forest soil management techniques. Prereq: basic soils course;/or permission. Special fee. Lab. 3 cr. (Not offered every year.)

902. Special Topics in Soil Science
Topics may include soil mineralogy, advanced soil chemistry, soil physical chemistry, or others as the need arises. Seminar or lecture format as appropriate to the topic. Prereq: permission. 1–3 cr. Cr/F. (Offered only with sufficient demand.)

949. Pedology
Extensive readings and discussion of recent literature dealing with soils from a process-oriented perspective. Topics include mineral weathering, soil-geomorphic relationships, quantification of soil-forming functions, and paleopedology. 4 cr.

995. Independent Work in Soil Science
A) Soil-Plant Relationships; B) Physics of Soils; C) Chemistry of Soils; D) Soil Classification; E) Forest Soils; F) Soil Science Education. Elective only after consultation with the instructor in charge. 1–4 cr.

Wildlife (WILD)

809. Wildlife Management Seminar
Discussions and assigned reports on current investigations and developments in wildlife management. Prereq: undergraduate courses in wildlife management or permission. Special fee. 3 cr.

837. Wildlife Population Dynamics
Mechanisms that influence and characteristics of terrestrial wildlife populations. Introduction to census methods and computer modeling. Prereq: permission. Special fee. 4 cr.

838. Wildlife Management
Habitat evaluation and management of terrestrial vertebrates. Consideration of game, nongame, and fur bearers. Prereq: permission. Special fee. 4 cr.

872. Wildlife Energetics
Energy requirements of wildlife species and the manner in which these needs are met in their natural environment. Thermodynamics in ecological systems, factors influencing metabolic rate, food habits, food use efficiency, food availability. Special fee. Prereq: permission. 2 cr.

995. Investigations in Wildlife Management
A) Wildlife Energetics and Physiology; B) Habitat Management; C) Population Dynamics; D) Waterfowl Management; E) Fire Ecology; F) Game Management; G) Wildlife Education. Prereq: permission. 1–4 cr.

Genetics Program (GEN)

Chairperson: Robert Zsigray
Professors: Thomas P. Fairchild; Donald M. Green; Yun-Tzu Kiang; J. Brent Loy; Subhash C. Minocha; Lincoln C. Peirce; Owen M. Rogers; Willard E. Urban, Jr.; Robert M. Zsigray
Associate Professors: Clyde L. Denis; Robert T. Eckert
Assistant Professors: John J. Collins; Thomas M. Davis; Anita S. Klein; Robert L. Taylor, Jr.
Adjunct Assistant Professor: Peter W. Garrett
Graduate Program Coordinator: Robert Zsigray

Degrees Offered

The interdepartmental genetics program offers graduate work leading to the degrees of master of science and doctor of philosophy.

The program is conducted by faculty members from animal sciences, biochemistry, forest resources, microbiology, plant biology, and zoology, as well as faculty from the Agricultural Experiment Station and the U.S. Forest Service, Northeastern Forest Experiment Station.

Admission Requirements

Qualified applicants are admitted 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.

M.S. Degree Requirements

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 and pass an oral examination covering graduate courses and thesis.

Ph.D. Degree Requirements

The chairperson of the genetics program, with the concurrence of the chairperson of the department of major interest, nominates the student's guidance and doctoral committees, which administer the qualifying and final examinations. Specific course requirements are 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 determines whether a foreign language will be required.

Teaching Experience

All students are required to participate in a one-year directed teaching experience and are required to attend genetics seminars.

804. 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: gen. micro.; physiol. chem. and nutrition. (Also offered as MICR 804.) Lab. 4 cr.

805. Population Genetics
Population growth and regulation; genetic variation; factors affecting gene frequency; ecological genetics. Prereq: prin. of genetics or permission. (Also offered as PBIO 805.) 4 cr. (Not offered every year.)

806. Genetics Laboratory
Advanced experiments in yeast genetics, including research techniques in biochemical, transmission, and molecular genetics. Prereq: prin. of genetics or equivalent; a course in biochemistry is recommended. (Also offered as BCHM 806.) Special fee. 3 cr.

840. 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: prin. of genetics or permission. (Also offered as PBIO 840.) 4 cr. (Not offered every year.)

871. Biochemical Genetics
Mechanisms of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Prereq: BCHM 851 or permission. (Also offered as BCHM 871.) 3 cr.

872. Introductory Laboratory in Molecular Genetics 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 852; BCHM 871 or MICR 804. (Also offered as BCHM 872.) Special fee. 3 cr.

874. Plant Cell Culture and Genetic Engineering
Theory and techniques of cell/tissue culture and genetic manipulation in plants, transformation vectors, somatic cell genetics, regulation of foreign gene expression, molecular basis of agriculturally important traits, environmental and social implications of genetic engineering in plants. Prereq: genetics or permission. Coreq: GEN 875. (Also offered as PBIO 874.) 3 cr.

875. Plant Cell Culture and Genetic Engineering Lab
Techniques of plant cell and tissue culture, protoplast fusion, genetic transformation. Mutant cell selection, analysis of foreign gene expression. (Also offered as PBIO 875.) Coreq: GEN 874. Special fee. 2 cr.

902. 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 PBIO 902.) 4 cr. (Not offered every year.)

904. Advanced Microbial Genetics
Advanced studies in express, regulation, recombination, and transmission of genetic information in prokaryotic microorganisms. Prereq: GEN 804; permission. (Also offered as MICR 904.) Lab. 4 cr. (Not offered every year.)

912. 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: FOR 811; digital computer systems;/or permission. 3 cr. (Not offered every year.)

942. 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 852 or permission. (Also offered as BCHM 942.) 3 cr.

991-992. Advanced Topics in Molecular Biology
Selected topics of current research on the molecular biology of gene regulation. Emphasis on eukaryotic systems such as yeast, mammals, and maize. (Also offered as BCHM 991-992.) 1 cr. Cr/F.

995, 996. 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.

998. 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 appropriate department for the convenience of the student.

Animal and Nutritional Sciences

822. Immunogenetics
Cellular interactions and immune regulatory mechanisms. Genetics of the major histocompatibility complex, antibody diversity and immune responses. Lab. 4 cr.

Forestry

811. 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.

820. 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. Special fee. Lab. 3 cr. (Not offered every year.)

Plant Biology

853. Cytogenetics
Chromosome structure, function, and evolution. Eukaryotic genome organization. Theory of, and laboratory techniques for, cytogenetic analysis in plants and animals. Prereq: prin. of genetics. Special fee. Lab. 4 cr. (Not offered every year.)

873. Breeding Improved Varieties
Techniques for creating new varieties of crop and ornamental plants. Prereq: genetics. Coreq: PBIO 973. 3 cr. (Not offered every year.)

973. Topics in Crop Improvement
Discussion and assigned readings in crop breeding. Coreq: PBIO 873. 1 cr.

History (HIST)

Chairperson: John O. Voll
Professors: Charles E. Clark; Robert C. Gilmore; Hans Heilbronner; William R. Jones; David F. Long; Francis D. McCann, Jr.; Robert M. Mennel; Harvard Sitkoff; John O. Voll; Douglas L. Wheeler; Donald J. Wilcox
Associate Professors: Jeffry M. Diefendorf; Allen B. Linden; Janet L. Polasky; Marc L. Schwarz; Laurel T. Ulrich
Assistant Professors: J. William Harris, Jr.; John Gregory McMahon; Lucy Salyer
Graduate Program Coordinator: Charles Clark

Degrees Offered

The Department of History offers the master of arts and doctor of philosophy degrees. The master of arts is offered in many fields. Doctoral dissertations may be written in American history or in comparative history (American/European or American/Atlantic topics).

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 a B average in history, allied humanities, and social sciences. In addition, applicants must submit general test scores on the Graduate Record Examination. 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 coursework 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 should include with their applications a personal statement indicating their reason for undertaking graduate study at the University of New Hampshire. 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.

M.A. Degree Requirements

A master's student designs a specific program to meet one of two plans: Plan A allows substantial training and research in a single subfield of history but within a foundation of broader coursework; Plan B allows substantial breadth over at least two subfields. The subfields in history are the following: 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.

Plan A: At least eight courses in history numbered 800 or above, including at least one research seminar; a thesis in a single subfield (equivalent to two courses).

Plan B: At least ten courses in history numbered 800 or above, including at least one research seminar; oral examination demonstrating competence in two subfields of history.

Ph.D. Degree Requirements

A doctoral student's program, which must be approved by the graduate committee of the department, shall include each of the following requirements:

1) two research seminars; one in early American history and one in modern American history;
2) courses in historiography and historical methods;
3) correction of any deficiencies in the student's previous program;
4) two languages or one language and a special research technique, whichever is deemed most relevant to the area of research;
5) courses in the entirety of American history, with accent upon either early or modern America and two subfields outside of American history;
6) a cognate field outside of history entirely or a subfield of non-Western history;
7) qualifying exams;
8) dissertation and successful defense.

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 HIST 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.

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.

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. The European Conquest of North America
A study of the social consequences of colonization, migration, and war in America, 1500–1775. Emphasis on the interaction of British colonists with competing European cultures

(French, Dutch, Portuguese, and Spanish), with native Americans, and with African and Afro-American slaves. 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.

808. Arts and American Society: Women Writers and Artists, 1850 -Present
Team-taught course studying the impact of gender definitions on the lives and works of selected American artists. Consider lesser-known figures such as Fannie Fern, Lilly Martin Spencer, and Mary Hallock Foote as well as better-known artists such as Willa Cather and Georgia O'Keeffe. 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
Advanced study in the history of American thought. Significant American thinkers considered in their social context. Semester I: 1600–1860. Semester II: 1860–present. 4 cr.

823. Anglo-American Social History
Study of everyday life in British America and the early United States, 1600–1820, with an emphasis on gender, class, and race. Consideration of childbearing, labor systems, religious observance, crime, and other themes in the light of recent social theory. Readings in both primary and secondary literature, with an emphasis on local records and on material culture. 4 cr.

824. Modern American Social History
Major social developments since 1820: industrialization and the history of labor, immigration, urban growth, race relations, history of women and of the family. 4 cr.

825. Southern History and Literature since 1850
Equal focus on the history and literature of the South. Topics include slavery, the Civil War, Reconstruction, the age of segregation, and the civil rights movement. Literary focus is on the "Southern Renaissance" of the 1930s and after, including works by William Faulkner, Robert Penn Warren, Flannery O'Connor, and Richard Wright. 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; reading and discussion of literature relative to selected topics. 4 cr.

839, 840. Three Medieval Civilizations
Advanced study in medieval civilizations. Demise 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, socioeconomic, 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.

865. Themes in Women's History
In-depth examination of a selected topic in women's history, such as women and health, women in modern European political theory, comparative history of women and revolution. See *Time and Room Schedule* or department for specific topic. May be repeated for credit with permission of instructor. 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.

872. Studies in Regional Material Culture
Designed to acquaint students with artifacts commonly used in New England homes during the period 1750–1860 and to present these artifacts in their contemporary cultural context, including their relationships with designers, clients, patrons, manufacturers, craftsmen, and consumers. 4 cr.

874. 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.)

875. 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.)

877. The Greek and Roman Near East
The later history of the ancient Near East, after it had been colonized or conquered by the Greeks and later the Romans. Greek trading colonies in Anatolia, the Levant, and Egypt, and Roman domination of the East, including North Africa. Primary sources include Sallust's *Jugurthine War*, Josephus, and the *Alexandrian and African Wars* of Caesar. Particular attention paid to questions such as the Roman conflict with the Parthians and the struggle to secure the eastern frontier, the administration of Roman Palestine, and the removal of the Roman capital to Constantinople. 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.

887. Quantitative Methods and Computers for Historians
The historian's use of computers and statistics: opportunities and problems in using and analyzing quantitative sources; elementary statistical techniques; practical applications involving microcomputers and applications programs. No previous knowledge of computers or college mathematics is assumed or required. Prereq: admission as a graduate student in history or permission of instructor. 4 cr.

892. Seminar in the History of Science
In-depth examination of a selected topic in the history of science. Subject varies. No special background in science required. 4 cr.

988. Historical and Descriptive Literature of Early America
The chief English-language writings about North America from John Smith and William Bradford to the book-length literature of the American Revolution, considered as sources, as documents of intellectual history and historiography, and as literary genres. Emphasis on development of skills of analytical and critical reading and professional-level scholarly writing. 3 cr.

989, 990. Seminar in American History
1) Early American Society; 2) Early American Culture; 3) Revolutionary Period; 4) 19th Century; 5) 20th Century. 3 cr.

991. Seminar in European History
1) Medieval; 2) Early Modern; 3) Modern. 3 cr.

993, 994. Seminar in African, Asian, Latin American History
1) African; 2) Asian; 3) Latin American; 4) Middle East. 3 cr.

995, 996. 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

Hydrology

(See Earth Sciences.)

Master's Continuing Enrollment (MCE)

900. 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 900 is an enrollment designation that appears on the academic record. Students registered for MCE 900 are considered full time; no credit hours are accumulated nor a grade given.

Mathematics (MATH)

Chairperson: Donovan H. Van Osdol
Professors: Homer F. Bechtell, Jr.; Albert B. Bennett, Jr.; David M. Burton; Arthur H. Copeland, Jr.; Donald W. Hadwin; A. Robb Jacoby; Loren D. Meeker; Eric A. Nordgren; Shepley L. Ross; Donovan H. Van Osdol
Adjunct Professor: Fernand J. Prevost
Associate Professors: William E. Bonnice; Joan Ferrini-Mundy; Marie A. Gaudard; William E. Geeslin; Berrien Moore III; Samuel D. Shore; Siu-Keung Tse
Assistant Professors: David V. Feldman; Karen J. Graham; Rita A. Hibschweiler; Edward K. Hinson; Ernst Linder; R. Scott Mcintire; Lee L. Zia
Graduate Program Coordinator: Donald W. Hadwin

Degrees Offered

The Department of Mathematics offers programs leading to a master of science in teaching degree in mathematics, a master of science degree in mathematics, a doctor of philosophy degree in mathematics, and a doctor of philosophy 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 programs leading to the Ph.D. degree. The Ph.D. programs are designed primarily for a career in post–secondary school teaching and research.

The graduate programs have limited enrollments so that a student can work closely with the faculty in their areas of expertise. Research is currently being conducted in ring theory, group theory, operator theory, C*-algebras, statistics, applied mathematics, topology, mathematics education, and category theory.

Admission Requirements

Applicants for the degree of master of science for teachers must have completed education courses sufficient for certification, or have three years of teaching experience, or hold a current full-time teaching position. Applicants for the master of science or doctor of philosophy degrees must have completed undergraduate courses in mathematics, preferably in analysis, algebra, or topology.

M.S. Degree Requirements

The program requires ten semester courses approved by the department and chosen from courses numbered 801–888 or 930–949; at least six of the ten courses must be from the 930–949 group. An oral comprehensive examination is required.

Master of Science for Teachers Degree Requirements

The program requires ten semester courses approved by the department. These will normally be taken from the courses numbered 901–929 and will usually include the six courses numbered 903–908. A comprehensive examination

based primarily on material in courses 903–908 is required. The courses in this program are offered primarily during summer sessions.

Ph.D. Degree Requirements

Basic degree requirements for the Ph.D. program: (1) all of the courses numbered 933–939; (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 may 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.

835. 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.

836. Statistics
Sampling theory, parameter estimation, hypothesis testing, regression, analysis of variance, nonparametric methods. Prereq: MATH 835. 4 cr.

839. 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 836 and 862. 4 cr. (Not offered every year).

840. Experimental Design
Randomized blocks, Latin square designs, factorial designs, fixed effects and random effects models, fractional factorial designs, response surface methodology. Applications to physical, engineering, and agricultural sciences. Prereq: MATH 839. 4 cr.

842. Applied Statistical Methods
Control charts, acceptance sampling, reliability, nonparametric methods, categorical data analysis. Applications to industrial problems. Prereq: MATH 835-836 or probability and statistics for applications. 4 cr.

845-846. 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.

853. 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. to data structures with C or scientific programming with FORTRAN or intro. to computer science II. (Also offered as CS 853.) 4 cr.

854. Numerical Methods and Computers II
Mathematical software. Computer solutions of differential equations, eigenvalues, and eigenvectors. Prereq: diff. equations with linear alg.; intro. to data structures with C or scientific programming with FORTRAN or intro. to computer science II. (Also offered as CS 854.) 4 cr.

861. Abstract Algebra
Basic properties of groups, rings, fields, and their homomorphisms. 4 cr.

862. Linear Algebra
Abstract vector spaces, linear transformations, and matrices. Determinants, eigenvalues, and eigenvectors. Prereq: MATH 861. 4 cr.

864. Advanced Algebra
Topics to be selected from among rings, modules, algebraic fields, and group theory. Prereq: MATH 861. 4 cr. (Not offered every year.)

867. One-Dimensional Real Analysis
Theory of limits, continuity, differentiability, integrability. 4 cr.

868. 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 867. 4 cr. (Not offered every year.)

876. Logic
Induction and recursion; sentential logic; first-order logic; completeness, consistency, and decidability; recursive function. 4 cr. (Not offered every year.)

883. 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.)

884. Topology
Open sets, closure, base, and continuous functions. Connectedness, compactness, separation axioms, and metrizability. 4 cr.

888. 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 867. 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.

901-902. 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.

903-904. 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.

905-906. 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.

907-908. 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.

909. Probability and Statistics for Teachers
Permutations and combinations; finite sample spaces; random variables; binomial distributions; statistical applications. 3 cr.

910. Mathematics Education
Current developments and issues in mathematics education; content, curricula, methods, and psychology of teaching mathematics. 1–4 cr.

911. Computers and Their Uses
Consideration of the role of microcomputers in schools; preparation of classroom materials for Apple II, Macintosh, and IBM; exchange of ideas and software. 3 cr.

914. Topology for Teachers
Fundamental concepts of elementary topology; network and map problems; sets, spaces, and transformations. 3 cr.

916. Theory of Numbers for Teachers
Divisibility and primes; congruences; quadratic reciprocity; number theoretic functions; Diophantine equations; perfect and amicable numbers. 3 cr.

917. Theory of Sets and Elementary Logic
An introduction to the methods of mathematical proof, and fundamentals of set theory and logic. 3 cr.

919. The Real Number System
A postulational approach to fundamentals of algebraic structure; sequences, limits, and continuity. 3 cr.

920. History of Mathematics
A problem-study approach to mathematical problems from the period of Greek mathematics until the modern era. 3 cr.

921. 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.

926. 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.

927. 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.

928. 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.

929. 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.

933. Algebra I
Fundamental results in group and ring theory. Prereq: algebra. 3 cr.

934. Algebra II
Fundamental results in module and field theory. Prereq: MATH 933. 3 cr.

935. Measure and Integration
Measurable spaces and functions, measures, Lebesque integrals, convergence theorems. Prereq: real analysis. 3 cr.

936. Functional Analysis
Banach and Hilbert spaces, Hahn-Banach theorem, open mapping and closed graph theorems, dual spaces, topological vector spaces. Prereq: MATH 935. 3 cr.

937. Complex Analysis
Cauchy theory and local properties of analytic functions, Riemann mapping theorem, representation theorems, harmonic functions. Prereq: real and complex analysis. 3 cr.

938. Algebraic Topology
Chain complexes; homology of simplicial complexes, singular homology and cohomology; axiomatic homology; cup and cap products. Prereq: MATH 861 and 884. 3 cr.

939. General Topology
Subspace, product, and quotient topologies; embedding; separation and countability axioms; connectedness; compactness and compactifications; paracompactness, metrization, and metric completions. Prereq: MATH 884. 3 cr.

The following more specialized courses are offered on an irregular schedule whenever mutual faculty and student interest justifies it. Content varies from year to year and is normally chosen from among the topics listed. With the permission of the instructor, each of these courses may be taken more than once for credit.

941. Topics in Logic and Foundations
Recursive functions; independence proofs; models; forcing techniques. 3 cr.

942. Topics in Algebra
Homological algebra; algebraic number theory; local algebra; category theory; group theory; ring theory; field theory. 3 cr.

943. Topics in Topology
Topological groups; algebraic topology; general topology. 3 cr.

944. Topics in Analysis
Calculus of variations; harmonic analysis; integral equations; operator theory; linear topological spaces; partially ordered spaces; topological algebras; complex variables. 3 cr.

945. 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.

946. Topics in Applied Mathematics
Distribution theory; potential theory; mechanics; control theory; mathematical biology; model theory; operations research. 3 cr.

947. 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.

948. Topics in Geometry
Analysis on manifolds; differential geometry; Riemannian geometry; algebraic geometry; convexity. 3 cr.

949. 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.

998. 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 (ME)

Chairperson: Charles K. Taft
Professors: Robert W. Corell; David E. Limbert; Godfrey H. Savage; Charles K. Taft; Russell L. Valentine
Associate Professors: Kenneth C. Baldwin; Barbaros Celikkol; Robert Jerard; William Mosberg; M. Robinson Swift; John A. Wilson
Assistant Professors: Barry K. Fussell; Todd Stuart Gross; James E. Krzanowski; John Philip McHugh; James A. Sherwood; David W. Watt
Adjunct Assistant Professor: Robert E. Phillips
Graduate Program Coordinator: John McHugh

Degree Offered

The Department of Mechanical Engineering offers the master of science, from the viewpoint both of the engineering sciences and of engineering design, in the areas of solid mechanics, dynamics, materials science, dynamic systems, automatic control, fluid mechanics, and the thermal sciences. The programs provide the background required for careers in research, engineering design, teaching, and for further graduate study.

Students interested in graduate study beyond the master's degree should refer to the section entitled Engineering Ph.D. Program.

Admission Requirements

Applicants should have completed work equivalent to that required for a bachelor of science degree in mechanical engineering.

M.S. Degree Requirements

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 ME 899, Master's Thesis; the project plan requires 28 semester hours of coursework in addition to 4 semester hours of ME 992, 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 900-level course for the project requirement.

At least 8 credits must be earned in 900-level courses other than ME 992, Master's Project; or the 900-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.

801. Macroscopic Thermodynamics
Thermodynamic principles using an analytic, postulational approach and Legendre transformations to obtain thermodynamic potentials. 4 cr.

802. Statistical Thermodynamics
Macroscopic thermodynamic principles developed by means of microscopic analysis. Prereq: thermodynamics. 4 cr.

807. Analytical Fluid Dynamics
Kinematics of flow; constitutive relationships; development of the Navier-Stokes equations; vorticity theorems; potential flow. Prereq: fluid dynamics. 4 cr.

808. Gas Dynamics
Study of one-dimensional subsonic and supersonic flows of compressible ideal and real fluids. Wave phenomena; linear approach to two-dimensional problems; applications in propulsion systems. Prereq: thermodynamics. 4 cr.

809. 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.

810. 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.

817. Cryogenics
Phenomena and processes at very low temperatures. Basic engineering sciences applied to problems of low temperature refrigeration, liquefaction, separation, and storage; transport of cryogenic fluids; measurement systems; vacuum technology. Prereq: thermodynamics. 4 cr.

823. Advanced Dynamics
Classical dynamics oriented to contemporary engineering applications. 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.

824. 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.

826. 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.

827. Advanced Mechanics of Solids
Stress, strain, stress-strain relations, anisotropic behavior, introduction to elasticity, plane stress/strain, bending and torsion of members with general cross-sections introduction to thin plates and shells, energy methods. 4 cr.

830. 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.

841. 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 EE 841.) 4 cr.

851. 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 OE 851.) 4 cr.

852. 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 OE 852.) 4 cr.

857. 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 CIE 857; OE 857.) 3 cr.

860. Physical Metallurgy I
Introduction to physical metallurgy: dislocations, thermodynamics of materials, diffusion, phase transformations, and strengthening mechanisms in solids. Prereq: intro. materials science or permission. Lab. 4 cr.

861. Diffraction and Imaging Methods in Materials Science
Introduction to x-ray diffraction and electron microscopy. Basic crystallography; reciprocal lattice; x-ray and electron diffraction; x-ray methods; transmission and scanning electron microscopy. Prereq: intro. to materials science, engineering materials, or principles of mineralogy. Lab. 4 cr.

866. 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.

871. Linear Systems and Control
Fundamentals of linear system analysis and design in both continuous and discrete time. Design of feedback control systems. Topics include modeling; time and frequency analysis; Laplace and Z transforms; state variables; root locus; digital and analog servomechanisms; proportional, integral, and derivative controllers. Includes demonstrations and computer simulations. Prereq: permission. (Also offered as EE 871.) 3 cr.

872. Control Systems
Extension of ME 871 to include more advanced control system design concepts such as Nyquist analysis; lead-lag compensation; multi-input/multi-output systems; state feedback;

parameter sensitivity; controllability; observability; decoupling; introduction to nonlinear and modern control. Includes interactive computer-aided design and real-time digital control. Prereq: ME 871 or permission. (Also offered as EE 872.) Lab. 4 cr.

874. Computer-Aided Engineering
Data acquisition and experiment control, multivariable data curve fitting, computer simulation of lumped systems based on analytical and databased 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: ME 849 or permission. 3 cr.

881. 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.

886. Introduction to Finite Element Analysis
Topics include basic matrix theory, Galerkin method, direct stiffness method, calculus of variations, development of finite element theory and modeling techniques. Applications in solid mechanics, heat transfer, fluids, dynamics, and electromagnetic devices, via both commercially available codes and student-written codes. Prereq: programming with FORTRAN; heat transfer;/or permission. (Also offered as CIE 886 in alternate years). 3 cr.

895. Special Topics in Mechanical Engineering
New or specialized courses and/or independent study. May be repeated for credit. 2–4 cr.

901. Irreversible Thermodynamics
Nonequilibrium thermodynamics from the viewpoint of fluctuation theory. The Onsager reciprocal relations. Prereq: ME 801. 4 cr.

903. 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.

904. 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.

906. 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.

907. 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: ME 807 or 808. 4 cr.

908. 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.

910. Turbulent Flow Analysis
Physical aspects and methods of analyzing turbulence. Turbulent transport of heat and momentum; second-order modeling techniques and computation of turbulent flows. Applications to problems in engineering science. Prereq: ME 807 and/or ME 809 or permission. 4 cr.

911. Theory of Hydrodynamic Stability
Equations of hydrodynamics in general coordinates; general instabilities caused by gravitational, surface tension, and hydromagnetic influences; instability of parallel viscous flows including the Orr-Sommerfeld equation and Tollmein-Schlicting waves; instability of free-surface waves; instability of stratified flows; instabilities in porous media. Prereq: ME 807 or permission. 4 cr.

922. 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.

924. 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.

926. 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 are used. 4 cr.

927. 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.

929. 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.

938. 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.

942. 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 EE 942.) 4 cr.

944. 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: EE or ME 951. (Also offered as EE 944.) 4 cr.

951. 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: EE or ME 882. (Also offered as EE 951.) 3 cr.

952. 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 sys-

tems, adaptive control systems. Prereq: EE or ME 951. (Also offered as EE 952.) 3 cr.

955. 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: ME or EE 951; MATH 835 or equivalent. (Also offered as EE 955.) 3 cr.

961. Physical Metallurgy II
Thermodynamics of solid solutions and mixtures, kinetics of selected solid state reactions including precipitation and recrystallization, martensite transformations. 4 cr.

965. Microscopic Mechanisms of Plastic Deformation
The mechanisms of plastic deformation in crystalline materials. Review of elasticity theory; point, line, and planar defects; dislocation interactions; strengthening mechanisms; creep mechanisms; application of deformation mechanisms to the development of constitutive models. Prereq: permission. 3 cr.

982. Mathematical Methods in Engineering Science II
Continuation of ME 881. Complex variable techniques, integral transform techniques for the solution of differential and partial differential equations, Green's functions. Weiner-Hopf techniques, variational techniques, stochastic problems with application to random vibration, statistical control theory, turbulence, heat conduction and fluctuation phenomena in solids, transport theory, gases, and liquids. Topics may vary from year to year. Prereq: ME 881. 4 cr.

992. 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.

995. 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: Richard P. Blakemore; William R. Chesbro; D. Jay Grimes; Galen E. Jones; Thomas G. Pistole; Robert M. Zsigray
Associate Professor: Frank G. Rodgers
Assistant Professor: Aaron B. Margolin
Graduate Program Coordinator: Galen E. Jones

Degrees Offered

The Department of Microbiology offers the master of science and the doctor of philosophy degrees. Research opportunities are available in a broad range of areas, including magnetotactic bacteria, host-microbe interactions, biogeochemistry of marine sediments, *Yersinia* genetics, comparative immunology, molecular mechanisms of pathogenesis, environmental and molecular virology, microbial growth and regulation, marine microbial ecology, and biotechnology.

Admission Requirements

Applicants 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. Applicants 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 required. 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.

M.S. Degree Requirements

Students admitted to the M.S. program are required to conduct an independent research project in conjunction with a faculty adviser and must submit a thesis based on this research to a faculty examining committee, which determines its acceptability. Students also defend their completed thesis work in a formal departmental seminar. Specific coursework is determined in conjunction with the faculty adviser.

Ph.D. Degree Requirements

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.

The department's acceptance of the dissertation is contingent on (1) its approval by the doctoral committee and (2) evidence that at least one manuscript based on the thesis research has been submitted to a refereed scientific journal appropriate to the topic.

All graduate students are expected to enroll in MICR 997, Microbiology Seminar, each semester.

801. 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. micro.; gen. biochem. Special fee. Lab. 4 cr.

802. Infectious Disease and Health
Principles underlying the nature of infectious agents and the diseases they cause. Pathogenic strategies employed by these microorganisms, response of the host at the animal and cellular levels, intracellular parasitism, epidemiology, role of control measures including vaccines and chemotherapy, mode of action of antimicrobial chemotherapeutic agents, pharmacokinetics and drug metabolism. Both well-established pathogens as well as newer and emerging human and animal disease agents will be covered. Prereq: pathogenic microbiology; permission. 4 cr.

804. 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: gen. micro.; physiol. chem. and nutrition. (Also offered as GEN 804.) Lab. 4 cr.

805. Immunology
Examination of the immune response in vertebrates. Characterization of the major components of the immune system; study of host-defense mechanisms and immunopathology. Serological and animal laboratory studies. Prereq: gen. micro.; permission. Special fee. Lab. 4 cr.

806. Virology
Principles of animal and, in selected instances, plant and bacterial virology in relation to infection and disease. Emphasis on the molecular biology of viruses, viral replication, isolation, propagation, assay, pathogenesis, diagnosis, epidemiology, and control. Virus-host interactions. Prereq: pathogenic micro.; permission. Special fee. Lab. 4 cr.

807. Marine Microbiology
Characterization of microorganisms in the sea including taxonomy, physiology, and ecology; sampling, enumeration, distribution; and effects of marine environment upon microbial populations. Prereq: gen. micr.; organic chem. Special fee. Lab. 4 cr.

808. 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, ferro-manganese nodules, corrosion, and fossil microorganisms. Prereq: gen. micro.; organic chem. Special fee. Lab. 4 cr.

810. Electron Microscopy and Microbial Cytology
Ultrastructure and function in eukaryotes, prokaryotes, and viruses. Practical operation of transmission and scanning electron microscopes, including manipulation of instrumentation and specimens. Application of shadowing, negative staining, embedding and thin sectioning, labeling, and freeze-fracture/etching to biological specimens; photographic techniques and the interpretation of micrographs. Discussion of role of bacterial appendages, cell membranes and cell walls, cytoplasmic inclusions, cell division and sporulation along with virus ultrastructure. Project work. Prereq: gen. microbiol.; permission. Special fee. Lab. 5 cr.

812. Microbial Symbioses
Biochemical, ultrastructural, and ecological aspects of stable host-microbe interactions; principally between prokaryotes and eukaryotes. Discussion focuses on several systems including animal digestive tracts and nutritive and luminous organs. Considerable attention is also given to plant-microbe interactions, especially those involving *Rhizobium* and *Agrobacterium*. Prereq: gen. micro.; gen. biochem.; permission. Special fee. Lab. 4 cr.

814. Water Pollution Microbiology
Application of general principles of microbial ecology, disease, genetics, and physiology and of organic and inorganic chemistry to water pollution and its abatement. Prereq: gen. micro. 3 cr.

816. Advanced Immunology
Basic concepts in immunology including immuno-recognition, effector systems, immunogenetics, immunopathology, and comparative immunology. Prereq: gen. immunology; gen. biochem.; 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. micro.; permission. (Also offered as ANSC 851 and PBIO 851.) Lab. 4 cr.

893. Advanced Problems and Techniques in Microbial Cytology
Research with electron microscopy. Includes reading, organized seminars in microbial cytology, recent advances in electron microscopy, and laboratory project work. Prereq: MICR 810; 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.)

902. Microbial Physiology
Means by which microorganisms survive: nutritional, chemical, physical factors; metabolism and its regulation; generation of cell ultrastructure; ecological interactions. Prereq: gen. micro.; gen. biochem. Lab. 2 or 4 cr. (Not offered every year.)

904. Advanced Microbial Genetics
Advanced studies in expression, regulation, recombination, and transmission of genetic information in prokaryotic microorganisms. Prereq: MICR 804; permission. (Also offered as GEN 904.) Lab. 4 cr. (Not offered every year.)

997. 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: John E. Rogers
Professors: Keith Polk; Mary H. Rasmussen; John E. Rogers; David E. Seiler
Adjunct Professor: Clark Terry
Associate Professors: Ruth S. Edwards; Stanley D. Hettinger; Cleveland L. Howard; Christopher Kies; W. Niel Sir; Robert Stibler; Peggy A. Vagts; Larry J. Veal; Paul F. Verrette; Henry J. Wing, Jr.
Assistant Professors: Mark S. Deturk; Robert W. Eshbach; Nicholas N. Orovich; Kathleen Wilson Spillane
Graduate Program Coordinator: Henry J. Wing, Jr.

Degrees Offered

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.

Admission Requirements

Master of Arts in Music 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 music theory and music history are required of all applicants. 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 in Music Education
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 music theory and music history are required of all applicants. 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.

M.A. Degree Requirements

The degree of master of arts in music, while designed basically for students interested in broadening their knowledge of the history of music, has proven valuable to students who wish to augment undergraduate degrees in performance and/or music education with more intensive studies in music theory, music literature, and performance-practice. The following courses (or their approved equivalents) are required: MUSI 955, 956, 957, 958, 991, and 994. Courses at the 800 and 900 levels in music, or at the 700, 800, and 900 levels in other departments, may be elected, with the approval of the student's adviser, to augment the required courses for a minimum total of 30 credits. Students emphasizing performance-practice are encouraged to give a graduate recital. 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.

M.S. Degree Requirements

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, and theory. The following courses are required: MUED 983 or 984; MUED 995 and 996; and MUSI 994 and 995. Also required are two graduate-level courses in the Department of Education as approved by the adviser. Vocal or instrumental study at the 800 level is required to a minimum of 4 credits. Each candidate will be required to complete an independent project (MUED 995) of a substantive nature in an area of the candidate's special interest as approved by the adviser. Sufficient electives must be taken to bring the total credits to 30. A comprehensive exam concerning the application of philosophical, sociological, psychological, and technical aspects of music education completes the program.

History and Literature

807. 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. 3 cr.

809. 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. 3 cr.

811. 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. 3 cr.

832. 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. 3 cr.

833. Survey of Opera
History of the genre from Monteverdi to the present. Representative masterpieces by Handel, Mozart, Beethoven, Weber, Wagner, Verdi, Mussorgsky, Debussy, Berg, and others. 3 cr.

835. 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. 3 cr.

895. Special Studies in Music
A) J. S. Bach; B) Franz Schubert; C) Debussy and Ravel; D) The World of Jazz; E) The Iconography of Western European Musical Instruments; F) 19th-Century French Music; G) Advanced Analysis; H) Advanced Study in Electronic Music; I) Composition through Computer-generated Sound; J) Woodwind Literature; K) Brass Literature; L) String Literature; M) Medieval Performance Practice; N) Renaissance Performance Practice; O) Baroque Performance Practice; P) Classical Performance Practice; Q) 19th-Century Performance Practice; R) 20th-Century Performance Practice; S) Woodwind Repair; T) String Repair; U) Advanced Jazz Improvisation; V) Advanced Piano Pedagogy; W) Advanced Accompanying; X) Advanced Conducting; Y) Independent Study. Prereq: permission. May be repeated for credit with permission. 1–4 cr.

955. 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.

956. Readings in Music History: Antiquity to 1600
An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

957. Readings in Music History: 1600–1820
An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

958. 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.

991. Research Seminar
Guidance in individual research projects. Prereq: permission. 1–4 cr.

995. 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

871-872. 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.

875-876. Composition
Construction of phrases, periods, and short compositions following classical models. Problems of text-setting. Prereq: music theory II or permission. 3 cr.

877. Advanced Composition
Continuation of MUSI 876. Individual compositional projects. Prereq: MUSI 876 and permission. May be repeated for credit. 3 cr.

879. 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. 3 cr.

881, 882. Analysis: Form and Structure
An introduction to analytical techniques through the study of representative masterworks; formal and structural elements and their interrelationships. Semester I: analysis of 18th- and 19th-century works; semester II: analysis of 20th-century works. Prereq: music theory II or permission. 2 cr.

885. Electronic Sound Synthesis
Analog and digital synthesizers, methods of sound synthesis (e.g., fm synthesis), MIDI programming in BASIC, control programs for synthesizers (e.g., Personal Composer). 4 cr. (Generally offered Spring.)

895. Special Studies in Music
Refer to History and Literature section.

994. 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.

995. Independent Study in the History and Theory of Music
Refer to History and Literature section.

Performance

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 courses 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 Violin, Viola

846. Graduate Violoncello, String Bass

847. Graduate Woodwind

848. Graduate Bass

849. Graduate Percussion

850. Graduate Harp

851. Graduate Early Wind Instruments

895. Special Studies in Music
Refer to History and Literature section.

Music Education (MUED)

841-842. 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.

843. 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.

845-846. 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.

847-848. 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.

849. 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.

851. 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.

885. 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.

887-888. 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.

891-892. 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.

895. 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.

983. 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.

984. Choral Literature and Its Performance
Analysis, discussion, and conducting of excerpts from choral masterpieces from all major periods and styles. Students 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.

995. Special Projects in Music Education
Independent study, investigation, or research in music education. Creative projects may be included. Prereq: permission. 1–4 cr.

996. 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.

Nursing (NURS)

Chairperson: Karen R. Johnson
Associate Professors: Maureen Giuffre; Karen R. Johnson; Juliette D. Petillo; Raelene Shippee-Rice; Margaret W. Spears; Rosemary Y. Wang; Carol L. Williams
Assistant Professors: Margaret A. Crowley; Gene E. Harkless; Anne L. Lacey

Degree Offered

The Department of Nursing offers the master of science degree in nursing. Two specialty areas are offered: adult health nursing and nursing administration.

Admission Requirements

Applicants are required to have (1) a baccalaureate degree with an upper-division nursing major from an NLN-accredited program and a grade-point average of 3.00 on a 4.00-point scale; (2) current registered nurse licensure for practice in the United States; (3) evidence of current experience in professional nursing practice; (4) evidence of skill in physical assessment; (5) official scores on the Graduate Record Examination general test; (6) three professional references evaluating the applicant's potential for success in graduate study and leadership in nursing; (7) completion of a course in introductory statistics and nursing research; (8) a written statement of goals and objectives.

M.S. Degree Requirements

The program for the master of science degree includes a total of 39 credits. It is designed to be completed within 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:

1) *Core courses (12 credits):* Courses required of all students include (a) foundation and role courses (8 credits): 900, 901, 904; and (b) research courses (4 credits): 902 and 903.

2) *Specialty courses (18 credits):* Courses required for each area of specialization include, for adult health nursing: 910, Advanced Nursing Concepts in Adult Health; 911, Clinical Decision Making in Nursing; 912, Advanced Practice of Nursing in Adult Health; 919, Role Practicum and Seminar in Nursing Care of Adults; and 920, Administrative Theories of Nursing. For nursing administration: 910, Advanced Nursing Concepts in Adult Health; 920, Administrative Theories of Nursing; 921, Administrative Context for Quality Nursing Care Delivery; 922, Re-

source and Financial Management in Nursing; and 929, Role Practicum and Seminar in Nursing Administration.

3) *Elective courses (3–6 credits):* Three or six credits of elective coursework are required based upon the student's choice of master's thesis or project option. If the project is taken for three credits, the student will select a three-credit elective associated with and supportive of the project.

4) *Master's thesis (6 credits) or master's project (3–6 credits):* A student may elect either a thesis or nonthesis option. A formal presentation of the completed project or thesis is required.

900. The Discipline of Nursing
Nursing as a discipline with a focus on paradigms for nursing science, patterns of knowing, concept analysis, and nursing theory. Emphasis on concepts fundamental to nursing practice, including advocacy, caring, power, and collaboration; analysis of nursing theories in relation to practice and research. Prereq: permission. 3 cr.

901. The Changing Role of Professional Nursing and the Health-Care System
Examination of issues affecting the practice of contemporary nursing. Emphasis on the systematic analysis of nursing and health-care system problems from multiple vantage points including historical, social, political, economic, legal, and ethical perspectives. Students present the strengths and limitations of current proposed solutions to specific problems in health policy, such as entry into nursing practice, indigent health-care policy, and the role of the nurse as advocate. Students then construct new approaches to the problems and argue their merits. Prereq: permission. 3 cr.

902. Research in Nursing I
Overview of current research in nursing. Importance of research for the development of a professional discipline and the importance of understanding ethical issues for the researcher, practitioner, and consumer. Emphasis on quantitative research methodologies and appropriate research designs for selected clinical questions. Pre- or coreq: NURS 900 or permission. 2 cr.

903. Research in Nursing II
Introduction to dominant paradigm and new paradigm qualitative nursing research methods including sampling, data collection, analysis, evaluation, utilization, and communication. Ethical implications and the nature of the research-participant relationship are addressed. Prereq: NURS 902 or permission. 2 cr.

904. Role Development Seminar
Analysis of role development and role enactment in professional nursing practice. Focus on roles related to specialization including those of advocate, researcher, educator, and consultant. Prereq: NURS 900 or permission. 2 cr.

910. Advanced Nursing Concepts in Adult Health
Theoretical course investigating the major health problems among adults. Focus on theory and research pertaining to selected concepts and those dimensions critical to nursing practice. Pre- or coreq: NURS 900 or permission. 3 cr.

911. Clinical Decision Making in Nursing
In-depth analysis of client health problems, integrating theoretical, ethical, empirical, and interpretive perspective leading to the development of an assessment data base for nursing diagnosis, intervention, and evaluation. Emphasis on clinical decision making and application of nursing theories to practice. Prereq: NURS 900; 910;/or permission. 3 cr.

912. Advanced Practice of Nursing in Adult Health
Application of nursing diagnoses and clinical management of health problems of adult populations. Analysis of theories and concepts applicable to nursing interventions. Emphasis on research-based clinical nursing practice. Prereq: NURS 911. 3 cr.

919. Role Practicum and Seminar in Nursing Care of Adults
Role development preceptorship in the clinical setting; integration of consultation, patient education, and research into specialist role. Seminar directed at evaluation of the effectiveness and appropriateness of theories in practice. Interactive learning opportunities for students in clinical specialization and nursing administration. Prereq: permission. 6 cr.

920. Administrative Theories in Nursing
Exploration of administrative theories and organizational behavior concepts. Application of administrative theory to the practice of nursing administration in current and emerging health care settings. Role of the nurse executive and issues facing women in management are examined. Pre- or coreq: NURS 900 or permission. 3 cr.

921. Administrative Context for Quality Nursing Care Delivery
Examination of administrative context of nursing practice and the impact of internal and external forces. Identification of strategies to achieve efficient and effective quality nursing care. Focus on creating a climate that enhances nursing practice, education, and research. Prereq: 920 or permission. 3 cr.

922. 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 effective nursing administration. Analysis of concepts and principles of administration, supervision, and consultation. Prereq: NURS 920 or permission . 3 cr.

929. Role Practicum and Seminar in Nursing Administration
Role development preceptorship in the clinical setting; integration of consultation, patient education, and research into specialist role. Seminar directed at evaluation of the effectiveness and appropriateness of theories in practice. Interactive learning opportunities for students in clinical specialization and nursing administration. Prereq: permission. 6 cr.

994. 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.

996. 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 Project
Opportunity to develop, implement, and evaluate a project relevant to the practice setting. Prereq: permission. 3 or 6 cr. (An "IA" course.) Cr/F.

899. Master's Thesis
Prereq: permission. 6 cr.

Occupational Education (VTAE)

Program Coordinator: David L. Howell
Professor: William H. Annis
Associate Professors: Peter J. Horne; David L. Howell; Lewis Roberts, Jr.
Assistant Professor: Patricia D. Dugan-Bedker

Degree Offered

The program in occupational 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.

Admission Requirements

Applicants 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 Analogies Test, in addition to the materials required by the Graduate School.

Master of Occupational Education Degree Requirements

All students are required to take VTAE 912, Introduction to Research; VTAE 998, Vocational/Technical and Adult Education Seminar (1–2 cr.); and VTAE 802, Concepts of Vocational/Technical and Adult Education. Students concentrating in the area of vocational/technical education must also complete VTAE 901, Advanced Methods and Materials of Instruction. Students concentrating in adult education are required to take VTAE 990, Programming in Adult Education.

A graduate guidance committee consisting of a minimum of two faculty from occupational education plus one other graduate faculty is appointed for each student. Prior to the completion of 12 credit hours, the individual's graduate program is approved by the student's graduate committee. A minimum of 18 credit hours within the program is required. The committee, working with the candidate, makes every effort to provide a total program that reflects the goals of the individual.

Students must select a thesis or nonthesis option. Students completing a thesis are required to defend it orally. Students following the nonthesis option are 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.

800. Workshops in Vocational/Technical and Adult Education
Modularized instruction of in-service education. Focus varies with the needs of the student. May be repeated up to 8 credits. 1–2 cr.

802. Concepts of Vocational/Technical and Adult 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. 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 degree candidates in VTAE concentrations. 4 cr.

852. Youth Organizations
Organizational Development: advising youth organizations; teaching parliamentary procedure; developing programs and activities; leadership. organizations.

FFA/SOEP (Future Farmers of America/Supervised Occupational Experience Programs for high school youth).

VICA (Vocational Industrial Clubs of America).

4-H (Cooperative Extension Youth Program). 4 cr.

883. 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.

891. 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.

896. 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.

900. 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.

901. 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.

903. Administration and Supervision of Vocational Education
Students identify 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.

904. 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.

905. 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.

906. 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.

908. 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.

909. 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 membership to the general welfare of the area and the development of a public relations program. 4 cr.

911. 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.

912. 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 is examined in terms of selection and formulation of research problems, design, techniques of data collection, analysis, and interrelation of data and reporting. 4 cr.

920. 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.

990. Programming in Adult 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 and to educational programs in both the Cooperative Extension Service and continuing education. Required for master's degree candidates concentrating in adult education. 4 cr.

995. Independent Study
Individual study problems in various phases of vocational/technical and adult education. Prereq: permission. May be repeated. 2–6 cr.

998. 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.

Ocean Engineering (OE)

Coordinator: Kenneth C. Baldwin
Professors: Wendell S. Brown; Robert W. Corell; Stephen S.T. Fan; Albert D. Frost; David E. Limbert; Godfrey H. Savage; Kondagunta Sivaprasad
Associate Professors: Kenneth C. Baldwin; Thomas P. Ballestero; Jean Benoit; Barbaros Celikkol; Pedro A. De Alba; Allan Drake; David L. Gress; Nancy E. Kinner; Donald W. Melvin; M. Robinson Swift
Research Associate Professor: James D. Irish

Degree Offered

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.

Admission Requirements

Applicants to the program should have completed a baccalaureate degree in either chemical, civil, electrical, or mechanical engineering or have an equivalent background.

M.S. Degree Requirements

Each student in the program is required to take ESCI 858, Introductory Physical Oceanography and OE 990, 991, Ocean Engineering Seminar I, II. In addition, each student must select three of the following six courses: OE 881, Physical Instrumentation; OE 810, Ocean Measurements Laboratory; OE 853, Ocean Hydrodynamics; OE 854, Ocean Waves and Tides; OE 885, Underwater Acoustics; and ESCI 959, Data Analysis Methods in Ocean and Earth Sciences. Students are also required to take a minimum of 12 credits of additional coursework and complete a master's thesis for 6 credits. Normally the additional courses are in the student's field of engineering.

810. 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. 4 cr.

851. 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 ME 851.) 4 cr.

852. 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 ME 852.) 4 cr.

853. 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.

854. Ocean Waves and Tides
Introduction to waves: small-amplitude, linear wave theory, standing and propagating waves, transformation in shallow water, energy and forces on structures, generation by wind and specification of a random sea, long waves with rotation, and internal waves. Introduction to tides: description of tides in ocean tidal generation forces, equilibrium tide, and tidal analysis. Lab/project: field and lab measurements with computer analysis. Prereq: gen. physics; differential equations;/or permission. (Also offered as EOS 854.) Lab. 4 cr.

857. 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 CIE 857 and ME 857.) 3 cr.

861. 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.

881. 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 EE 881.) 4 cr.

885. 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 EE 885.) 4 cr.

895. Special Topics in Ocean Engineering
New or specialized courses and/or independent study. May be repeated for credit. 2–4 cr.

937. 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.

990, 991. Ocean Seminars I, II
Various topics, including marine systems design, marine vehicle operation, data collecting and processing, and marine law. 2 cr.

998. 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: Stephen H. Hardy
Professor: Robert Kertzer
Associate Professors: Katherine Amsden; Michael A. Gall; Stephen H. Hardy; Phyllis A. Hoff; Walter E. Weiland
Assistant Professors: Ronald C. Croce; Neil B. Vroman; Sally A. White
Graduate Program Coordinator: Stephen H. Hardy

Degree Offered

The Department of Physical Education offers a master of science degree with the following areas of concentration: exercise science, sport studies, and special physical education with an emphasis in pediatric exercise and motor behavior.

Admission Requirements

Admission is based on undergraduate preparation, academic record, Graduate Record Examination general test scores, and letters of recommendation. 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.

M.S. Degree Requirements

Students in the exercise science concentration must follow the thesis plan; students in the sport studies and the special physical education concentrations may follow either the thesis or the nonthesis plan. All degree candidates will be required to take 800, Applied Statistics; 901, Analysis of Professional Literature; the designated concentration core; and electives as required.

Exercise science core: 822, Graded Exercise Testing and Exercise Prescription; 832, Electrocardiography; 833, Environmental physiology; two semesters of 902, Colloquium.

Sport studies core: 841, Sport in Society; 880, Psychological Factors in Sport; and one adviser-approved PHED elective at the 800 or 900 level.

Special physical education core: 902, Colloquium; 909, Special Physical Education Practicum/Seminar; 942, Diagnostic/Prescriptive Psychomotor Assessment; 944, Physical and Medical Aspects of Disabling Conditions; and 12 credits of adviser-approved electives.

Any remaining coursework in the concentrations should 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 895, Advanced Studies, are required. A student may take 895 only after completing at least three approved graduate courses including 901.

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: measurement procedures or equivalent. 4 cr.

806. Neurology
Morphology, physiology, and histology of the human nervous system. Prereq: human anatomy and physiology. Lab. 4 cr.

822. 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.

823. Epidemiology of Exercise
Considers the hazards and benefits of exercise, physical activity, and physical fitness in relation to health from an epidemiological perspective. Prereq: phys. of exercise. 4 cr.

832. Electrocardiography
Introduction to electrocardiographic interpretation. Prereq: physiology of exercise or equivalent; permission. 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.

841. 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: intro. soc. or permission. 4 cr.

880. 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 perceptual motor learning. 4 cr.

881. Special Physical Education Pedagogy
Overview of special physical education. Corrective, developmental, and adapted approaches addressed in accordance with the physical and motor behaviors of children with special needs. 4 cr.

885. Applied Behavior Management
Overview of applied behavior management procedures used in special physical education. A number of investigations and approaches utilized by researchers and practitioners in the field are described, practiced, and critically analyzed. Provides practical and philosophical understanding of behavior management, which can be applied with children who continually misbehave, exhibit behavior disorders, or have an emotional disturbance. 4 cr.

895. Advanced Studies
Independent study problems. Prereq: permission of graduate adviser. May be repeated up to 8 cr. 2–4 cr.

898. 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.

901. Analysis of Professional Literature
Critical interpretation of professional literature. 4 cr.

902. 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.

903. 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. Cr/F.

909. Special Physical Education Practicum/ Seminar
Prepares master teachers to employ many teaching skills so that they can interact effectively in educational environments. Methods for a special physical education teacher to design and implement an educational program for children with disabilities that is congruent with the idiosyncrasies of a realistic school situation. 2 cr. Cr/F.

925. Functional Kinesiological Analysis & Remediation
Examination of normal and pathological movement patterns; important anatomical, physiological, and biomechanical variables constraining movement organization; and appropriate programs for ameliorating physical and motor dysfunction in special populations.

Prereq: kinesiology or equivalent; physiology of exercise. Lab. 4 cr.

942. Diagnostic/Prescriptive Psychomotor Assessment
Overview of diagnostic and prescriptive procedures used in special physical education. Psychomotor assessment instruments utilized by practitioners in the field are described, practiced, and critically analyzed. Provides a practical and philosophical understanding of psychomotor assessment, which can be applied when discerning level of performance in children with special needs. Prereq: measurement procedures in physical education. Lab. 3 cr.

944. Physical and Medical Aspects of Disabling Conditions
A study of disabilities caused by anomalies found within neurological, cardio-respiratory, sensory, and musculoskeletal systems. Programming techniques necessary for physical and motor development relative to present physiological and kinesiological functioning are addressed. Prereq: adapted physical education. 3 cr.

960. 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.

899. Master's Thesis
6 cr.

Physics (PHYS)

Chairperson: Jochen Heisenberg
Professors: Roger L. Arnoldy; L. Christian Balling; John R. Calarco; Edward L. Chupp; John F. Dawson; Lennard A. Fisk; Jochen Heisenberg; Richard L. Kaufmann; Robert H. Lambert; John A. Lockwood; Lyman Mower; John E. Mulhern, Jr.; Harvey K. Shepard; Robert E. Simpson; William R. Webber; John J. Wright
Research Professors: Joseph V. Hollweg; Martin A. Lee
Associate Professors: F. William Hersman; Roy B. Torbert
Research Associate Professors: Terry Forbes; David J. Forrest; James M. Ryan
Assistant Professor: Dawn C. Meredith
Research Assistant Professors: George A. Simpson; W. T. Vestrand
Graduate Program Coordinator: L. Christian Balling

Degrees Offered

The Department of Physics offers the degrees of master of science, master of science for teachers, and the doctor of philosophy. Areas of specialization are space physics and astrophysics, nuclear physics, atomic and molecular physics, and nonlinear dynamical systems.

Admission Requirements

Applicants for the degree of master of science for teachers must hold secondary school teacher certification in physics or in general physical science.

Applicants to the master of science and doctor of philosophy programs are expected to have a bachelor's degree in science, with at least 24 credits in physics and closely allied fields.

M.S. Degree Requirements

The courses required for the master of science in physics include PHYS 805, 931, 939, 941, and 943. Students 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 6 semester hours' work, and pass an oral examination on the thesis.

Master of Science for Teachers Degree Requirements

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.

Ph.D. Degree Requirements

The courses required for a doctor of philosophy degree in physics are (1) 805, 931-932, 935, 939-940, 941-942, 943-944; and (2) any additional four full courses at the 900 level, excluding 969, 989, 997, and 999. (For students doing Ph.D. research in astrophysics or space physics, one of these four courses must be 951 or 952.)

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. Upon completion of a dissertation, doctoral candidates will take an oral examination based upon the area of their research.

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 provisions may be made. A cooperative program with the Department of Electrical and Computer Engineering is available to master's students in physics. Physics students specializing in space science may complete M.S. or Ph.D. theses under the guidance of professors or research professors in the Institute for the Study of Earth, Oceans, and Space. (See EOS.) Contact the department chairperson or graduate adviser for details.

801-802. Introduction to Quantum Mechanics I and II
Nonrelativistic Schroedinger equation, the hydrogen atom, applications to atomic and nuclear structure. Prereq: diff. equations; multidim. calculus;/or permission. Intro. mathematical physics course desirable. 4 cr.

803-804. 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. equations; multidim. calculus;/or permission. Intro. mathematical physics course desirable. 4 cr.

805. 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.

810. 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: phys. mechanics; diff. equations;/or permission. 4 cr.

818. 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. equations, multidim. calculus. 4 cr. (Not offered every year.)

895. Independent Study
Individual project under direction of a faculty adviser. Prereq: department permission. 1–8 cr.

931-932. Mathematical Physics
Complex variables, differential equations, asymptotic methods, integral transform, 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.

935. Statistical Physics
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: PHYS 931; PHYS 943;/or permission. 3 cr.

939-940. Theoretical Mechanics I and II
Newtonian, Lagrangian, and Hamiltonian formulation of the classical mechanics of particles and rigid bodies; continuum mechanics. Topics that serve as background for the study of modern physical theories are emphasized. 3 cr.

941-942. Electromagnetic Theory
The formulation and detailed application of electromagnetic theory to physical problems. Prereq: permission. 3 cr.

943-944. Quantum Mechanics
Wave mechanical and Dirac formulations of nonrelativistic quantum mechanics. Prereq: permission. 3 cr.

951-952. Plasma Physics I and II
Kinetic theory of plasmas; plasma waves, instabilities, turbulence, diffusion, adiabatic motion of charged particles, nonlinear plasma phenomena. Prereq: PHYS 935 or permission. 3 cr. (Not offered every year.)

953. Solar Magnetohydrodynamics
Introduction to solar physics, with emphasis on gas dynamics and magnetic fields. Interior structure, the theory of convection, wave motions in the presence 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.)

954. 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 are reviewed. Prereq: permission. 3 cr. (Not offered every year.)

961-962. 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 939; PHYS 944. 3 cr. (Not offered every year.)

963-964. 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 944. 3 cr. (Not offered every year.)

965. Solid State Physics
Development of quantum mechanical theory of solids, transport phenomena, etc. Prereq: PHYS 943; PHYS 935. 3 cr. (Not offered every year.)

969. Nuclear Physics Seminar
Lectures and discussion of current topics in nuclear and particle physics. 1–3 cr.

987, 988. Introduction to Space Science I and II
Topics are 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.)

989. 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.

991. Problems in Theoretical Physics
May be repeated to six credits. 1–3 cr. (Offered on request.)

993. Problems in Experimental Physics
May be repeated to six credits. 1–3 cr. (Offered on request.)

995. 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.

997. Colloquium
Required of all graduate students. Topics to be selected. 0 cr.

899. Master's Thesis
6 cr.

999. Doctoral Research

Plant Biology (PBIO)

Chairpersons: Thomas C. Harrington; Owen M. Rogers
Professors: Robert O. Blanchard; A. Linn Bogle; George O. Estes; Yun-Tzu Kiang; J. Brent Loy; William E. MacHardy; Arthur C. Mathieson; Subhash C. Minocha; Lincoln C. Peirce; Owen M. Rogers; Douglas G. Routley; Otho S. Wells
Associate Professors: Alan L. Baker; Garrett E. Crow; Thomas C. Harrington; Leland S. Jahnke; Thomas D. Lee; James R. Mitchell; James E. Pollard; John M. Roberts
Assistant Professors: Thomas M. Davis; Wayne R. Fagerberg
Graduate Program Coordinators: Thomas D. Lee; Lincoln C. Peirce

Degrees Offered

The Department of Plant Biology offers the master of science and the doctor of philosophy degrees. Research opportunities are available in both basic and applied areas of plant biology, including breeding and genetics, cell biology, cell and tissue culture, crop management, ecology, genetic engineering, marine and freshwater biology, morphology and anatomy, mycology, pathology, phycology, physiology, and systematic botany.

Admission Requirements

Applicants are expected to have adequate preparation in plant biology and in the physical sciences; they must also submit general and subject biology scores for the Graduate Record Examination.

M.S. Degree Requirements

Students will meet the Graduate School's requirements for the degree. Students will be required to write and defend a thesis based on field or laboratory research and pass a comprehensive examination.

Ph.D. Degree Requirements

Students will complete a program of study as determined by their guidance committee. Students will be advanced to candidacy after successfully completing comprehensive written and oral qualifying examinations. Candidates must successfully defend a dissertation based on original research in plant biology. For some program areas, a foreign language may be required at the discretion of the student's guidance committee.

Teaching Requirements

Teaching experience is required of all M.S. and Ph.D. degree students. The require-

ment may be fulfilled by enrolling in a supervised teaching course, by serving as a teaching assistant, or by having previous professional teaching experience.

801. The Research Process
For first-year M.S. and Ph.D. program and undergraduate honors students in biological sciences. Philosophy, logic, ethics in science; techniques of organization and design of research and of data presentation. 2 cr. Cr/F.

803. Topics in Developmental Plant Physiology
A) Plant Hormones: chemical nature, uptake, translocation, biosynthesis, and metabolism of plant hormones; mechanism of hormone action; B) Stress Physiology: physiological effects of environmental stress (heat, cold, drought, air pollution, etc.) on plant growth and 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. 2 cr.

805. Population Genetics
Population growth and regulation; genetic variation; factors affecting gene frequency; ecological genetics. Prereq: prin. of genetics or permission. (Also offered as GEN 805.) 4 cr. (Not offered every year.)

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 are examined. Prereq: plant physiology or biochem. 4 cr. (Not offered every year.)

814. Electron Microscopy
Theory and principles involved in preparing plant and animal tissue for observation with the transmission (TEM) and scanning (SEM) electron microscopes; X-ray analysis (EDAX); freeze-fracture; including shadow casting and photographic techniques, and presentation of micrographs for publication. Prereq: permission. Coreq: PBIO 815. 2 cr.

815. Electron Microscopy Lab
Practical application of theoretical principles and practices utilized in preparing and observing plant and animal tissues with the transmission and scanning electron microscopes. Student project assigned. Prereq: permission. Coreq: PBIO 814. 3 cr.

817. 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: general ecology or equivalent. (Also offered as ZOOL 817.) 4 cr.

819. Field Limnology
Freshwater ecology examined through laboratory exercises with freshwater habitats. Methods used to study freshwater lakes; interpretation of data. Seminars and occasional Saturday field trips. Prereq: general limnology or permission. (Also offered as ZOOL 819.) Lab. 4 cr.

821. 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.

822. Marine Phycology
Identification, classification, ecology, and life histories of the major groups of marine algae, particularly the benthonic marine algae of New England. Periodic field trips. Prereq: elem. bot. or survey of the plant kingdom. Lab. 4 cr. (Not offered every year.)

823. 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: marine phycology or permission. Lab. 4 cr. (Not offered every year.)

824. Freshwater Algal Ecology
Survey of freshwater algal habitats; physiological explanation of population models. Individual experimental projects. Prereq: microscopic algae, general limnology;/or permission. 4 cr.

827. Algal Physiology
Survey of major topics in the physiology and biochemistry of marine and fresh water algae including nutrition, metabolic pathways, reproductive physiology, storage and extracellular products, cell inclusion, growth and development. Prereq: plant physiology and intro. biochem. or permission. 2 cr. (Not offered every year.)

829. 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: PBIO 827. 2 cr. (Not offered every year.)

832. Cell Biology
The cell concept and the relationship of cell structure to function. The importance of cell-to-cell communication, replication, and the factors controlling cell structure in the function of the whole organism. Major tools used by the cell biologist to study cells. Prereq: one year of biology and an intro. chem. course. 4 cr.

840. 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: prin. of genetics or permission. (Also offered as GEN 840.) 4 cr. (Not offered every year.)

842. 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.

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 modeling of succession. Occasional Saturday field trips. Prereq: intro. statistics and intro. ecology. Lab. 4 cr. (Not offered every year.)

847. 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 or permission. Lab. 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. Prereq: 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.

852. Mycology
Classification, identification, culturing, life histories, and ecology of parasitic and saprophytic fungi; their role in the environment and human affairs. Prereq: elem. bot. Lab. 4 cr.

853. Cytogenetics
Chromosome structure, function, and evolution. Eukaryotic genome organization. Theory of, and laboratory techniques for, cytogenetic analysis in plants and animals. Prereq: prin. of genetics. Special fee. Lab. 4 cr. (Not offered every year.)

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.)

856. Topics in Agricultural Applications of Statistics and Computing
Two-credit, seven-week modules offered in the middle of the spring semester. A) Current Ap-

plication 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.

858. Plant Anatomy
Anatomy of vascular plants; structure and development of basic cell and tissue types and the major organs of woody plants. Prereq: intro. bot. or survey of the plant kingdom or prin. of biol.; permission. 5 cr.

861. Plant Geography
Distribution of plants, a consideration of world vegetation types and floras, with emphasis on North America. Major influential factors such as geologic, climatic, edaphic, and biotic. Includes such topics as island biogeography, continental drift, and the historical development of floras from the Tertiary through the Pleistocene to major floras of today. Prereq: plant taxonomy or permission. 4 cr. (Not offered every year.)

862. 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 or prin. of biol. Lab. 4 cr. (Not offered every year.)

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

867. Advanced Systematic Botany
Principles of plant classification and rules of nomenclature; plant families; field and herbarium work. Prereq: plant taxonomy. 4 cr.

868. Optical Microscopy and Photomicrography
Theory and techniques for the optimal use of the optical microscope, including bright field and dark field modes; various types of condensers; camera equipment; films, filters, and photographic techniques. Prereq: permission. Special fee. Lab. 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.

873. Breeding Improved Varieties
Techniques for creating new varieties of crop and ornamental plants. Prereq: genetics. Coreq: PBIO 973. 3 cr.

874. Plant Cell Culture and Genetic Engineering
Theory and techniques of cell/tissue culture and genetic manipulation in plants, transformation vectors, somatic cell genetics, regulation of foreign gene expression, molecular basis of agriculturally important traits, environmental and social implications of genetic engineering in plants. Prereq: genetics or permission. Coreq: PBIO 875. (Also offered as GEN 874.) 3 cr.

875. Plant Cell Culture and Genetic Engineering Lab
Techniques of plant cell and tissue culture, protoplast fusion, genetic transformation. Mutant cell selection, analysis of foreign gene expression. (Also offered as GEN 875.) Coreq: PBIO 874. Special fee. 2 cr.

876. Radiation Biology
Nature, sources, and behavior of ionizing radiation and its interaction with biological systems. Detection, measurement, and dosimetry techniques. Radiation effects on cells, organs, and organisms. Radiotracer techniques in biological research and medicine. Terrestrial and marine radioecology; pathways through the food chain. Environmental radioactivity, nuclear power, weapons systems, and waste disposal. Lab. 4 cr.

895. Investigations in Botany
A) Systematic Botany; B) Plant Physiology; C) Plant Pathology; D) Plant Anatomy; E) Plant Ecology; F) Mycology; G) Cell Biology; H) Phycology; I) Botanical Teaching; J) Morphology; K) Cell Physiology; L) Scientific Writing; M) Microtechnique; N) Cell and Tissue Culture; O) History of Botany. Individual projects under faculty guidance. Prereq: permission. 1–6 cr.

902. 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 902.) 4 cr. (Not offered every year.)

922. Advanced Marine Phycology
Classification, ecology, and life histories of marine algae considered at an advanced level. Seminars, discussion, assigned reading, and laboratory. Prereq: marine phycology or equivalent. 4 cr.

959. Advanced Mycology
Biology, isolation, and identification of fungi treated at an advanced level. Assigned readings and a collection required. Prereq: mycology or equivalent. Lab. 4 cr. (Not offered every year.)

973. Topics in Crop Improvement
Discussion and assigned readings in crop breeding. Coreq: PBIO 873. 1 cr.

977. Supervised Teaching for Graduate Students
Students plan and present lectures, recitations, and/or teach laboratories in selected plant biology courses with faculty supervision and evaluation. Prereq: permission. 2 cr. Cr/F.

985. Advanced Topics in Plant Biology
Discussions of current topics in selected areas of plant biology. A) Systematic Botany; B) Plant Physiology; C) Plant Pathology; D) Plant Anatomy; E) Plant Ecology; F) Mycology; G) Cell Biology; H) Phycology; I) Plant Genetics; J) Plant Evolution; K) Plant Utilization; L) Morphology; M) Plant Cell Physiology; N) Developmental Plant Biology. Prereq: permission. 2 cr.

995. Research in Plant Biology
Supervised research projects in selected areas of plant biology. A) Systematic Botany; B) Plant Physiology; C) Plant Pathology; D) Plant Anatomy; E) Plant Ecology; F) Mycology; G) Cell Biology; H) Phycology; I) Morphology; J) Cell Physiology; K) Microtechnique; L) Cell and Tissue Culture; M) Plant Genetics; N) Crop Management; O) Developmental Plant Biology. Prereq: permission. 1–6 cr.

997. Graduate Seminar
Library research and discussion of current topics of plant biology. Required of all graduate students majoring in plant biology. 1 cr.

899. Master's Thesis
6–10 cr.

999. Doctoral Research

Political Science (POLT)

Chairperson: Robert E. Craig
Professors: Bernard K. Gordon; David L. Larson; David W. Moore; George K. Romoser; B. Thomas Trout
Associate Professors: Warren R. Brown; Robert E. Craig; John R. Kayser; Lawrence W. O'Connell; Susan O. White; Clifford J. Wirth
Assistant Professors: Judith A. Gentleman; Aline M. Kuntz; Susan J. Siggelakis
Graduate Program Coordinator: Lawrence W. O'Connell

Degrees Offered

The Department of Political Science offers the master of arts in political science and the master of public administration. Areas of specialization for the master of arts are political thought, American politics, comparative politics, and international politics.

Admission Requirements

Applicants are expected to have majored either in political science or a closely related field. Where undergraduate preparation has been insufficient, applicants may be admitted provided that they follow without credit a program of study approved by the chairperson. The Graduate Record Examination general test is required for the M.A.; either the Graduate Record Examination general test or the Graduate Management Admission Test is required for the M.P.A.

M.A. Degree Requirements

This program is normally to be completed in a single calendar year (an academic year plus the following summer) and is based on three elements: the development of advanced knowledge in at least three fields of the department, research, and familiarization with modern methodology in the discipline. Each student will complete seven courses and seminars (28 credits) and a master's thesis (8 credits).

Students must include at least one seminar or advanced course in each of the four fields of the discipline emphasized by the department.

Master of Public Administration Degree Requirements

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. Students will be required to complete eight full courses (32 credits) and a four-credit internship program (POLT 970, Administrative Internship) for a total of 36 credits.

Of the eight courses, three are required core courses (POLT 905, POLT 906, POLT 907), two are elective courses in public administration and political science, and three may be selected from other departments in related fields, including administration, health management and policy, leisure management and tourism, resource economics, community development, and others.

Students who have had appropriate responsibility in public administration may be exempted from the internship upon petition for such exemption. Such students will be required to undertake independent research on an approved topic related to public administration (POLT 995 or 996, four credits).

A student may concentrate all three electives in one department or choose from separate departments. A student who concentrates three courses in leisure management and tourism may also take the internship under the direction of faculty in that department.

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.

American Politics and Public Administration

801. Courts and Public Policy
Impact of judicial decisions on public policy at federal, state, local, and regional levels. 4 cr.

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.

803. Urban and Metropolitan Politics
Planning and management of the urban community, intergovernment relations, administrative functions, and general urban problems. 4 cr.

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 policy-making decisions. 4 cr.

897, 898. Section B: Seminar in American Politics
Advanced analysis and individual research. 4 cr.

897, 898. Section F: Seminar in Public Administration
Advanced analysis and individual research, including opportunities for direct observation of governmental administration. 4 cr.

905. Methods of Policy Analysis
Research design, survey methods, experimental techniques, and aggregate data analysis applied to public policy settings. 4 cr.

906. 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.

907. 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

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.

897, 898. Section I: Seminar in Political Thought
Advanced treatment and individual research. 4 cr.

Comparative Politics

841. Politics of Industrialized States
Impact of modern industrialism and its organization upon political life and the conduct of government. 4 cr.

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.

843. Comparative Political Economy
Exploration of the origins, development, and functions of the modern state in the West, its links with markets and capitalism, and its role in contemporary political economy. Examples from various advanced industrial societies. 4 cr.

897, 898. Section C: Seminar in Comparative Politics
Advanced analysis and individual research on foreign nations or regions, focusing on governmental institutions, foreign policy, political parties, or bureaucracy. 4 cr.

International Politics

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.

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.

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 domes-

tic as well as international political considerations. 4 cr.

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.

897, 898. Section E: Seminar in International Politics
Advanced analysis and individual research; emphasis on developments in theory. 4 cr.

General Courses

970. Administrative Internship
Practical administrative experience in an area of professional interest. Prereq: M.P.A. candidate. 4 cr.

995, 996. 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 Leisure Management and Tourism

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: Victor A. Benassi
Professors: William M. Baum; Raymond L. Erickson; Gordon A. Haaland; John A. Nevin
Associate Professors: Victor A. Benassi; Ellen S. Cohn; Peter S. Fernald; Kenneth Fuld; Earl C. Hagstrom; John E. Limber; Robert G. Mair; Carolyn J. Mebert; Rebecca M. Warner; Daniel C. Williams; William R. Woodward
Assistant Professors: Kathleen McCartney; Edward J. O'Brien; William Stine

Degree Offered

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 have a broad knowledge of psychology, who can teach and communicate effectively, and who can carry out sound research in an area of specialization. Although some students seek employment outside academia, the program is oriented toward developing the skills required by the research psychologist who intends to become a college or university teacher.

Areas in which the student may specialize are cognition and psycholinguistics, developmental psychology, the history and theory of psychology, learning and behavior analysis, physiological psychology, sensation and perception, and social psychology. The department *does not* offer training in clinical or counseling psychology.

Admission Requirements

In addition to meeting the requirements for admission to the Graduate School, applicants must intend to be full-time students working toward the doctoral degree (not just the master's degree), and they must submit Graduate Record Examination general test scores and the score on the subject test in psychology along with other standard application forms, which can be obtained from the department. Before beginning graduate work, the applicant must have completed a minimum of 15 undergraduate credits in psychology, including courses in elementary statistics and experimental psychology.

Ph.D. Degree Requirements

Required courses include two semesters of the graduate proseminar (PSYC 901-902), three semesters of research methodology and statistics (PSYC 905-906; 907), and two semesters of the practicum and seminar in the teaching of psychology (PSYC 991-992). Work outside the department is also included in each student's program. Depth in a particular area is obtained through participation in advanced seminars and by independent reading and research conducted under the supervision of a faculty member. Since topics generally differ each time an advanced seminar is offered, advanced seminars may be repeated for credit.

Prior to the doctoral dissertation, the student carries out original research that culminates either in a master's thesis or a paper of publishable quality. A master's degree is awarded upon the successful completion of a program approved by the department and dean of the Graduate School. This typically takes place by the end of the second year.

The third year of the program is dedicated to the practicum and seminar on the teaching of psychology in conjunction with the teaching of introductory psychology.

Advancement to candidacy for the Ph.D. degree depends upon receiving the master's degree, the passing of a specialist examination in one of the department's areas of specialization, and identifying a topic for doctoral research. Advancement to candidacy is usually accomplished by the end of a student's third year in the program; the fourth year is generally devoted to dissertation research and to the teaching of an introductory course in the student's specialty area.

For more details about the graduate program, for application forms, and for a schedule of course offerings, contact the department. Approval of the instructor is required before registering for any graduate course.

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.

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 biochemi-

cal 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.

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.

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.

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.

881. Developmental Psychology
Concepts, issues, theories, and methods in developmental psychology and their role in research. Content areas include cognitive, language, social, and personality development. 4 cr.

901-902. Graduate Proseminar
An intensive, two-semester, team-taught introduction to the specialty areas represented by the department. 8 cr.

905-906. 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.

907. Research Methods and Statistics III
The application of multivariate methods of data analysis in psychological research: multiple regression, analysis of covariance, Hotelling's T2 multivariate analysis of variance, path analysis, discriminant functions, canonical correlation, factor analysis. 4 cr.

908. 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. May be repeated for credit. 4 cr.

914. 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. May be repeated for credit. 4 cr.

917. Advanced Seminar in Sensory and Perceptual Processes
Comprehensive examination of a specific topic in sensory and perceptual processes. May be repeated for credit. 4 cr.

933. 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. May be repeated for credit. 4 cr.

945. Advanced Seminar in Learning and Behavior Analysis
Current empirical and theoretical issues in learning and the analysis of behavior. May be repeated for credit. 4 cr.

954. Advanced Seminar in Social Psychology
Intensive coverage of the experimental and theoretical literature in a selected area of basic or applied social psychology. Students 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.

962. Advanced Seminar in Abnormal Psychology
An in-depth examination of topics in abnormal, clinical, and counseling psychology. 4 cr.

973. 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.

974. Advanced Seminar in the History and Theory of Psychology
In-depth examination of a specific topic in the history and/or theory of psychology. Topics vary each time the seminar is offered. Prereq: PSYC 870 or 871 or permission. May be repeated for credit. 4 cr.

982. Advanced Seminar in Developmental Psychology
In-depth analysis of one or several specific topics or issues in developmental psychology. May be repeated for credit. 4 cr.

991-992. 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. 6 cr.

995. Reading and Research in Psychology
A) Cognition/Psycholinguistics; B) Developmental Psychology; C) History and Theory of Psychology; D) Learning and Behavior Analysis; E) Personality/Psychopathology; F) Physiological Psychology; G) Sensation/Perception; H) Social Psychology; I) Statistics/Methodology. 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 faculty member directing project. May be repeated for credit. 1–4 cr.

998. Problems and Issues in Psychology
Seminar on a problem that has been the subject of specialized research and study by a member of the faculty. Topic and instructor vary. May be repeated for credit. 4 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 satisfies 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.

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

cal 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.

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.

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.

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.

881. Developmental Psychology
Concepts, issues, theories, and methods in developmental psychology and their role in research. Content areas include cognitive, language, social, and personality development. 4 cr.

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An intensive, two-semester, team-taught introduction to the specialty areas represented by the department. 8 cr.

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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.

907. Research Methods and Statistics III
The application of multivariate methods of data analysis in psychological research: multiple regression, analysis of covariance, Hotelling's T2 multivariate analysis of variance, path analysis, discriminant functions, canonical correlation, factor analysis. 4 cr.

908. 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. May be repeated for credit. 4 cr.

914. 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. May be repeated for credit. 4 cr.

917. Advanced Seminar in Sensory and Perceptual Processes
Comprehensive examination of a specific topic in sensory and perceptual processes. May be repeated for credit. 4 cr.

933. 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. May be repeated for credit. 4 cr.

945. Advanced Seminar in Learning and Behavior Analysis
Current empirical and theoretical issues in learning and the analysis of behavior. May be repeated for credit. 4 cr.

954. Advanced Seminar in Social Psychology
Intensive coverage of the experimental and theoretical literature in a selected area of basic or applied social psychology. Students 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.

962. Advanced Seminar in Abnormal Psychology
An in-depth examination of topics in abnormal, clinical, and counseling psychology. 4 cr.

973. 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.

974. Advanced Seminar in the History and Theory of Psychology
In-depth examination of a specific topic in the history and/or theory of psychology. Topics vary each time the seminar is offered. Prereq: PSYC 870 or 871 or permission. May be repeated for credit. 4 cr.

982. Advanced Seminar in Developmental Psychology
In-depth analysis of one or several specific topics or issues in developmental psychology. May be repeated for credit. 4 cr.

991-992. 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. 6 cr.

995. Reading and Research in Psychology
A) Cognition/Psycholinguistics; B) Developmental Psychology; C) History and Theory of Psychology; D) Learning and Behavior Analysis; E) Personality/Psychopathology; F) Physiological Psychology; G) Sensation/Perception; H) Social Psychology; I) Statistics/Methodology. 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 faculty member directing project. May be repeated for credit. 1–4 cr.

998. Problems and Issues in Psychology
Seminar on a problem that has been the subject of specialized research and study by a member of the faculty. Topic and instructor vary. May be repeated for credit. 4 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 satisfies 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.

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

802. 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.

804. Agricultural and Food Policy
Issues and problems in agricultural and food policy in the United States are identified and analyzed from the perspective of producers, consumers, and the government. The economic, political, and social consequences of alternative policies and programs are evaluated. Prereq: resource economics perspectives or equivalent. 4 cr.

806. 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.)

808. 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.)

810. Resource Economics Seminar
Seminars arranged to students' needs and offered as demand warrants. A) Rural Development; B) Marine Economics; C) Community Economics; D) Land and Water Economics; E) Quantitative Methods; F) Recreation Economics; G) Small Business Economic and Managerial Issues. In-depth treatment of area, including classic works. May be repeated. 2–4 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: permission. 2 cr.

817. 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.

818. 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: contemp. conserv. issues, or land use economics, or permission. 3 cr.

856. Rural and Regional Development
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.)

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. Prereq: permission. May be repeated. 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 "IA" grade (continuous course) given at the end of the first semester. Prereq: permission. 2–6 cr. Cr/F.

903. 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 RAM 903.) Prereq: permission. 2 cr.

904. 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 is placed on empirical research studies and their implications. Prereq: applied statistics; intermediate microeconomic analysis. 4 cr. (Not offered every year.)

909. 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.)

911. 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. (Also offered as RAM 911.) Prereq: permission. 4 cr.

993. 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 RAM 993.) 1 cr. Cr/F.

899. Master's Thesis
6–10 cr.

Sociology (SOC)

Chairperson: Peter Dodge
Professors: Melvin T. Bobick; Bud B. Khleif; Arnold S. Linsky; Stuart Palmer; Frederick Samuels; Murray A. Straus
Associate Professors: Peter Dodge; Lawrence C. Hamilton; Sally K. Ward; Kirk Williams
Assistant Professors: Cynthia M. Duncan; Stephan Fuchs; Karl A. Pillemer
Graduate Program Coordinator: Kirk Williams

Degrees Offered

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.

Admission Requirements

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.

M.A. Degree Requirements

Students must fulfill the following requirements:

1) Complete satisfactorily at least one full year (24 credit hours) of graduate-level coursework in sociology including Sociological Methods I (901); and either 902, 903, or 904; and Sociological Theory I (911).

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.

3) Submit for approval a report of a research endeavor to the thesis committee.

Students anticipating careers in applied sociology may receive academic credit for ongoing field experience under SOC 995, 996; an academic paper is required.

Ph.D. Degree Requirements

As part of fulfilling the residence requirement of three years' work after the bachelor's degree, students must

1) take a minimum of 12 courses in sociology (at least 8 as seminars), other than thesis or dissertation research, including Sociological Theory I and II (911 and 912), Sociological Methods I and II (901 and 902), and one other course in methods or statistics (903 or 904), three courses in a major area, and two in a minor area of sociology;

2) complete a second minor consisting of three related courses whether or not sociological in content (these three courses are in addition to the twelve required courses in sociology); no preliminary examination is required;

3) pass written examinations in the major and minor areas of sociological specialization and in advanced theory and methodology;

4) demonstrate reading-level proficiency in a foreign language or a research tool 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);

5) fulfill the research and/or teaching requirement described below;

6) write and defend an acceptable doctoral dissertation.

Teaching Requirement

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 doctoral students are therefore expected to assist a member of the department in teaching and/or research.

820. Current Developments in Sociology of the Family
A current topic is 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.

821. 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.

835. Complex Organizations
Comparative study of the structure and dynamics of complex, formal organizations (business, military, political, and 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.

840. 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.

841. Social Change and Societal 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 840 recommended. 4 cr.

850. 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; ethnic division of labor; work, pluralism, and family networks; mobility and immobility; estates vs. classes. 4 cr.

857. 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.

861. 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.

870. 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.

880. 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.

885. 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.

890. 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 focuses on a social problem and writes a paper covering the above issues. Applied projects where possible. Prereq: meth. of soc. res. 4 cr.

894. 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.

897. Special Topics in Sociology
Occasional or experimental offerings. Prereq: permission. May be repeated for different topics. 4 cr.

901. Sociology 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.

902. 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 are pursued. Prereq: meth. of soc. res.; soc. stat.;/or their equivalents or permission. 4 cr.

903. Sociological Methods III: Special Problems in Methods and Statistics
Course alternates among special problems, such as measurement and advanced statistics. 4 cr.

904. 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.

911. 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.

912. Sociological Theory II
The content, presuppositions, and implications of contemporary sociological theory. Students engage in theory construction and analysis and in this endeavor are encouraged to develop their particular interests in substantive areas. Prereq: SOC 911. 4 cr.

913. 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.

921. 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.

930. 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.)

934. Sociology of Mental Health and Illness
This seminar reviews major sociological theories of mental illness including social isolation, labeling, stressful life events, role conflicts, social class, and economic factors and family dynamics. Family and community processes involved in becoming a mental patient and the problems of leaving the role of the mentally ill are examined. The politics of mental illness are considered, including decarceration, issues surrounding sex roles and mental illness, patients' rights, and the prediction of dangerousness. Other topics covered include cross-cultural comparisons in diagnosis and treatment, training of clinicians, and mental health as a social movement. 4 cr.

938. 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.

942. 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.

950. Methods of Social 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.

951. 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 are expected to read and evaluate selected empirical research. 4 cr.

954. 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.

961. 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 861 or permission. 4 cr.

970. 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.

975. 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.

976. Violence in the Family
Analysis of abusive relationships within the family, especially physical and sexual abuse of children and spouses. The primary focus is on the design of research to test theories purporting to explain intra-family violence, consequences of violence for family members and society, and research on prevention. 4 cr.

980. 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.

985. 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.

989. Sociology of Education: Race and Ethnic Relations in Schools and Society
Ethnic stratification inside and outside the school. The schooling of whites and nonwhites. Issues of bilingualism, culture, and identity. 4 cr.

995, 996. Reading and Research in Sociology and Anthropology
A) Communications; B) Criminology; C) Cultural/Social Anthropology; D) Culture 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 prepared by training and experience 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.

899. Master's Thesis
Usually 6 cr. but up to 10 cr. when the problem warrants.

999. Doctoral Research

Soil Science (SOIL)

(See Department of Forest Resources.)

Spanish (SPAN)

Chairperson: Barbara H. Wing
Professors: Richard J. Callan; Charles H. Leighton
Associate Professors: F. William Forbes; Bernadette Komonchak; Barbara H. Wing
Assistant Professors: Phoebe A. Porter; William Mejias-Lopez; Magda Renoldi-Tocalino
Graduate Program Coordinator: Charles H. Leighton

Degree Offered

The Department of Spanish and Classics offers a master of arts degree in Spanish with concentrations in Hispanic literature, Hispanic linguistics, foreign language methodology, and interdisciplinary Hispanic studies.

Admission Requirements

Applicants 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. The Graduate Record Examination general test is required.

M.A. Degree Requirements

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 (1) successfully complete ten graduate courses (of which eight should be from the Spanish offerings); or (2) 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, all students are required to take 901. Teaching assistants must also take 903. 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 is given four times a year; in January, May, August, and September. Candidates are 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.

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, Casona, 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, Baroja, 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 Gasset
Philosophical ideology and literary content of major contributions of Miguel de Unamuno and Jose 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 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
Interdepartmental 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.

901. 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.

903. 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.

925. 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.)

926. 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.)

995. 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 1898–1936); 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) Catalán; 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.

996. Special Studies in Spanish Language and Literature
A) Hispanic Minorities of the United States; B) Portuguese; 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.

Wildlife (WILD)

(See Department of Forest Resources.)

Zoology (ZOOL)

Chairperson: Peter F. Sale
Professors: Arthur C. Borror; James F. Haney; Larry G. Harris; Peter F. Sale; John J. Sasner, Jr.; Edward K. Tillinghast
Associate Professors: John E. Foret; Edward N. Francq; W. Huntting Howell; Stacia A. Sower; James T. Taylor; Charles W. Walker; Winsor H. Watson III
Assistant Professors: Thomas D. Kocher; R. Randolph Olson

Degrees Offered

The Department of Zoology offers the master of science and the doctor of philosophy degrees. Students can specialize in behavior, development, ecology (freshwater and marine), endocrinology, fisheries, genetics, invertebrate zoology, mammalogy, neurobiology, parasitology, and physiology.

Admission Requirements

Applicants 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, organic chemistry and a semester each of calculus and physics are necessary. Applicants 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 must submit general and subject biology scores for the Graduate Record Examination.

M.S. Degree Requirements

Students plan a program of study in conjunction with a faculty advisory committee. Students complete 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 student's University of New Hampshire experience.

Ph.D. Degree Requirements

Students plan a program of study in conjunction with a faculty guidance committee. 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 is 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, and their ability to carry out basic research in zoology. 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.

Teaching Requirement

Students who hold a teaching assistantship are 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.

803. Marine Ecology
Marine environment and its biota, emphasizing intertidal and estuarine habitats. Includes field, laboratory, and independent research project. Prereq: gen. ecol.; permission. Marine invert. zool., oceanog., and statistics are desirable. 4 cr. (Not offered every year.)

804. Endocrinology
Structure and function of vertebrate endocrine systems. Influence of endocrine system on the physiology of vertebrates, with special reference to mammals. Current investigations of the endocrine system as a regulator and integrator of body functions including such systems as growth, reproduction, metabolism, differentiation, and behavior. Prereq: principles of biology. 4 cr.

805. Techniques in Endocrinology
Application of modern laboratory techniques to the study of hormonal and molecular mechanisms in the endocrine system. (Also offered as BCHM 805.) Prereq: ZOOL 804 or ANSC 801 or BCHM 851, 852, 855;/or permission. Special fee. Lab. 4 cr.

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. Streams as ecosystems. 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.)

809. Environmental Physiology of Animals
Animals' responses to natural changes or extremes of the physical environment. Synthesis of basic concepts from ecology and physiology for students with background in these areas. Emphasis on adaptations of animals to major environmental parameters such as nutrient levels, light, temperature, ionic environment, etc., as well as temporal (seasonal, daily) changes in these major environmental factors. Examples from several levels of organization including biofeedback mechanisms. Prereq: ecology and physiology;/or equivalent. 4 cr. (Not offered every year.)

810. Ichthyology
An introduction to the evolution, systematics, anatomy, physiology, and ecology of fishes, with an emphasis on New England species. Prereq: prin. of biol. or equivalent. Lab. 4 cr. (Offered alternate years.)

811. Freshwater Zooplankton Ecology
Methods of sampling populations; factors regulating temporal and spacial 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. and limnology, ZOOL/PBIO 817, or equivalent; permission. 4 cr. (Not offered every year.)

812. Mammalogy
Origins, diversification, reproduction, ecology, behavior of mammals. Identification of local forms. Prereq: prin. of biol. or equivalent. Lab. 4 cr.

813. 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. (Not offered every year.)

816. Quantitative Ecological Analysis
Methods of observation and inference in ecology; data reduction and exploratory analysis; detection of association, difference, and similarity using linear models and other multivariate approaches. Critiques of design and analysis of published studies. Prereq: formal coursework in statistics and ecology; permission. 4 cr.

817. 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. (Also offered as PBIO 817.) 4 cr.

819. Field Limnology
Freshwater ecology examined through laboratory exercises with freshwater habitats. Methods used to study freshwater lakes; interpretation of data. Seminars and occasional Saturday field trips. Prereq: general limnology or equivalent; permission. (Also offered as PBIO 819.) Lab. 4 cr.

823. Molecular Biology of the Eukaryotic Cell
Examination of dynamic interrelationships between cellular structure and function at the molecular level. Viral, prokaryotic, and eukaryotic models used to illustrate molecular regulatory mechanisms underlying biological complexity. Recent advancements presented against a background of fundamental concepts. Emphasis on normal and impaired cellular differentiation, growth, interphase function, and proliferation. Also considered are the coupling of energy to cellular processes, the role of bioelectricity, and intrinsic and extrinsic chemical messengers. Prereq: organic chemistry. Recommended: developmental or cell biology; biochemistry or physiology. 4 cr.

824. Laboratory in Cell Biology
Complements class material (in ZOOL 823) and stresses use of modern research tools in addressing fundamental questions about the biology of the cell. Immunochemical techniques, traditional and innovative applications of electron and light microscopy, bioassay, cell culture and fractionation, and electrophysiology. Coreq: ZOOL 823. Special fee. 2 cr.

828. 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 biol. or intro to invert. zool. Lab. 4 cr.

850. Biological Oceanography
Biological processes of the oceans including primary and secondary production, trophodynamics, plankton diversity, zooplankton feeding ecology, microbial ecology, and global ocean dynamics. Emphasis on experimental approaches. Term project involves either development of an ecosystem model or performance of a field experiment. Field trips on *R.V. Jere Chase* and to the Jackson Estuarine Laboratory. Prereq: one year of biol. or permission of instructor. (Also offered as ESCI 850.) 4 cr.

872. Fisheries Biology
The principles of fisheries science, with an emphasis on techniques used to assess the biological characteristics of exploited fish populations, and the use of such information for fisheries management. Prereq: ZOOL 810 or equivalent; permission. Lab. 4 cr. (Offered alternate years.)

877. Neurobiology and Behavior
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. of biol. or permission. 4 cr.

878. Neuroscience Techniques
A techniques- and laboratory-oriented course designed for students of the behavioral and physiological sciences who wish to understand the basic electrophysiological properties of neurons and how they interact. Both invertebrate and vertebrate systems are called upon to illustrate principles of synaptic transmission, integration, sensory information processing, and the control of movement. Prereq: ZOOL 877 or equivalent. Lab. 4 cr.

895, 896. Advanced Studies 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. 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. 1–4 cr.

915. 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.)

921. 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.)

922. Protozoology
General biology of protozoa; morphology, physiology, natural history, and economic importance. Prereq: ZOOL 921 or permission. 4 cr. (Not offered every year.)

925. 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 and hormonal factors; larval settlement and metamorphosis; and evolutionary significance and functional consequences of reproductive cycles in animals. Prereq: permission. 4 cr.

926. Comparative Physiology
Nutrition, metabolism, neural function, reproduction and homeostatic mechanisms of animals, especially invertebrates. Prereq: ZOOL 723; permission. 4 cr. (Not offered every year.)

997, 998. Zoology Seminar
Reports on recent zoological literature. Subject fields are those listed under ZOOL 895, 896; 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.

999. Doctoral Research

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Director of Cooperative Extension

Faculty of the Graduate School

(This listing is current as of July 1, 1989. The date of appointment appears in parentheses following the faculty member's name.)

Aber, John D. (1987)
Associate Professor of Forest Resources and Earth, Oceans, and Space; Ph.D., Yale University, 1976.
Aikins, Janet (1979)
Associate Professor of English; Ph.D., University of Chicago, 1980.
Amsden, Katherine (1967)
Associate Professor of Physical Education; Ph.D., University of Southern California, 1967.
Andersen, Kenneth K. (1960)
Professor of Chemistry; Ph.D., University of Minnesota, 1959.
Anderson, Franz E. (1967)
Professor of Geology; Ph.D., University of Washington, 1967.
Andrew, Michael D. (1966)
Professor of Education; Ed.D., Harvard University, 1969.
Annis, William H. (1962)
Professor of Occupational Education; Ed.D., Cornell University, 1961.
Antonak, Richard F. (1975)
Professor of Education; Ed.D., Temple University, 1975.
Arnoldy, Roger L. (1967)
Professor of Physics and Earth, Oceans, and Space; Ph.D., University of Minnesota, 1962.
Ashley, Charles H. (1969)
Associate Professor of Education; Ed.D., Boston University, 1969.
Baber, Kristine M. (1984)
Assistant Professor of Family and Consumer Studies; Ph.D., University of Connecticut, 1983.
Bailey, Brigitte Gabcke (1987)
Assistant Professor of English; Ph.D., Harvard University, 1985.
Baker, Alan L. (1972)
Associate Professor of Plant Biology; Ph.D., University of Minnesota, 1973.
Baldwin, Kenneth C. (1982)
Associate Professor of Mechanical Engineering; Ph.D., University of Rhode Island, 1982.
Ballestero, Thomas P. (1983)
Associate Professor of Civil Engineering; Ph.D., Colorado State University, 1981.
Balling, L. Christian (1967)
Professor of Physics; Ph.D., Harvard University, 1965.
Barkey, Dale P. (1987)
Assistant Professor of Chemical Engineering; Ph.D., University of California at Berkeley, 1987.
Barnett, John H. (1983)
Associate Professor of Business Administration; D.B.A., University of Colorado at Boulder, 1978.
Barrett, James P. (1962)
Professor of Forest Biometrics and Management; Ph.D., Duke University, 1962.
Bauer, Christopher F. (1981)
Associate Professor of Chemistry; Ph.D., Colorado State University, 1979.
Baum, William M. (1977)
Professor of Psychology; Ph.D., Harvard University, 1966.
Bechtell, Homer F., Jr. (1966)
Professor of Mathematics; Ph.D., University of Wisconsin at Madison, 1963.
Behr, Richard Alan (1987)
Assistant Professor of Civil Engineering; Ph.D., Texas Tech University, 1982.
Benassi, Victor A. (1982)
Associate Professor of Psychology; Ph.D., City University of New York, 1974.
Bennett, Albert B., Jr. (1967)
Professor of Mathematics; Ed.D., University of Michigan at Ann Arbor, 1966.
Benoit, Jean (1983)
Associate Professor of Civil Engineering; Ph.D., Stanford University, 1983.
Bergeron, R. Daniel (1974)
Associate Professor of Computer Science; Ph.D., Brown University, 1973.
Berndtson, William E. (1979)
Associate Professor of Animal Science; Ph.D., Cornell University, 1971.
Birch, Francis S. (1972)
Professor of Earth Sciences; Ph.D., Princeton University, 1969.
Blakemore, Richard P. (1977)
Professor of Microbiology; Ph.D., University of Massachusetts at Amherst, 1975.
Blanchard, Robert O. (1972)
Associate Dean of the College of Life Sciences and Agriculture and Professor of Plant Biology; Ph.D., University of Georgia at Athens, 1971.
Bobick, Melvin T. (1958)
Professor of Sociology; Ph.D., University of Illinois at Urbana, 1958.
Bocialetti, Gene (1983)
Associate Professor of Organizational Behavior; Ph.D., Case Western Reserve University, 1982.
Bogle, A. Linn (1970)
Professor of Plant Biology; Ph.D., University of Minnesota, 1968.
Bonnice, William E. (1962)
Associate Professor of Mathematics; Ph.D., University of Washington, 1962.
Borror, Arthur C. (1961)
Professor of Zoology; Ph.D., Florida State University, 1961.
Bothner, Wallace A. (1967)
Professor of Geology; Ph.D., University of Wyoming, 1967.
Boudette, Eugene L. (1985)
Adjunct Professor of Geology and New Hampshire State Geologist; Ph.D., Dartmouth College, 1969.
Boulton, Elizabeth P. (1988)
Assistant Professor of Animal Science; D.V.M., University of Georgia at Athens, 1980.
Bowden, William B. (1987)
Assistant Professor of Water Resource Management and Adjunct Assistant Professor of Earth Sciences; Ph.D., North Carolina State University, 1982.
Bowman, James S. (1971)
Professor of Entomology and Extension Entomologist; Ph.D., University of Wisconsin at Madison, 1958.
Boy, Angelo V. (1965)
Professor of Education; Ed.D., Boston University, 1960.
Brown, Warren R. (1972)
Associate Professor of Political Science; Ph.D., Claremont Graduate School and University Center, 1976.
Brown, Wendell S. (1974)
Professor of Earth Sciences and Earth, Oceans, and Space; Ph.D., Massachusetts Institute of Technology, 1971.
Burger, John F. (1977)
Associate Professor of Entomology; Ph.D., University of Arizona, 1971.
Burton, David M. (1959)
Professor of Mathematics; Ph.D., University of Rochester, 1961.
Calarco, John R. (1981)
Professor of Physics; Ph.D., University of Illinois at Urbana, 1969.
Calculator, Stephen N. (1983)
Associate Professor of Communication Disorders; Ph.D., University of Wisconsin at Madison, 1980.
Callan, Richard J. (1969)
Professor of Spanish; Ph.D., St. Louis University, 1965.
Carney, John J. (1973)
Associate Professor of Education; Ph.D., Syracuse University, 1973.
Carnicelli, Thomas A. (1967)
Professor of English; Ph.D., Harvard University, 1966.
Carr, Russell T. (1984)
Assistant Professor of Chemical Engineering; Ph.D., University of Rochester, 1984.
Carroll, John E. (1974)
Professor of Environmental Conservation; Ph.D., Michigan State University, 1974.
Carter, Michael Joel (1987)
Assistant Professor of Electrical Engineering; Ph.D., University of Michigan at Ann Arbor, 1984.
Celikkol, Barbaros (1969)
Associate Professor of Mechanical Engineering; Ph.D., University of New Hampshire, 1972.
Chaltas, John G. (1967)
Associate Professor of Education; Ed.D., Columbia University, 1957.
Chamberlin, Kent A. (1985)
Associate Professor of Electrical Engineering; Ph.D., Ohio University, 1982.
Chandler, Donald S. (1981)
Associate Professor of Entomology and Curator; Ph.D., Ohio State University, 1976.
Charos, Evangelos (1988)
Adjunct Associate Professor of Economics; Ph.D., University of New Hampshire, 1984.
Chasteen, N. Dennis (1972)
Professor of Chemistry; Ph.D., University of Illinois at Urbana, 1969.
Chesbro, William R. (1959)
Professor of Microbiology; Ph.D., Illinois Institute of Technology, 1959.
Chupp, Edward L. (1962)
Professor of Physics and Earth, Oceans, and Space; Ph.D., University of California at Berkeley, 1954.
Cioffi, Grant L. (1980)
Associate Professor of Education; Ph.D., University of Minnesota, 1980.

Clark, Charles E. (1967)
Professor of History; Ph.D., Brown University, 1966.
Clark, Mary Morris (1978)
Associate Professor of English; Ph.D., University of Massachusetts at Amherst, 1978.
Clark, Ronald R. (1957)
Professor of Electrical Engineering; Ph.D., Syracuse University, 1963.
Cohn, Ellen S. (1978)
Associate Professor of Psychology; Ph.D., Temple University, 1978.
Collins, John J. (1988)
Assistant Professor of Biochemistry and Genetics; Ph.D., University of Wisconsin at Madison, 1984.
Collins, Michael R. (1985)
Assistant Professor of Civil Engineering; Ph.D., University of Arizona, 1985.
Condon, William A. (1976)
Professor of Animal Science; Ph.D., University of Massachusetts at Amherst, 1975.
Connors, Robert J. (1984)
Associate Professor of English; Ph.D., Ohio State University, 1980.
Copeland, Arthur H., Jr. (1968)
Professor of Mathematics; Ph.D., Massachusetts Institute of Technology, 1954.
Corcoran, Ellen P. (1972)
Associate Professor of Education; Ph.D., New York University, 1972.
Corell, Robert W. (1957–60, 1964)
Professor of Mechanical Engineering and Earth, Oceans, and Space; Ph.D., Case Institute of Technology, 1964.
Cote, Richard H. (1988)
Assistant Professor of Biochemistry; Ph.D., University of Wisconsin at Madison, 1980.
Craig, Robert E. (1966)
Associate Professor of Political Science; Ph.D., University of North Carolina at Chapel Hill, 1971.
Crill, Patrick M. (1988)
Research Assistant Professor of Earth Sciences and Earth, Oceans, and Space; Ph.D., University of North Carolina at Chapel Hill, 1984.
Croce, Ronald C. (1986)
Assistant Professor of Physical Education; Ph.D., University of New Mexico, 1983.
Croker, Robert A. (1966)
Professor of Environmental History and Conservation; Ph.D., Emory University, 1966.
Crow, Garrett E. (1975)
Associate Professor of Plant Biology; Ph.D., Michigan State University, 1974.
Crowley, Margaret A. (1983)
Assistant Professor of Nursing; M.S., Boston College, 1977.
Curran-Celentano, Joanne (1987)
Assistant Professor of Animal Science and Nutrition; Ph.D., University of Illinois at Urbana, 1982.
Darlington, Sidney W. (1971)
Adjunct Professor of Electrical Engineering; Ph.D., Columbia University, 1940.
Davis, Thomas Medford (1984)
Assistant Professor of Plant Biology and Genetics; Ph.D., University of California at Davis, 1985.
Dawson, John F. (1968)
Professor of Physics; Ph.D., Stanford University, 1963.
De Alba, Pedro A. (1977)
Associate Professor of Civil Engineering; Ph.D., University of California at Berkeley, 1975.
De la Torre, Pilar (1989)
Assistant Professor of Computer Science; Ph.D., University of Maryland, 1987.
Denis, Clyde L. (1982)
Associate Professor of Biochemistry and Genetics; Ph.D., University of Washington, 1982.
DePorte, Michael V. (1972)
Professor of English; Ph.D., Stanford University, 1966.
Deturk, Mark S. (1988)
Assistant Professor of Music; Ph.D., University of Wisconsin at Madison, 1988.
Deuel, Nancy R. (1985)
Assistant Professor of Animal Science; Ph.D., University of Illinois at Urbana, 1984.
Diefendorf, Jeffry M. (1976)
Associate Professor of History; Ph.D., University of California at Berkeley, 1975.
Diller, Ann L. (1973)
Associate Professor of Education; Ed.D., Harvard University, 1971.
Diller, Karl C. (1972)
Professor of English; Ph.D., Harvard University, 1967.
Dingman, S. Lawrence (1975)
Professor of Hydrology and Water Resources; Ph.D., Harvard University, 1970.
Dodge, Peter (1964)
Associate Professor of Sociology; Ph.D., Harvard University, 1961.
Dolan, Elizabeth M. (1980)
Associate Professor of Family and Consumer Studies; Ph.D., Virginia Polytechnic Institute and State University, 1980.
Dowse, Mary E. (1988)
Adjunct Associate Professor of Earth Sciences; Ph.D., West Virginia University, 1980.
Drake, Allen D. (1983)
Associate Professor of Electrical Engineering; Ph.D., Tufts University, 1978.
Dugan-Bedker, Patricia D. (1985)
Assistant Professor of Animal Science; Ph.D., Cornell University, 1985.
Duncan, Cynthia M. (1989)
Assistant Professor of Sociology; Ph.D., University of Kentucky, 1985.
Durgin, Owen B. (1951)
Professor of Resource Economics; M.A., University of New Hampshire, 1951.
Eckert, Robert T. (1978)
Associate Professor of Forest Genetics; Ph.D., Ohio State University, 1978.
Edwards, Ruth S. (1966)
Associate Professor of Music; M.M., Northwestern University, 1950.
Eggers, Walter F. (1989)
Vice President for Academic Affairs and Professor of English; Ph.D., University of North Carolina, 1971.
Eighmy, T. Taylor (1987)
Research Assistant Professor of Civil Engineering; Ph.D., University of New Hampshire, 1986.
Ellis, Nancy E. (1987)
Assistant Professor of Education; Ph.D., Stanford University, 1987.
Elmslie, Bruce T. (1989)
Assistant Professor of Economics; Ph.D., University of Utah, 1988.
Engalichev, Nicolas (1963)
Professor of Resource Economics and Extension Economist; M.S., S.U.N.Y. College of Environmental Science and Forestry at Syracuse, 1960.
England, Richard W. (1976)
Associate Professor of Economics; Ph.D., University of Michigan at Ann Arbor, 1974.
Erickson, Raymond L. (1963)
Dean of the Graduate School, Special Assistant to the President, and Professor of Psychology; Ph.D., University of California at Los Angeles, 1962.
Eshbach, Robert W. (1987)
Assistant Professor of Music; M.M., New England Conservatory of Music, 1976.
Estes, George O. (1969)
Professor of Plant Biology; Ph.D., Oregon State University, 1969.
Etebari, Ahmad (1980)
Associate Professor of Business Administration; Ph.D., North Texas State University, 1979.
Evans, Christine V. (1987)
Assistant Professor of Pedology; Ph.D., University of Wyoming, 1987.
Fagerberg, Wayne R. (1984)
Assistant Professor of Plant Biology; Ph.D., University of South Florida at Tampa, 1975.
Fairchild, Thomas P. (1969)
Dean of the College of Life Sciences and Agriculture, Director of the Agricultural Experiment Station, and Professor of Animal Science and Genetics; Ph.D., University of Wisconsin at Madison, 1964.
Falvey, Janet Elizabeth (1984)
Assistant Professor of Education; Ph.D., Pennsylvania State University, 1983.
Fan, Stephen S. T. (1962)
Professor of Chemical Engineering; Ph.D., Stanford University, 1962.
Farag, Ihab H. (1976)
Associate Professor of Chemical Engineering; Sc.D., Massachusetts Institute of Technology, 1976.
Federer, C. Anthony (1970)
Adjunct Associate Professor of Micrometeorology; Ph.D., University of Wisconsin at Madison, 1964.
Feintuch, Burt H. (1988)
Director of the Center for the Humanities and Professor of English; Ph.D., University of Pennsylvania, 1975.
Feldman, David V. (1987)
Assistant Professor of Mathematics; Ph.D., Wesleyan University, 1987.
Ferber, Michael K. (1987)
Associate Professor of English; Ph.D., Harvard University, 1975.
Fernald, Peter S. (1966)
Associate Professor of Psychology; Ph.D., Purdue University, 1963.
Ferrini-Mundy, Joan (1983)
Associate Professor of Mathematics; Ph.D., University of New Hampshire, 1980.
Fink, Stephen L. (1969)
Professor of Organizational Behavior; Ph.D., Case Western Reserve University, 1959.
Fisher, G. Thomas (1969)
Associate Professor of Entomology and Extension Entomologist; Ph.D., Rutgers, the State University of New Jersey, 1954.

Fisher, Lester A. (1968)
Associate Professor of English; Ph.D., Brown University, 1976.
Fisk, Lennard A., Jr. (1977)
Professor of Physics and Earth, Oceans, and Space; Ph.D., University of California at San Diego, 1969.
Forbes, F. William (1970)
Associate Professor of Spanish; Ph.D., University of Arizona, 1971.
Forbes, Terrence G. (1987)
Research Associate Professor of Physics and Earth, Oceans, and Space; Ph.D., University of Colorado at Boulder, 1978.
Foret, John E. (1967)
Associate Professor of Zoology; Ph.D., Princeton University, 1966.
Forrest, David J. (1984)
Research Associate Professor of Physics and Earth, Oceans, and Space; Ph.D., University of New Hampshire, 1969.
Foxall, Thomas L. (1984)
Assistant Professor of Animal Science; Ph.D., University of New Hampshire, 1980.
Francq, Edward N. (1965)
Associate Professor of Zoology; Ph.D., Pennsylvania State University, 1967.
Frankel, Barbara R. (1988)
Assistant Professor of Family and Consumer Studies; Ph.D., Purdue University, 1988.
Franzosa, Susan D. (1979)
Associate Professor of Education; Ph.D., State University of New York at Buffalo, 1979.
Freear, John (1983)
Professor of Accounting and Finance; M.A., University of Kent, England, 1969. F.C.A.
Freuder, Eugene C. (1977)
Associate Professor of Computer Science; Ph.D., Massachusetts Institute of Technology, 1975.
Frost, Albert D. (1957)
Professor of Electrical Engineering; Sc.D., Massachusetts Institute of Technology, 1952.
Fuchs, Stephan (1989)
Assistant Professor of Sociology; Ph.D., University of California at Riverside, 1989.
Fuld, Kenneth (1979)
Associate Professor of Psychology; Ph.D., Dartmouth College, 1976.
Fussell, Barry K. (1987)
Assistant Professor of Mechanical Engineering; Ph.D., Ohio State University, 1987.
Garland, Virginia E. (1988)
Assistant Professor of Education; Ph.D., University of Connecticut, 1981.
Garrett, Peter W. (1970)
Adjunct Assistant Professor of Forest Genetics; Ph.D., University of Michigan at Ann Arbor, 1969.
Gass, Michael A. (1981)
Associate Professor of Physical Education; Ph.D., University of Colorado at Boulder, 1986.
Gaudard, Marie A. (1977)
Associate Professor of Mathematics; Ph.D., University of Massachusetts at Amherst, 1977.
Gaudette, Henri E. (1965)
Professor of Geology and Earth, Oceans, and Space; Ph.D., University of Illinois at Urbana, 1963.
Geeslin, William E. (1972)
Associate Professor of Mathematics; Ph.D., Stanford University, 1973.
Gentleman, Judith A. (1988)
Assistant Professor of Political Science; Ph.D., State University of New York at Buffalo, 1982.
Gerhard, Glen C. (1967)
Professor of Electrical Engineering; Ph.D., Ohio State University, 1963.
Gilmore, Robert C. (1952)
Professor of History; Ph.D., Yale University, 1954.
Giuffre, Maureen (1987)
Associate Professor of Nursing; Ph.D., University of Rochester, 1983.
Glanz, Filson H. (1965)
Associate Professor of Electrical Engineering; Ph.D., Stanford University, 1965.
Goodman, Richard H. (1976)
Adjunct Associate Professor of Education; Ed.D., Harvard University, 1961.
Goodspeed, Charles H. (1978)
Associate Professor of Civil Engineering; Ph.D., University of Cincinnati, 1972.
Gordon, Bernard K. (1971)
Professor of Political Science; Ph.D., University of Chicago, 1959.
Gow, Anthony Jack (1985)
Adjunct Professor of Glaciology; Ph.D., Victoria University of Wellington, New Zealand, 1973.
Graham, Karen J. (1987)
Assistant Professor of Mathematics; Ph.D., University of New Hampshire, 1986.
Graulich, Melody G. (1978)
Associate Professor of English; Ph.D., University of Virginia, 1979.
Graves, Donald H. (1973)
Professor of Education; Ed.D., State University of New York at Buffalo, 1973.
Green, Donald M. (1967)
Professor of Biochemistry and Genetics; Ph.D., University of Rochester, 1958.
Greenlaw, Raymond (1989)
Assistant Professor of Computer Science; Ph.D., University of Washington, 1988.
Gress, David L. (1974)
Associate Professor of Civil Engineering; Ph.D., Purdue University, 1976.
Grimes, D. Jay (1987)
Director of the Institute of Marine Science and Ocean Engineering and Professor of Microbiology; Ph.D., Colorado State University, 1971.
Gross, Charles W. (1986)
Professor of Marketing; D.B.A., University of Colorado at Boulder, 1972.
Gross, Todd Stuart (1988)
Assistant Professor of Mechanical Engineering; Ph.D., Northwestern University, 1981.
Guare, Richard (1988)
Adjunct Assistant Professor of Communication Disorders; Ph.D., University of Virginia, 1982.
Gust, David A. (1985)
Assistant Professor of Geology; Ph.D., Australian National University, 1982.
Gutman, Jonathan (1987)
Professor of Business Administration; Ph.D., University of Southern California, 1967.
Haaland, Gordon A. (1965–74, 1979)
President and Professor of Psychology; Ph.D., State University of New York at Buffalo, 1966.
Hadwin, Donald W. (1977)
Professor of Mathematics; Ph.D., Indiana University at Bloomington, 1975.
Hageman, Elizabeth H. (1971)
Professor of English; Ph.D., University of North Carolina at Chapel Hill, 1971.
Hagstrom, Earl C. (1965)
Associate Professor of Psychology; Ph.D., Brown University, 1957.
Hall, Francine S. (1980)
Associate Professor of Administration; Ph.D., University of Toronto, 1975.
Hall, Francis R. (1964)
Professor of Hydrogeology; Ph.D., Stanford University, 1961.
Halstead, John M. (1988)
Assistant Professor of Resource Economics; Ph.D., Virginia Polytechnic Institute and State University, 1988.
Hamilton, Lawrence C. (1977)
Associate Professor of Sociology; Ph.D., University of Colorado at Boulder, 1978.
Haney, James F. (1972)
Professor of Zoology; Ph.D., University of Toronto, 1970.
Hanrahan, Linda (1988)
Adjunct Associate Professor of Communication Disorders; Ph.D., University of Oregon, 1980.
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.
Hapgood, Robert (1965)
Professor of English; Ph.D., University of California at Berkeley, 1955.
Hardy, Stephen H. (1988)
Associate Professor of Physical Education; Ph.D., University of Massachusetts at Amherst, 1980.
Harkless, Gene E. (1985)
Assistant Professor of Nursing; M.S.N., Vanderbilt University, 1980.
Harrigan, Jane T. (1985)
Assistant Professor of English; M.A., Syracuse University, 1976.
Harrington, Thomas C. (1983)
Associate Professor of Plant Biology; Ph.D., University of California at Berkeley, 1983.
Harris, J. William, Jr. (1985)
Assistant Professor of History; Ph.D., Johns Hopkins University, 1982.
Harris, Larry G. (1969)
Professor of Zoology; Ph.D., University of California at Berkeley, 1970.
Harriss, Robert C. (1988)
Professor of Earth Sciences and Earth, Oceans, and Space; Ph.D., Rice University, 1965.
Harter, Robert D. (1969)
Professor of Soil Chemistry; Ph.D., Purdue University, 1966.
Hatcher, Philip John (1986)
Assistant Professor of Computer Science; Ph.D., Illinois Institute of Technology, 1985.
Hebert, David J. (1967)
Associate Professor of Education; Ph.D., Kent State University, 1967.
Heilbronner, Hans (1954)
Professor of History; Ph.D., University of Michigan at Ann Arbor, 1954.
Heisenberg, Jochen (1978)
Professor of Physics; Doctor, University of Hamburg, West Germany, 1966.

Henry, Robert M. (1980)
Associate Professor of Civil Engineering; Ph.D., University of Pennsylvania, 1980.
Herhold, Susan H. (1988)
Assistant Professor of Accounting; Ph.D., Syracuse University, 1984.
Herold, Marc W. (1975)
Associate Professor of Economics; Ph.D., University of California at Berkeley, 1979.
Hersman, F. William (1984)
Associate Professor of Physics; Ph.D., Massachusetts Institute of Technology, 1982.
Hertz, Susan Margaret (1986)
Assistant Professor of English; B.A., University of New Hampshire, 1978.
Hettinger, Stanley D. (1965)
Associate Professor of Music and Band Director; M.M.E., Vander-Cook College, 1966.
Hibschweiler, Rita A. (1988)
Assistant Professor of Mathematics; Ph.D., State University of New York at Albany, 1988.
Hill, John L. (1964)
Professor of Wood Science and Technology; D.F., Yale University, 1954.
Hines, Mark E. (1984)
Research Associate Professor of Earth Sciences and Earth, Oceans, and Space; Ph.D., University of New Hampshire, 1981.
Hinson, Edward K. (1985)
Assistant Professor of Mathematics; Ph.D., Northwestern University, 1985.
Hoff, Phyllis A. (1967)
Associate Dean of the School of Health and Human Services; and Associate Professor of Physical Education; Ph.D., University of Southern California, 1967.
Hollweg, Joseph (1980)
Research Professor of Physics and Earth, Oceans, and Space; Ph.D., Massachusetts Institute of Technology, 1968.
Holter, James B. (1963)
Professor of Animal Science; Ph.D., Pennsylvania State University, 1962.
Hornbeck, James W. (1979)
Adjunct Associate Professor of Forest Hydrology; Ph.D., S.U.N.Y. College of Environmental Science and Forestry at Syracuse, 1973.
Horne, Peter J. (1984)
Director of Cooperative Extension Service and Associate Professor of Adult Education; Ed.D., Boston University, 1980.
Horrigan, James O. (1966)
Professor of Accounting and Finance; Ph.D., University of Chicago, 1967.
Hosseini, Jinoos A. (1987)
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Howard, Theodore E. (1981)
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Howell, David L. (1982)
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Howell, W. Huntting (1980)
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Hubbard, Colin D. (1967)
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Huk, Romana C. (1987)
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Hurd, Richard W. (1973)
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Irish, James D. (1979)
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Jahnke, Leland S. (1977)
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Jansen, Edmund F., Jr. (1969)
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Janson-Sand, Colette H. (1981)
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Jenks, Stephen (1967)
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Jerard, Robert (1988)
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Johnson, Karen R. (1986)
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Johnson, Paul C. (1979)
Associate Professor of Entomology; Ph.D., Cornell University, 1974.
Johnson, Richard P. (1985)
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Jones, Galen E. (1966)
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Jones, Paul R. (1956)
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Jones, William R. (1962)
Professor of History; Ph.D., Harvard University, 1958.
Kaen, Fred R. (1973)
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Kalinowski, Michael F. (1980)
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Karson, Marvin J. (1983)
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Katz, Ruth M. (1988)
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Kayser, John R. (1969)
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Kennard, Jean E. (1975)
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Kertzer, Robert (1965)
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Khan, Mohammad Ayab (1989)
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Khleif, Bud B. (1967)
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Kiang, Yun-Tzu (1970)
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Kies, Christopher (1979)
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Kimball, Roland B. (1963)
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Kingston, Richard S. (1988)
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Kinner, Nancy E. (1983)
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Kocher, Thomas D. (1989)
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Komonchak, Bernadette (1976)
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Kraft, L. Gordon (1978)
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Krasner, James (1989)
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Krzanowski, James E. (1985)
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Kull, Judith A. (1985)
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Kuntz, Aline M. (1988)
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Kuo, Shan S. (1964)
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Lacey, Anne L. (1988)
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LaCourse, John R. (1980)
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Laird, Jo (1979)
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Lambert, Robert H. (1955–56, 1961)
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Leak, William B. (1967)
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Lee, Thomas D. (1980)
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Levin, Robert E. (1982)
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Lewis, Frederick C. (1976)
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Limber, John E. (1971)
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Limbert, David E. (1969)
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Linden, Allen B. (1963)
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Linder, Ernst (1987)
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Lindsay, Bruce E. (1976)
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Linsky, Arnold S. (1966)
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Mallory, Bruce L. (1979)
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Manalo, Alberto B. (1986)
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Margolin, Aaron B. (1988)
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Mathieson, Arthur C. (1965)
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Mathur, Virendra K. (1974)
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Mautz, William W. (1969)
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McBride, Mekeel (1979)
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Messner, Richard A. (1985)
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Mills, Richard L. (1967)
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Mitchell, James R. (1964)
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Moore, David W. (1972)
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Morris, Douglas E. (1984)
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Morrison, James D. (1965)
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Mulhern, John E., Jr. (1954)
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Murdoch, Joseph B. (1952)
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Murray, Frederick P. (1966)
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Nevin, John A. (1972)
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Newkirk, Thomas R. (1977)
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Nicoloff, Philip L. (1954)
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Niman, Neil B. (1985)
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Nisbet, Jane E. (1987)
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Nordgren, Eric A. (1964)
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O'Brien, Edward J. (1988)
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O'Connell, Lawrence W. (1966)
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Oja, Sharon N. (1977)
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Olson, David P. (1964)
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Olson, R. Randolph (1988)
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Orovich, Nicholas N. (1987)
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Ossenbruggen, Paul J. (1975)
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Page, Lincoln R. (1984)
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Palais, Julie M. (1988)
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Palmer, Stuart (1955)
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Parsons, Alan H. (1979)
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Peirce, Lincoln C. (1964)
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Petillo, Juliette D. (1973)
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Phillips, Robert E. (1988)
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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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Pillemer, Karl A. (1986)
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Pistole, Thomas G. (1971)
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Planalp, Roy P. (1987)
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Pokoski, John L. (1967)
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Polasky, Janet L. (1981)
Associate Professor of History; Ph.D., Stanford University, 1978.
Polk, Keith (1964)
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Poll, Solomon (1964)
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Pollard, James E. (1970)
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Porter, Phoebe A. (1988)
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Potter, Hugh M., III (1962)
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Prevost, Fernand J. (1987)
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Puth, Robert C. (1967)
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Rasmussen, Mary H. (1968)
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Reeves, R. Marcel (1964)
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Reid, R. Dan (1987)
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Renoldi-Tocalino, Magda (1989)
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Roberts, John M. (1979)
Associate Professor of Plant Biology and Extension Specialist, Turf; Ph.D., Purdue University, 1977.
Roberts, Lewis, Jr. (1972)
Dean of University of New Hampshire at Manchester and Associate Professor of Occupational Education; Ed.D., Auburn University, 1972.
Rock, Barrett N. (1987)
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Rodgers, Frank G. (1985)
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Rogers, John E. (1967)
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Rogers, Owen M. (1959)
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Romoser, George K. (1961–62, 1967)
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Ross, Shepley L. (1955)
Professor of Mathematics; Ph.D., Boston University, 1953.
Rothwell, Kenneth J. (1963)
Interim Dean of the Whittemore School of Business and Economics and Professor of Economics; Ph.D., Harvard University, 1961.
Routley, Douglas G. (1957)
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Rucinski, Andrzej (1984)
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Russell, Robert D. (1975)
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Russell, Sylvia Weber (1982)
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Ryan, James M. (1984)
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Salyer, Lucy (1989)
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Samuels, Frederick (1966)
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Schibanoff, Susan (1971)
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Schlobohm, Starr F. (1975)
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Schwab, Richard L. (1979)
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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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Selikowitz, Stuart M. (1987)
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Sethuraman, Ramachandran (1989)
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Shen, Weicheng (1986)
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Shepard, Harvey K. (1969)
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Shepherdson, Charles P. (1989)
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Sherman, Sarah Way (1984)
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Sherwood, James A. (1986)
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Shetty, Sandhya (1988)
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Shore, Barry (1974)
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Shore, Samuel D. (1965)
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Siggelakis, Susan J. (1988)
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Simic, Charles D. (1973)
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Simos, Evangelos O. (1977)
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Simpson, George A. (1987)
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Simpson, Robert E. (1963)
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Sir, W. Niel (1970)
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Sitkoff, Harvard (1976)
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Sivaprasad, Kondagunta (1969)
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Smith, C. Tattersall (1982)
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Smith, Karen M. (1987)
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Smith, M. Daniel (1967)
Associate Professor of Education; Ed.D., Harvard University, 1961.
Smith, Mark R. (1966)
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Smith, Samuel C. (1961)
Professor of Animal Science and Biochemistry; Ph.D., Pennsylvania State University, 1962.
Sohl, Jeffrey E. (1983)
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Sower, Stacia A. (1982)
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Sparr, Ted Martin (1989)
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Spears, Margaret W. (1981)
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Stewart, James A. (1968)
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Stibler, Robert (1978)
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Stine, 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, Patricia A. (1988)
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Sundberg, Donald C. (1978)
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Taft, Charles K. (1967)
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Tischler, Herbert (1965)
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Ulrich, Gael D. (1970)
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Ulrich, Laurel T. (1985)
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Urban, Willard E., Jr. (1963)
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Professor of Mechanical Engineering; M.S.M.E., Purdue University, 1954.
Van Osdol, Donovan H. (1970)
Professor of Mathematics; Ph.D., University of Illinois at Urbana, 1969.
Vasudevan, Palligarnai T. (1988)
Assistant Professor of Chemical Engineering; Ph.D., Clarkson University, 1988.
Veal, Larry J. (1982)
Assistant Professor of Music; M.M. Cello, University of Illinois at Urbana, 1976.
Verbyla, David L. (1989)
Assistant Professor of Remote Sensing; Ph.D., Utah State University, 1988.
Verrette, Paul F. (1962)
Associate Professor of Music; M.A., Boston University, 1971.
Vestrand, W. T. (1987)
Research Assistant Professor of Physics and Earth, Oceans, and Space; Ph.D., University of Maryland, 1980.
Voll, John O. (1965)
Professor of History; Ph.D., Harvard University, 1969.
Vroman, Neil B. (1984)
Assistant Professor of Physical Education; Ph.D., Pennsylvania State University, 1982.
Walker, Charles W. (1976)
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.
Wansart, William L. (1985)
Assistant Professor of Education; Ed.D., University of Northern Colorado, 1984.
Ward, Sally K. (1980)
Associate Professor of Sociology; Ph.D., Brown University, 1977.
Warner, Rebecca M. (1981)
Associate Professor of Psychology; Ph.D., Harvard University, 1978.
Watson, Winsor H., III (1978)
Associate Professor of Zoology; Ph.D., University of Massachusetts at Amherst, 1978.
Watt, David W. (1987)
Assistant Professor of Mechanical Engineering; Ph.D., University of Michigan at Ann Arbor, 1987.
Watters, David H. (1978)
Associate Professor of English; Ph.D., Brown University, 1978.
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 and Earth, Oceans, and Space; Ph.D., University of Iowa, 1957.
Weber, James H. (1963)
Professor of Chemistry; Ph.D., Ohio State University, 1963.
Webster, Penelope E. (1987)
Assistant Professor of Communication Disorders; Ed.D., Boston University, 1984.
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 at Madison, 1976.
Wells, Otho S. (1966)
Professor of Plant Biology and Extension Horticulturist, Vegetables; Ph.D., Rutgers, the State University of New Jersey, 1966.
Wells, Roger E. (1981)
Associate Professor of Animal Science; D.V.M., Ohio State University, 1972.
Wetzel, William E., Jr. (1967)
Professor of Administration; M.B.A., University of Chicago, 1967.
Weyrick, Richard R. (1970)
Associate Professor of Forest Resources; Ph.D., University of Minnesota, 1968.
Wharton, T. J. (1982)
Assistant Professor of Business Administration; Ph.D., University of Minnesota, 1985.
Wheeler, Douglas L. (1965)
Professor of History; Ph.D., Boston University, 1963.
White, Sally A. (1988)
Assistant Professor of Physical Education; Ph.D., University of New Mexico, 1988.
White, Susan O. (1969)
Associate Professor of Political Science; Ph.D., University of Minnesota, 1970.
Wible, James R. (1984)
Associate Professor of Economics; Ph.D., Pennsylvania State University, 1980.
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 of America, 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.
Willits, Robin D. (1965)
Associate Dean of the Whittemore School of Business and Economics and 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.
Wirth, Clifford J. (1981)
Associate Professor of Political Science; Ph.D., Southern Illinois University at Carbondale, 1976.
Wong, Edward H. (1978)
Professor of Chemistry; Ph.D., Harvard University, 1975.
Woodward, William R. (1975)
Associate Professor of Psychology; Ph.D., Yale University, 1975.
Wright, John J. (1970)
Professor of Physics; Ph.D., University of New Hampshire, 1969.
Wrightsman, Dwayne E. (1964)
Professor of Finance and Administration; Ph.D., Michigan State University, 1964.
Yount, John A. (1962–64, 1965)
Professor of English; M.F.A., University of Iowa, 1962.
Zia, Lee L. (1985)
Assistant Professor of Mathematics; Ph.D., Brown University, 1985.
Zsigray, Robert M. (1970)
Professor of Microbiology and Genetics; Ph.D., Georgetown University, 1969.

Committees of the Graduate School

Graduate Council

Raymond L. Erickson, Ph.D.
Dean of the Graduate School, Chairperson

Harry J. Richards, Ph.D.
Associate Dean of the Graduate School, Secretary

Roger L. Arnoldy, Ph.D.
Professor of Physics

Russell T. Carr, Ph.D.
Assistant Professor of Chemical Engineering

Grant L. Cioffi, Ph.D.
Associate Professor of Education

Charles E. Clark, Ph.D.
Professor of History

Ellen S. Cohn, Ph.D.
Associate Professor of Psychology

Clyde L. Denis, Ph.D.
Associate Professor of Biochemistry

Mark S. Deturk, Ph.D.
Assistant Professor of Music

Thomas L. Foxall, Ph.D.
Assistant Professor of Animal Science

Douglas E. Morris, Ph.D.
Associate Professor of Resource Economics

Lawrence W. O'Connell, Ph.D.
Associate Professor of Political Science

Three graduate students are appointed to this council each year.

Research Council

Kathryn B. Cataneo, M.B.A.
Director of Research Administration

Brigitte Bailey, Ph.D.
Assistant Professor of English

Robin Gorsky, Ph.D.
Assistant Professor of Health Management and Policy

James F. Haney, Ph.D.
Professor of Zoology

Andrew P. Laudano, Ph.D.
Assistant Professor of Biochemistry

W. Rudolf Seitz, Ph.D.
Professor of Chemistry

Jeffrey E. Sohl, Ph.D.
Associate Professor of Business Administration

One faculty member from the College of Life Sciences and Agriculture, one from the College of Engineering and Physical Sciences, and two from the College of Liberal Arts will be appointed in the fall. Two graduate students are appointed to the council each year.

Student Fellowship Selection Committee

David A. Gust, Ph.D.
Assistant Professor of Earth Sciences

Thomas C. Harrington, Ph.D.
Associate Professor of Plant Pathology

Jeffrey E. Sohl, Ph.D.
Associate Professor of Business Administration

Margaret W. Spears, Ed.D.
Associate Professor of Nursing

Rachel Trubowitz, Ph.D.
Assistant Professor of English

Faculty Fellowship Selection Committee

William M. Baum, Ph.D.
Professor of Psychology

Stephen N. Calculator, Ph.D.
Associate Professor of Communication Disorders

Jonathan Gutman, Ph.D.
Professor of Business Administration

L. Gordon Kraft, Ph.D.
Associate Professor of Electrical and Computer Engineering

Thomas D. Lee, Ph.D.
Associate Professor of Botany

Tuition Scholarship Selection Committee

Harry J. Richards, Ph.D.
Associate Dean of the Graduate School

Karen R. Johnson, Ed.D.
Associate Professor of Nursing

Fred R. Kaen, Ph.D.
Professor of Finance

Anthony R. Tagliaferro, Ph.D.
Associate Professor of Animal and Nutritional Sciences

Donovan H. Van Osdol, Ph.D.
Professor of Mathematics

Sally K. Ward, Ph.D.
Associate Professor of Sociology

Graduate School Calendar, 1989–1991*

1989–1990

Semester I

September 5, Tuesday
8 A.M. Classes begin.

September 11, Monday
Graduate student registration (day students).

September 11–14, Monday–Thursday
Graduate student registration (evening students).

September 15, Friday
Last day to register without $25 late registration fee.

September 18, Monday
Last day for graduate students to withdraw or drop courses and qualify for 3/4 tuition refund.

September 22, Friday
Last day to file Intent-to-Graduate form for December graduation without late fee.
Last day to add courses without dean's approval and $25 per course late add fee.
Last day to drop courses without $25 per course late drop fee.
Last day to choose credit/fail option.

September 30–October 1, Saturday–Sunday
Rosh Hashanah.**

October 5, Thursday
Last day for graduate students to withdraw or drop courses and qualify for 1/2 tuition refund.

October 6, Friday
Last day to drop courses without dean's approval and grade of W.
Last day to change to audit without dean's approval.
Last day to carry more than 16 credits without a surcharge.

October 9, Monday
Yom Kippur.**

October 20, Friday
Midsemester.
Last day to drop courses or withdraw from the University without academic liability (a grade of WP/WF).

November 1, Wednesday
Application forms for part-time tuition scholarships for Semester II are available at the Graduate School.

November 10, Friday
Veterans Day holiday observed—no classes.

November 22, Wednesday
Classes follow Friday schedule.
Last day for Ph.D. dissertation defense (December graduation).
Last day to file Intent-to-Graduate form for December graduation.

November 23–24, Thursday–Friday
Thanksgiving holiday—no classes.

November 27, Monday
8 A.M. Classes resume.

December 1, Friday
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Semester II, 1989–90.
Last day for completing application for part-time tuition scholarships for Semester II, 1989–90.

December 8, 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 14, Thursday
Last day of classes.
Last day for resolving incompletes from Semester II, 1988–89, and/or Summer 1989.

December 15, Friday
Reading Day.

December 16, Saturday
Commencement.

December 18–22, Monday–Friday
Final exams.

Semester II

January 24, Wednesday
8 A.M. Classes begin.

January 29, Monday
Graduate student registration (day students).

January 29–February 1, Monday–Thursday
Graduate student registration (evening students).

February 2, Friday
Last day to register without $25 late registration fee.

February 5, Monday
Last day for graduate students to withdraw or drop courses and qualify for 3/4 tuition refund.

February 9, Friday
Last day to add courses without dean's approval and $25 per course late add fee.
Last day to drop courses without $25 per course late drop fee.
Last day to file Intent-to-Graduate form for May graduation without late fee.
Last day to choose credit/fail option.

February 15, Thursday
Last day for completing application for admission to graduate study for Semester I, 1990–91, to insure consideration for financial assistance for the 1990–91 academic year.

February 22, Thursday
Last day to withdraw or drop courses and qualify for 1/2 tuition refund.

February 23, Friday
Last day to drop courses without dean's approval and grade of W.
Last day to change to audit without dean's approval.
Last day to carry more than 16 credits without a surcharge.

March 16, Friday
Midsemester.
Last day to drop courses or withdraw from the University without academic liability (grade of WP/WF).

March 19–23, Monday–Friday
Spring recess.

March 26, Monday
8 A.M. Classes resume.

April 2, Monday
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Summer Session 1990.
Application forms for part-time tuition scholarships for Semester I, 1990–91, are available at the Graduate School.

April 10, Tuesday
Passover.**

*The University reserves the right to modify this calendar subsequent to printing.

**These holidays, important to many members of the University community, are not University holidays, but they are listed here to facilitate planning of University events. Faculty and staff should be sensitive to the needs of those who celebrate these and other holidays.

April 13, Friday
Good Friday.**

April 27, Friday
Last day to file Intent-to-Graduate form for May graduation.

May 2, Wednesday
Last day for final Ph.D. dissertation defense (May graduation).

May 11, 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 15, Tuesday
Last day of classes.
Last day for resolving incompletes from Semester I, 1989–90.

May 16–17, Wednesday–Thursday
Reading days.

May 18–24, Friday–Thursday
Semester II final exams.

May 26, Saturday
Commencement.

Summer Session 1990

June 1, Friday
Last day to file Intent-to-Graduate form for September graduation.
Last day for completing application for part-time tuition scholarships for Semester I, 1990–91.

July 2, Monday
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Semester I, 1990–91.

July 25, Wednesday
Last day for final Ph.D. dissertation defense (September graduation).

August 3, Friday
Last day for presenting final copies of doctoral dissertation or master's thesis to the Graduate School for binding (September graduation).

1990–1991

Semester I

September 5, Wednesday
8 A.M. Classes begin.

September 10, Monday
Graduate student registration (day students).

September 10–13, Monday–Thursday
Graduate student registration (evening students).

September 14, Friday
Last day to register without $25 late registration fee.

September 17, Monday
Last day for graduate students to withdraw or drop courses and qualify for $^3/_4$ tuition refund.

September 20–21, Thursday–Friday
Rosh Hashanah.**

September 21, Friday
Last day to file Intent-to-Graduate form for December graduation without late fee.
Last day to add courses without dean's approval and $25 per course late add fee.
Last day to drop courses without $25 per course late drop fee.
Last day to choose credit/fail option.

September 29, Saturday
Yom Kippur.**

October 4, Thursday
Last day for graduate students to withdraw or drop courses and qualify for $^1/_2$ tuition refund.

October 5, Friday
Last day to drop courses without dean's approval and grade of W.
Last day to change to audit without dean's approval.
Last day to carry more than 16 credits without a surcharge.

October 19, Friday
Midsemester.
Last day to drop courses or withdraw from the University without academic liability (a grade of WP/WF).

November 1, Thursday
Application forms for part-time tuition scholarships for Semester II are available at the Graduate School.

November 12, Monday
Veterans Day holiday observed—no classes.

November 21, Wednesday
Classes hold Monday schedule.
Last day for Ph.D. dissertation defense (December graduation).
Last day to file Intent-to-Graduate form for December graduation.

November 22–23, Thursday–Friday
Thanksgiving holiday—no classes.

November 26, Monday
8 A.M. Classes resume.

December 3, Monday
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Semester II, 1990–91.
Last day for completing application for part-time tuition scholarships for Semester II, 1990–91.

December 7, 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, Thursday
Last day of classes.
Last day for resolving incompletes from Semester II, 1989–90, and/or Summer 1990.

December 14, Friday
Reading Day.

December 17–21, Monday–Friday
Final exams.

December 22, Saturday
Commencement (tentative).

Semester II

January 23, Wednesday
8 A.M. Classes begin.

January 28, Monday
Graduate student registration (day students).

January 28–31, Monday–Thursday
Graduate student registration (evening students).

February 1, Friday
Last day to register without $25 late registration fee.

February 4, Monday
Last day for graduate students to withdraw or drop courses and qualify for 3/4 tuition refund.

February 8, Friday
Last day to add courses without dean's approval and $25 per course late add fee.
Last day to drop courses without $25 per course late drop fee.
Last day to file Intent-to-Graduate form for May graduation without late fee.
Last day to choose credit/fail option.

February 15, Friday
Last day for completing application for admission to graduate study for Semester I, 1991–92, to insure consideration for financial assistance for the 1991–92 academic year.

February 21, Thursday
Last day to withdraw or drop courses and qualify for 1/2 tuition refund.

February 22, Friday
Last day to drop courses without dean's approval and grade of W.
Last day to change to audit without dean's approval.
Last day to carry more than 16 credits without a surcharge.

March 15, Friday
Midsemester.
Last day to drop courses or withdraw from the University without academic liability (grade of WP/WF).

March 18–22, Monday–Friday
Spring recess.

March 25, Monday
8 A.M. Classes resume.

March 29, Friday
Good Friday.**

March 30, Saturday
Passover.**

April 1, Monday
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Summer Session 1991.
Application forms for part-time tuition scholarships for Semester I, 1991–92, are available at the Graduate School.

April 26, Friday
Last day to file Intent-to-Graduate form for May graduation.

May 1, Wednesday
Last day for final Ph.D. dissertation defense (May graduation).

May 10, 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 14, Tuesday
Last day of classes.
Last day for resolving incompletes from Semester I, 1990–91.

May 15–16, Wednesday–Thursday
Reading days.

May 17–23, Friday–Thursday
Semester II final exams.

May 25, Saturday
Commencement.

Summer Session 1991

June 7, Friday
Last day to file Intent-to-Graduate form for September graduation.
Last day for completing application for part-time tuition scholarships for Semester I, 1991–92.

July 1, Monday
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Semester I, 1991–92.

July 31, Wednesday
Last day for final Ph.D. dissertation defense (September graduation).

August 2, Friday
Last day for presenting final copies of doctoral dissertation or master's thesis to the Graduate School for binding (September graduation).

Index

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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 Student Development Office, Huddleston Hall.

The University is in compliance with federal guaranteed student loan regulations and will supply information about the 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, but their chances for employment are enhanced if they have begun career planning early in their undergraduate days.

The University provides full information pertaining to the Family Educational Rights and Privacy Act of 1974 (the "Buckley Amendment") in the annual student handbook. Information also is available from the offices of the dean for student affairs and the vice president for academic affairs. The annual student handbook also contains University regulations and policies regarding student conduct.

Course descriptions and program descriptions may vary from the actual content or requirements because of advancements in the discipline or the active nature of academic planning and decision making. Accordingly, the University reserves the right to make whatever changes are deemed necessary in schedules, course content, requirements, academic programs (including their termination), calendar, tuition and fees, services, or any other aspect of the University's operations, giving whatever notice thereof is reasonable under the circumstances. Therefore, the provisions of this catalog are not an irrevocable contract between the students and the University. The University is also not responsible for failure to provide or for delay in providing expected services and/or facilities when such failure arises from causes beyond the reasonable control of the University.

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